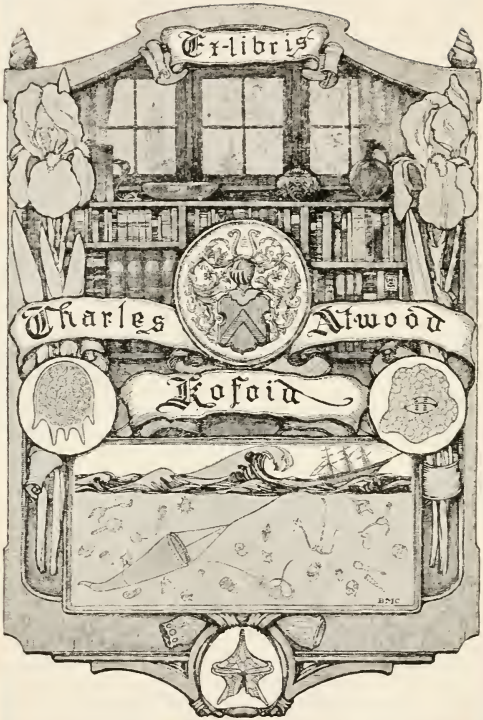

A

PRACTICAL TREATISE

ON

MANURES.

FROM THE

RECENT PUBLICATION OF THE BRITISH SOCIETY FOR THE DIFFUSION OF USEFUL KNOWLEDGE;

WITH

ADDITIONAL NOTES BY THE AMERICAN EDITOR.

PHILADELPHIA:
E. S. JONES & CO.
S. W. CORNER FOURTH & RACE STS.
1851.

PRINTED BY T. K. & P. G. COLLINS,
NO. 1 LODGE ALLEY.

PREFACE.

THE British Society for the Diffusion of Useful Knowledge, was established about the year 1825, for the purpose of furnishing a series of books in various branches of science, better adapted to the wants of the public than the old treatises, or the compilations by authors but little acquainted with the subjects which they endeavored to discuss.

The Society published a series of maps, and various treatises upon Natural Philosophy, History, Mathematics, and other subjects. To these treatises the general title of *Library of Useful Knowledge* was given, and in the course of their publication it was found expedient to issue works of a different character, especially adapted to the agricultural interests, and to this portion of the "Library" the title of "*The Farmer's Series*" was given. Among the works in this department were published Youatt's works on the *Horse—Cattle—Sheep*—and the *Dog;* treatises on *British Husbandry*, *Flemish Husbandry*, and the present treatise on *Manures*, all of which acquired a wide-spread reputation.

The subject to which this volume is devoted is an

important one to farmers and gardeners, as much of their success must depend upon their acquaintance with the various fertilizing agents, and the modes and circumstances of their employment.

Judicious manuring alone will prevent farms from gradually deteriorating, or wearing out to such an extent as to be unfit for cultivation. Deterioration under an improper mode of cropping and manuring, may proceed so slowly that it cannot be detected except by keeping regular farm accounts, and comparing the produce of the same field at distant intervals, and under the same crop.

In the Report of the Massachusetts Commissioners, in 1851, on the subject of an Agricultural School, the following facts are stated:

'Already the exhaustive process of perpetual cropping has travelled over the once fertile lands of New England, and in its desolating march is wending its way over the fair fields of New York, Ohio, and on to the Far West. Under the influence of this system of cultivation, the crops of wheat in these States have receded from an average of twenty-two bushels to fourteen bushels, or less, per acre; and the same remark will apply to other crops, in like ratio of reduction.

"From this sad, but common error, Europe is just recovering; and, under the influence of her agricultural schools, now scattered all over the continent, and of scientific cultivation, her crop of wheat in many parts has advanced from sixteen bushels to an average of over thirty bushels per acre; and a similar increase has taken place in other crops. Wonders have also been achieved in

reclaiming waste lands, and in converting those which were *barren and worthless*, into rich and productive farms."

These considerations are of the utmost importance to those who wish to improve their land, or to keep it from becoming worse. It is worthy of the attention not only of the proprietor of the soil, but of legislators, and all who wish to transmit an undiminished legacy to their posterity, and particularly to the proprietors of small farms, these being more under control,—capable of being better worked,—and having many advantages over such extensive tracts as are but half worked and half manured—producing limited crops at great expense. The same remark may be extended to gardens, particularly such as are cultivated for the purpose of raising vegetables for profit.

Manure comprehends all animal, vegetable, and mineral substances, which promote the growth of vegetation; and the number of these is so great, that at first view the reader of a treatise on the subject is likely to be confounded by a first attempt to make a selection from them. But he will soon find the list diminished by the circumstances in which he is placed. The use of fish or sea-weed, for example, is restricted to those who live within reach of them; green sand, or green sand marl, (which is a valuable fertilizer on account of its potash, iron, and in some cases, lime,) is mostly confined in its use to those parts of New Jersey, Maryland, Delaware, and Virginia, which produce it; and those who do not live near large towns cannot readily procure the offals derived from certain manufactories. When sand cannot be pro-

cured to improve a hard clay soil, the vicinity of saw-mills will often supply a substitute in saw dust, but as some is rather acid, it should be corrected by composting with the aid of lime, or by not using it until it has been exposed some time to the weather.

A reference to the abstract of the *Contents* will give the reader a better idea of the scope of this Treatise, than any account which can be given within the limits of a preface.

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CHAPTER I.

ON THE NATURE AND PROPERTIES OF MANURE.

Though manuring has been generally practised wherever cultivation has been attended to, its principles are still but vaguely understood, and the best adaptation to various soils of the different articles of which it consists is far from being accurately ascertained. Yet, although it be true that chemical research into the component parts of soils and manures has not reached any positive conclusion respecting their effects upon the growth of vegetables, still it is certain that the principles on which they are nourished depend altogether upon chemistry; and agriculture, in its modern improved state, has led with considerable precision to a knowledge of those laws of vegetation by which we are enabled to ameliorate the land, and to increase the quantity, as well as to improve the quality of its productions. The farmer, who applies a peculiar species of manure, which has been found beneficial to his ground, being himself ignorant of chemistry, only follows the practice of his predecessors or neighbors; but while he sneers at the theorist who would direct his attention to the study of the first principles of his art, both he, and those whom he follows, were probably originally indebted for that practice to the observations of men of science.

No one who is at all conversant with the subject of manure can be ignorant that, notwithstanding the management of intelligent husbandmen, a great want of knowledge prevails among the common run of farmers regarding the best modes of its preparation and application. In making this remark, we do not, however, mean to allude to the deficiency of chemical knowledge, which, however valuable, is but little within the scope of the mere farmer; nor do we intend to

convey instruction by abstruse disquisitions or fine-spun theories, respecting the food of plants, or the manner in which they are nourished; but we think that a few remarks on the nature and properties of manure may properly precede the practical details of its application to the soil, and will not be unfavorably received even by men whose superior experience does not seem to need such information.

Distinction of Manures.—Cultivation consists of two distinct objects, of which one comprehends the *mechanical labor* bestowed upon the soil, and the other is composed of the *chemical application of manures*, which either directly communicate the nutriment which they convey to plants, or which assist vegetation by promoting the active powers of the soil, and of those substances with which it may be combined. It is well known that, when plants are continually reaped from off the land, the soil in time becomes exhausted, and then it becomes necessary to restore the waste which has taken place by a supply of matter either affording direct nourishment or stimulating the power of the soil. These substances, being mixed with the ground by the action of the plough, are termed manure.

All *vegetable* and *animal substances* which become decomposed, or putrid, contain the necessary elements for the reproduction of the plants which we cultivate, provided they be duly mixed in just proportions with the soil, and that they be reduced to no more than a certain degree of putrefaction, by which they can be applied to the land in a beneficial state as manure. It is for the most part composed of straw which has served as litter to animals, and which, being impregnated with their dung and urine, and thrown into heaps, is thus suffered to heat, ferment, and rot. The mould produced by the decomposition of vegetables appears, however, to act more slowly, but yet more durably, as the aliment of plants, than that which has been produced by passing through the bodies of animals, which latter not only operates more promptly as nourishment, but also acts directly upon the sap, to the manifest vigour of their growth. The great object of these manures should be to make them afford as much soluble matter as possible to the roots of the plant, and that in a gradual manner, so that it may be entirely consumed in forming the sap. Those substances which in their nature partake of mucilaginous, gelatinous, or saccharine matter, of oily and extractive fluids, and of solutions of carbonic acid in water, all

contain in their unchanged states most of the principles which conduce to the life of plants; but there are few cases in which they can be applied to their production in a pure form, for vegetable manures in general contain a portion of fibrous, woody, and insoluble matter, which must undergo some chemical change before they can be converted to the purposes of vegetation.

Fossil or mineral manures, though not containing nutritive matter,* yet materially assist in the development of the powers of the soil, and in the decomposition of other substances contained in it, which they combine in a manner which enables plants to appropriate the kind of nourishment best adapted to their growth, and thus promotes vegetation. As the soil, however, is of infinite variety, so the nature of these manures requires more care and discrimination in their application than those composed of vegetable and animal matter; for an excess of the latter can only occasion immediate rankness in the present crop, while an undue proportion of the former may for a long time be productive of very serious injury to the land.

The action of manure upon the soil is commonly expressed by saying, 'that it fertilizes the land;' and that is generally deemed sufficiently intelligible to common comprehension; but it is of great importance to both the theory and the practice of agriculture to distinguish the properties and the mode of application by which each of these manures is made productive of that effect; and it is only by means of an acquaintance with their composition that we can form any safe conclusion regarding their respective merits. Besides the distinction already drawn between the vegetable, animal, and mineral substances, manures of the same kind in some cases act differently,—in the one resisting putrefaction, and in the other promoting it. Among the former are several species of salts, formed from the ashes of burnt vegetables, the dung of fowls, that of horses in some states of preparation, and quicklime. Among the latter are certain salts found in calcareous earths; lime, which, after having been burnt and allowed to rest during a few months, converts all the putrescible matter contained in the soil into a sort of mucilage; and horse-litter, which, when in a forward state, becomes a stimulant from the salts contained in it, and thus also promotes putrefaction. It must also be observed, that several of these manures acquire different properties

* Lime, however, though not considered nutritive, yet forms, in very minute portions, a component part of plants and the bones of animals.

when combined with other substances, and in other stages of preparation, from those of which they were possessed in a simple state.

The process of fermentation likewise requires extreme care, and is an object very imperfectly understood. It is often confounded with that ebullition, or hissing noise, which may be noticed when limestone or other alkaline matter is mixed with vinegar or other acids; but this effervescence is merely occasioned by the escape of fixed air, (carbonic acid gas) and though the word 'fermentation' may be retained in compliance with common usage, it has nothing in unison with those operations which are properly termed the *vinous*, the *acetous*, and the *putrefactive fermentations*.

Of these, the first causes the sweet materials to become spirituous, though the latter quality applies more particularly to the juices of fruits; the second occasions a sourness, which in liquids produces vinegar; and the third is productive of putrefaction.

During the process of fermentation, as applied to manure, it heats, after more or less time, according to its contents, and at last it is converted into mucilage and salts. The latter part of this operation is the most important, for it requires great care to ascertain, by mixing the whole mass well together, that every part of it is in the same state of fermentation, lest some parts of it should reach the last stage—which produces salts—before the other portion has become mucilaginous,—an accident which frequently happens when lime is laid among dung without being well mixed throughout the heap, by which much of its benefit is lost, as it acts as a stimulant, and becomes hurtful if not used in a very small proportion.

The materials of which the first-mentioned of these manures are chiefly composed, are stable-dung and litter, urine, night-soil, and all weeds or other vegetable substances which can be converted into muck, together with the putrid remains of animals and fish—which may be all classed under the common name of *putrescent manures*.

Then chalk, lime, marl, gypsum, shells, ashes, soapers' waste, and burnt clay, which, being fossil, or of the nature of fossil substances, fall under the denomination of *mineral manures*.

And lastly, green crops ploughed down, as well as the various articles made use of as top-dressings and composts, which may be generally designated as *miscellaneous manures*.

These will become the subject of separate chapters; but it

is not proposed to enter into any philosophical discussion regarding their powers, the consideration of which will be confined to a practical view of their nature and operation. The farmer who has a large portion of them at command will find in their alternate and judicious employment the certain means of increasing the usual products of the soil; and his success, as a husbandman, will doubtless be in proportion to his intelligence, and to the attention bestowed upon its cultivation. The importance to be attached to an acquaintance with the principles of vegetation, and the application of manures, cannot therefore but be sensibly felt by every man who sets a due value either upon his character for ability in his profession, or upon his pecuniary interest; and, with the intention of facilitating its study, we add a brief explanation of the common terms employed in this branch of chemistry. Our object, however, being merely to be useful to persons who are strangers to that science, and being aware of the prejudice already existing against it in the minds of those who are uninformed of its value, we have abstained from any thing beyond a slight sketch, or from employing any other than those phrases which may be rendered easily intelligible to persons of the plainest education and understanding.

CHAPTER II.

ON PUTRESCENT MANURES.—FARM-YARD DUNG.

Putrescent manures, as we have already seen, consist of all animal and vegetable substances which can be reduced through decomposition, fermentation, and putrefaction, into such a state as will render them fit to assist the melioration of the land, and to forward the purposes of vegetation. When combined, they form a saponaceous, solid mass of great nutritive power, well known to farmers under the common term of 'muck;' which, although a seemingly uncouth expression, conveys an idea distinct from that which is meant by dung. Of these, the most generally useful are composed of the excrements of animals; for that which passes through them is not composed alone of the residue of their food, but also of certain secretions of other matter in the intestinal canal; so that

the dung, even of those which are supported entirely on vegetables, partakes more of an animal than of a vegetable nature. The food on which they are supported, and their state of flesh, also make an essential difference in the quality of the manure. If the stomach of an animal be filled with provision which contains but little nutriment, and which is composed of fibrous matter which it is difficult to decompose—for instance, straw alone, without grain—this will pass through the intestines in almost the same state as it was eaten. The dung will contain less of that secretion which belongs to animals whose flesh has not been deprived of its nourishing juices; though even this small quantity serves to give the straw a stimulus to putrefaction. But the excrement of animals which have been supported upon nutritive food—as corn and pulse, or the oleaginous seeds of rape and linseed, though given in the shape of cake—and which are thus maintained in high condition, imbibes much of that property to which we have alluded, which thereby yields a more fertilizing manure than that furnished by lean stock. This, indeed, is strikingly exemplified by the difference observable in that produced by stall-fed cattle, and those kept in the straw yard; and there can be no doubt that the fatter the animal, the richer will be its dung.*

It has been thought that the dung of ruminant animals—oxen and sheep—when pastured, is preferable to that of horses, also kept at grass, which is supposed to be owing to the greater quantity of animal juices secreted with their food in the act of chewing; but the fact requires to be established by a more minute and critical analysis of its properties. All animal manure, however, partakes in its fertilizing properties of the richness of the food by which it has been created; yet experience proves that its immediate powers are in several instances widely different. Thus the ordure of a man and that of a dog, though fed upon the same food, is so wholly distinct in its effects, that the excrement of the latter is used instead of bark in the process of tanning goat-skins for the production of morocco leather. Pigeon's dung, too, is hotter than that of other fowls,† though both are fed alike; and it is said that

* It is stated in the Norfolk Report, that 10 loads of dung from cattle fed upon oil-cake, have been found to answer as well as 16 from beasts fed upon turnips.—p. 420.

† By an experiment stated in the Agricultural Magazine, it was found that the dung of hens was more effectual than that of ducks; while that of geese was scarcely perceptible as manure.

a celebrated foreign chemist—M. Vauquelin—has not only lately discovered a very remarkable difference between the dung of cocks and hens, but that there also exists a sensible distinction between that of hens which lay, and of those which do not produce eggs! However deserving those researches may be of inquiry, and however important they may hereafter prove, if followed up with regard to the larger animals, it would yet be difficult, and perhaps, under all circumstances, unnecessary, to state the differences of the comparative character and value of these and various other putrescible bodies—such as fish, spoiled flesh, and many other substances, which, though all, no doubt, useful to vegetation, when they can be procured on such terms as that the farmer finds they can be profitably applied to his purpose, are yet seldom found in such abundance as to require a separate account of the properties of each. We therefore do not deem it necessary to pursue that portion of the subject farther, and shall accordingly proceed to the consideration of that compound of vegetable and animal substance so well known under the title of

Farm-yard Manure.—This must ever be ranked in the first class; and when improved yards have been constructed for the soiling of cattle, and attention has been paid to the quality as well as the increase of their dung, the manure thus produced becomes of inestimable value. No husbandman can carry on his business without it, and every one who attends for a moment to the difficulty of procuring a sufficient quantity of dung, as well as of preparing what is got, will acknowledge, that however imperfectly the subject be understood, none is more deserving of serious investigation; yet even the most superficial observer on the common state of culture can hardly fail to remark, that the evident inattention to its management is such as would almost lead to the supposition that it is not worth the pains of the farmer's care. Nothing is more common than to see large heaps of manure thrown out from the stables and feeding-sheds, and exposed in that state to the weather, without any regard to its being laid up in a regular and careful manner, secured from evaporation, or carefully mixed in different proportions according to its various qualities; yet these proportions are severally of a very distinct and important nature.

When *horse-dung* is sufficiently moist, and is exposed to the action of the air, it speedily enters into a state of fermentation, which is necessary to mix and assimilate its watery,

oily and saline parts; but if care be not taken in that process, it exhales so much heat that it soon becomes dried up, its volatile particles are evaporated, and it easily crumbles. If the parts of which it is composed are not also so compactly heaped as to exclude the air, they become likewise unequally decomposed, grow mouldy, and the whole mass is thus deprived of much of its fertilizing power. If, however, the natural moisture be retained, or it be regularly and moderately wetted, it acquires almost the consistence of a paste, or that state which is called *spit-dung;* and if it be laid upon the land before it is entirely decomposed, its effects upon vegetation are prompt and powerful; which is partly to be attributed to the heat which is developed anew, when, after being ploughed under the soil, its decomposition is completed. This occasions it to act with singular efficacy upon lands which are cold and clayey, the faults of which it tends greatly to correct, and the soil is much benefited. It also greatly improves land which abounds in vegetable mould, because the ammonia contained in the manure favours its decomposition.

When completely decomposed, and thus reduced to the condition of *rotten dung*, it is much lessened in quantity, but that residue contains the essential part of its substance, which is highly favourable to vegetation on land of every kind with which it is incorporated. In this state, however, it is often productive of bad effects upon dry, sandy, chalky, or other light and calcareous soils; for there it stimulates the plants too powerfully at the first period of their growth, so that when the action of the dung has ceased, vegetation becomes languid; in corn crops great bulk of straw is produced, but the grain is apt to be deficient. It also less durable, because it is consumed by the excess of its own fermentation, and its powers being thus exhausted, it has but little effect upon the future crops on such land.

The *dung of hornèd cattle* also soon ferments when it is collected into a heap, and is only moistened by its own humidity; but this process is slower than in the dung of horses, because it is not so much exposed to the same internal heat, in consequence of which the evaporation is less, and being ordinarily voided in a very moist state, it does not require to be wetted. Neither is it subject to crumble; but it rather becomes a mass of unctuous substance, which it retains until its moisture is entirely exhausted, when it assumes the appearance of dried peat, or turf, and, when not well mixed with the earth, it is

found in the land in clods sometimes so long as two or three years after it has been laid on. Its effect upon the soil is slower than that of horse-dung: it has been also considered more durable; but, as we have already observed, this latter effect must in a great measure depend upon the nature of the food by which it has been produced. Whatever may be the degree of fermentation at which it has arrived, it does not seem to occasion any perceptible heat when laid upon the land; for which reason it is best adapted to dry and warm soils. Thus, upon sands and gravels, which, from their nature are apt to be hot, its cooling qualities counteract that effect, and upon such land it has been found of infinite service; but upon strong clays, it appears to be nearly inoperative if buried under the ground, and not exposed to contact with the atmosphere by repeated ploughings. When used alone, it has, however, been considered, in most instances, as nearly worthless;* and the most advantageous mode of employing it is to form it into a compost with the other contents of the farm-yard. It has also been thought that the dung of milch cows is inferior to that of oxen; but this can only be attributed to their yield of milk, which probably deprives it of some portion of its richness, and when they are dried off and fattened, there is no perceptible difference.

Sheep-dung decomposes quickly when it is moist and compactly heaped together; but when dry and dispersed, its decomposition is slow and imperfect. Its effect upon the soil is soon dissipated, and is generally exhausted after a second crop. Much ammonia is disengaged from the excrements, and more especially from the urine of sheep, and this renders their manure particularly valuable upon soils which contain insoluble mould. That which is found on the floor of sheep-cotes, when left undisturbed, is of two qualities—that of the upper layer, which is occasionally renewed with fresh litter, being strawy, dry, and not fermented; while, on the contrary, that of the under layer is moist, clammy, and fit for use. When the dung is removed, care should therefore be taken to mix both layers, so that they may be equally decomposed; and, when

* An instance is mentioned in the Essex Report of 15 acres having been manured for beans—6 with horse-dung, and 9 with dung from the cow-yard; and that the 6 acres produced far more than the 9.—Vol. ii. p. 230. In an experiment, made near Grantham, in Lincolnshire, on a poor dry soil, the manure from a horse-yard, and that from a yard where neat cattle were wintered, were used separately for turnips, and the former was found to have greatly the advantage.

thus prepared, the manure should be spread sparingly upon the land, if used for corn crops, or it is apt to make them run to straw: but upon cold, sour soils, this unfermented dung may be used in large quantities with considerable advantage.

Swine's dung is, by many persons, considered as the richest of all animal manure, except night-soil; while others view it as being of a cold description. It is of a soapy nature, is slow of fermentation, and when laid upon very cold soils, it should be mixed with horse-dung; for although its stimulating powers upon vegetation are very great, yet of itself it does not heat sufficiently to destroy the seeds of weeds. Mr. Malcolm, indeed, says that 'he has often seen it applied to land consisting of a shallow loam upon a fine gravel, and land of a sandy nature, in which soils it has filled the ground with weeds, particularly the May-weed; and in a hot season a crop of barley has been entirely burnt up.' The loss of the barley-crop may however be partly attributed to the dryness of the season, and the foulness of the land to the want of good culture. Any ill-managed manure may be full of the seeds of weeds, and therefore they may be sown with it. But it is a futile charge against any species of manure to say that it encourages weeds; for it is evident that, if the land were clean, the same stimulus which acts upon them would be applied, in like manner, to the crop of grain intended to be cultivated. We do not hear such complaints from farmers who drill their corn and effectually hoe the intervals. When, therefore, it is considered that vast quantities of weeds are usually cast into the pigsties, many of them bearing seeds fully ripened, it will be evident that caution is requisite to destroy their vegetative powers before this manure is laid upon arable lands. On this account, nothing can be more proper than to form a dunghill by a mixture from the pigsties and the stable. The well-known property of horse-dung to ferment freely will completely effect what is required, and the compost will be found most valuable. The worth of manure from the pigsties will however depend much upon the mode in which it is prepared. If the litter be often renewed, and it be kept dry, either by sloping gutters, or by means of holes bored in the planking of the floor, then the straw will retain but a small quantity of the urine, and will be productive of little other effect than if it were merely rotten. But if it be allowed to become saturated with the urine, by stopping those drains, and care be taken to preserve the litter in a proper state for decomposition, it will ferment rapidly, lose its

coldness, and become a very strong manure. The necessity of cleanliness in the stye is a consideration apart, which belongs more properly to the future subject of the treatment of hogs.

A full stock of swine effect very great service when permitted to run loose in farm-yards where much straw is used; they highly enrich it by their dung and urine, and mechanically promote the decomposition of its woody fibre by the manner in which they constantly work among it—breaking it to pieces, and thus rendering it more manageable on arable land, even when in the earliest stage of decomposition. They have, indeed, been strongly recommended by Mr. Blaikie, who advises, in his very judicious essay on farm-yard manure, 'that those industrious and useful animals should be attracted to the yard, because they rout the straw and dung about in search of grains of corn, bits of Swedish turnips, and other food, by which means the manure becomes more intimately mixed, and is proportionally increased in value.' Great inconvenience has, however, arisen from allowing them to run about the buildings, through the difficulty of preventing them from getting out and damaging crops and fences; wherefore many farmers have adopted the plan of having paled yards, with open sheds, for the sole purpose of keeping their store pigs.

Urine, although essentially composed of water, yet contains much of the elements of vegetation in a state of solution peculiar to itself, and is combined, through the secretion of the vessels, with carbon and saline matter, from which it derives its nutritive properties, as well as with a large portion of ammonia, to which it owes the peculiar smell by which it is distinguished. The various species of urine from different animals differ in their constituents, and the urine of the same animals alters when any material change is made in the nature of the food.* The analysis of its composition has shown it to

* By experiments made by Mr. Brande on 100 parts of the urine of cows, and by Fourcroy and Vauquelin of horses, the following proportions were found in each, viz.:—

COWS.		HORSES.	
Phosphate of lime	3	Carbonate of lime	11
Muriates of potassa and ammonia	15	do. of soda	9
Sulphate of potassa	6	Benzoate of do.	24
Carbonate of potassa and ammonia	4	Muriate of potassa	9
Urea	4	Urea	7
Water	65	Water and mucilage	40

There is, therefore, more alkaline salts in the urine of horses, which consequently possesses greater fertilizing powers than that of oxen; and it has

be most favourable to vegetation when mixed with other excrement, and with straw, or similar substances, because it occasions their combination, and contributes to their more perfect decomposition, by which they are converted into the species of manure of which we are treating; and although we confine that manure to straw, or haulm, and to the dung of horses and oxen, both as that of which it is the most generally composed, and as folding and night-soil will be separately considered, it yet includes every other kind of ordure.(*a*)

Straw of all kinds, or similar dry vegetable matter, when used as litter, is well known to form a principal ingredient in the composition of farm-yard manure; not perhaps so much by the nourishment which it is of itself capable of imparting to the soil, as from the value which it acquires by its absorption of urine, as well as by combining with dung in its different stages of decomposition, and imparting consistence to the whole mass, which is then carried more regularly through the processes of fermentation and putrefaction, by which it is rendered fit for the purpose for which it is wanted. Nothing, in fact, can be better adapted for the mixture than straw; for it would rot with difficulty and imperfectly but for the dung, which brings an accession of the richest materials to the heap, and there can be no doubt that, when thus combined, it forms the best and the most generally useful of all manures for every kind of land. All the various sorts of straw and haulm answer the purposes of litter, though opinions vary respecting its value for that use; some contending that rye straw is the best, while others insist, with more apparent reason, that the

been not inaptly demanded, whether, if these ingredients could be procured cheap, and rendered soluble in water, they might not be so prepared as to become valuable for saturating dung-hills, or for application in its liquid state?—*Leicester Report*, note, p. 190. Human urine contains a greater variety of constituents than any other species, and differs in comparison according to the state of the body. (*a*) [One hundred parts of the urine of a healthy man are estimated to be equal to 1300 parts of fresh horse-dung, and to 600 parts of fresh cow-dung.] All urine is liable to undergo putrefaction very suddenly; but that of carnivorous animals more rapidly than that of granivorous animals. The pot-ash and pearl-ash of commerce are carbonates of *potassa* of different degrees of purity.—*Sir H. Davy, Elem. of Agric. Chem.*, p. 256. See also the Analysis, by *Berzelius*, and by *W. Henry, M. D., F. R. S., Elem. of Exper. Chem.*, 10th edit., vol. ii. chap. xiii. sect. v.

The white globe turnip not only yields a larger quantity of urine, but its effect as a manure upon any crop is less apparent than that of either the yellow Aberdeen or the Swedish. That produced by cut-grass is comparatively weak: but the liquid manure from the refuse of distilleries, such as grains and dreg, has been found good.—*Quart. Jour. of Agric.*, No. xix. p. 96.

straw of wheat absorbs more moisture, and it is supposed to be equal to three times its weight after it has been saturated with urine.

It was the system of Bakewell, during a part of his life, to convert the whole of the straw into food for his stock, and it was also the opinion of many of his supporters, that this mode of consuming straw would not only tend considerably to increase the number of black cattle, but also to improve the quality of manure; for they argued—'that straw is not alone thus rendered fit for the support of live-stock, but that, by being digested and passed through their bodies, it must become a much more highly enriched manure than in the ordinary way of treading and rotting.' Bakewell, however, altered his opinion at a later period of his life, and the doctrine is certainly questionable; for although it be true that a part of the straw, when eaten, assists the fermentation of the remainder, yet, when partly used as a litter, it at once absorbs the urine, which is, perhaps, of more value, as manure, than straw which has been merely masticated and digested, without being combined with richer food; and it is yet very doubtful whether, if all the straw in the kingdom were to be passed through the intestines of animals, the manure made from their dung would not be thereby reduced both in quality and quantity. The practice differs in various counties: in some parts of Yorkshire, and other places, a farmer commonly makes his cattle eat almost every particle of straw, leaving scarcely any to litter their stalls; while in Norfolk, they convert nearly the whole into muck, and no system is considered more impoverishing to land, than that of applying the straw as food instead of treading it into dung.

The medium course is doubtless the most to be approved when it can be conveniently carried into effect; but there are many farms which either do not produce turnips, or only sufficient for their sheep, by which they are eaten off upon the land, and corn or oil-cake being too expensive for store and working stock, they must necessarily be chiefly kept upon straw. It is therefore profusely used for store-cattle in most yards, yet, by having abundance, they pick out the best and leave the refuse for litter; it is only necessary to supply it fresh, with a moderate quantity of turnips, or any succulent root, to promote the secretion of urine, and the manure thus produced will be found of excellent quality; but if they be

wholly fed on straw, although the farmer may have a large dunghill, it will be found to be of comparatively little value.

It has been thought that cattle getting wholly straw, or other dry forage, for both food and litter, may consume nearly three-fifths of it as food, and there would still remain a useful mixture of dung and straw for manure. When they are supplied, as young or keeping stock, with turnips to keep them merely in condition, the manure will be in good order when they eat about one-half of the straw, and leave the other half as litter. If, again, they are being fattened on turnips, or fed on distiller's wash, grains, or upon other food, which produces their dung with much urine, they would then require to have at least three-fifths, if not a still larger quantity of straw left for litter. These proportions will, in such instances, be generally found to produce manure of a good description; but when beasts are fatting upon steamed potatoes and oil-cake, or other provender which occasions costiveness, or does not occasion a free discharge of urine, it may sometimes be necessary to moisten the dung-heap, by which means any quantity of straw may be rotted, and, with a comparatively small proportion of dung, may be converted into manure. Mr. Marshall mentions having tried the effects of moisture in some experiments on his own farm upon heaps of dung which had lain until much of it had become mouldy, one of which he watered, bringing the outward and dry parts into the middle of the pile, and drenching it well with the drainage of the yard; it was then carefully turned over, breaking every lump and mixing all its parts, then finally wetting the surface, and clapping it smooth and close with the back of the shovel to keep in the heat. It began to work on the second or third day, after which the mouldiness disappeared, and it was converted into comparatively rich, black, and rotten dung; and other similar trials were equally successful. The utility of that point of management is, in fact, unquestionable; the trouble is not worth mentioning; but were it greater, and that any thing is to be thereby gained in the quality of the dung, that can form no sufficient excuse for its omission, for, if it be of any value, it cannot be too good, and the experience of kitchen gardeners, who are well known to use great care in the preparation of dung, and to profit accordingly, should operate as a hint to farmers to use similar means.

There can be no doubt that the *haulm of beans and peas* produces more nutritive food than straw. When the former

is well broken by thrashing, it also forms a very tolerable litter, for which purpose it is much used in most parts of England, though in some places it is wholly laid, as if of no further value, in the bottom of the straw-yard, and pea-haulm is more generally employed in cart-stables for racking up the horses, and for sheep, which are very fond of it. In Scotland, however, the haulm of neither is used for litter, unless it has been spoiled by the weather, or has become sticky by the crop having been allowed to stand too long upon the ground before being cut, and it is there, more prudently, kept for the purposes of feeding.

Yards and Sheds.—It may be observed that the former are often so full of large holes as to leave them in many parts saturated with water, or their bottoms are either so porous, or else situated on such declivities as to drain off the entire moisture; in either of which cases the loss cannot but be very considerable to the farmer, although he may be ignorant of what he is daily losing, because it does not go out of his pocket in the shape of hard cash. Whenever a yard is circumstanced in either of the ways just mentioned, all the inequalities should be levelled, the bottom should be rendered sound and water-tight, and if either any declivity in the yard, or the situation of the buildings, occasions the stock confined in it to give a preference to one part over another, the litter should, in that case, be occasionally removed, in order that it may be equally spread over every part, and the position of the feeding cribs should be altered; for although our opinion inclines to that form which prefers a gentle slope to the centre of the yard, and the dung should be kept moist, yet it should not be suffered to become drenched with rain. If this be not attended to, the excess of wet will prevent the bottom of the heap from rotting; and if it be not regularly spread to a nearly equal depth, the fermentation will be carried on imperfectly, which will occasion those parts where it may have been too much raised to contract an excess of heat, from which they become what is termed *fire-fanged.* This especially applies to stable-dung, which, if allowed to accumulate in heaps without being properly mixed, acquires a mouldy smell, and loses so considerable a portion of the best part of its substance, that its diminution in value has been estimated by a very experienced agriculturist at not less than from 50 to 75 per cent.

Acting upon the principle of preserving dung, and rendering it immediately available, it has been recommended to construct

cattle-sheds, sufficiently capacious to allow a space rather broader than the platform upon which the beasts lie, but sunk somewhat lower, and to which the dung may be swept up. When thus covered, its decomposition is effected by the aid of its natural humidity, and if left for three or four weeks, its fermentation will be completed. The time at which it is subject to the greatest evaporation of its volatile particles will then be past, and it may be immediately carried upon the land. Its quantity will be certainly less decreased, and its quality better preserved, by being left under the cover of a shed, and there will also be a saving of labour in its removal; but not alone should the neatness and order of stalls be taken into consideration, but also the cost. Theoretic people, when advocating new schemes in husbandry, rarely give themselves the trouble of calculating any thing beyond their effects upon crops, without due regard to the expense of their cultivation; and if in this case the additional charges of the erection of the building, together with the repairs rendered necessary by the steam arising from the dung, were to be reckoned, they would probably be found to exceed the value of the proposed advantages of the plan. While the opinions of practical men on this and other modes of management are so unsettled and discordant, those cannot be deemed imprudent who adopt that side of the question which is the most consistent with economy. We will, however, admit that it would be an improvement if reservoirs for the drainage of yards were so constructed that their contents might be pumped up, and sprinkled over horse-litter, whenever its too great dryness occasions any danger of its becoming fire-fanged; for, whether in the yard, or carried out to the dung-heap, it should never be allowed to become so dry as to lose the power of fermentation; and if there should be no portion of it sufficiently moist to allow of the dry part being mixed up with it, so as to prevent that risk, it should be sprinkled regularly when shook up. A watering-pot with a large rose will be found to answer the purpose.

There can, indeed, be nothing more appropriate to the subject than the observation of Sir Humphry Davy, 'that when dung is to be preserved for any time, the *site of the dung-hill* is of great importance. In order to have it defended from the sun, it should be laid under a shed, or on the north side of a wall. To make a complete dung-hill repository, the floor should be paved with flat stones, a little inclination being made from each side towards the centre: in the centre there

should be drains connected with a small well, furnished with a pump, by which any fluid matter may be collected for the use of the land; for it too often happens that the drainings of the dung-hill are entirely wasted.' A sheltered spot of ground ought always to be chosen for the site; and although some after-trouble may be saved by depositing it, in the first instance, in the field to which it is to be applied, it is yet, in most cases, found more convenient to place it in some secluded situation near the homestead. 'There it is always under the farmer's eye, and a greater quantity can be moved in a shorter time than when its position is more distant. Besides, in wet weather the roads are not only cut up by driving to a distance, but the field on which it is made may be poached and considerably injured.'

Should there be no perfect and permanent site formed for a complete dung-hill repository, accompanied by a well and pump, as above recommended, yet the space intended for the reception of any common dung-heap should be slightly hollowed out, leaving one side rather deeper than the other, and cutting a narrow drain through that side, from which any superfluous moisture may be carried off to a yet lower excavation, where it may be received upon a bed of loose mould, or among articles of slow decay, as cabbage-stalks, the tough haulm of over-ripe beans, or any similar substances. It should also be surrounded with a mound dug out from the hollowed place, to prevent water from running into it, and, if that be prevented, no danger need be apprehended from any excess of moisture, except in times of very heavy rain, which, in such seasons, can also be much guarded against by sloping the sides. Were roofs constructed over dung-hills, to protect them from the rays of the sun, as well as from the rain, there can be no doubt that, if roughly put up, at little cost, they would prove advantageous; but the benefit should be always closely estimated, in order that it may not exceed the charge: perhaps a contrivance of the kind might be made with spare branches of trees, and worn-out hurdles, supported by posts formed out of any otherwise useless timber.

Preservation of dung.—Practice differs in the modes adopted respecting the *care of farm-yard dung*. Most farmers allow it to accumulate for a long time in the yard, adding fresh straw regularly to the heap, from an impression that the bottom, if unremoved, will become the richest part, and that its accumulation imparts a certain degree of warmth to

the cattle; while some recommend 'that it should be cleaned out once a month at least, not only to sweeten the yard, and thereby to increase the health and vigor of the animals, but in order that its contents may be properly mixed in some other place, to induce and bring on a regular fermentation.' Now, on this it may be observed, that the fears which are entertained by some persons of the vapour arising from dung which is contained in the open air of the yards becoming prejudicial to the health of the cattle, are proved by experience to be completely visionary. No really bad odour prevails there; for, although it may be offensive to delicate nostrils, the air is always respirable, and when not confined in close stalls, by which the circulation is prevented, no ill effects are ever known to arise from it. But when the cattle are either fed upon turnips or other green food, the quantity of urine which they discharge drenches such a quantity of straw, that the beasts cannot be easily kept dry; or if they be crowded in badly arranged yards, and immersed in the filth proceeding from a scanty covering of straw, and the want of proper drains to carry off the superfluous moisture, they may then indeed be exposed to injury from the wet, and the dung should be removed, though in almost any case 'once a month' would be found too often. In many instances the yards are never cleared until the cattle are turned out after the close of the winter; and, unless in a very plentiful season for straw, it is seldom done more frequently, after they are shut up, than perhaps once more in the early part of the spring: except they be soiled during the summer, in which case it becomes frequently necessary. When proper care has been used to prevent an excess of rain-water, the manure thus obtained from the bottom layer will doubtless be found of superior quality; but the whole heap ought to be well mixed, in order to render it of equal value.

An eminent agricultural author, whom we have already quoted, complains that he has not, in any one instance, been able to find any thing like system in the mechanical arrangement of the component parts of farm-yard mixens, which he generally found put together as they arise, according to circumstances, and without any regard to rule. Hence it follows that their real value as manure can never be distinctly known to the farmer, nor can he apply that proportion which a more accurate knowledge of the contents would enable him to apportion to different kinds of grain, or to the particular soils

and seasons in which they can be most advantageously applied. A heap, for instance, composed entirely of dung from stables where horses have been plentifully fed with corn, must be far superior to one produced by cattle in the straw-yard; yet so little is this very material point adverted to, that nothing is more common than to hear of 'so many loads per acre' being laid upon the land, without regard to the ingredients which it contains, though nothing is more certain than that its power over the crops will be in exact proportion to the qualities of the materials of which it is composed.

This writer advocates the separation of the various species of manure, in order that the properties of each may be distinctly ascertained; yet another author, of equal experience, says, in treating of Norfolk, 'that the principal error in the common method of manufacturing farm-yard dung, originates in the prevailing custom of keeping the dung arising from different descriptions of animals in separate heaps or departments, and applying the same to the land without intermixture, and consequently in an improper state.' He then alludes to the difference arising in the manure from the modes of keeping fatting and store cattle in yards by themselves, 'while horse-dung is also usually thrown out at the stable-doors, and there accumulates in large heaps, which very soon ferment and heat to excess;' he therefore recommends that litter to be spread over the straw-yard, and the whole of the dung from the different yards and the hog-styes to be mixed together.*

On these opposite opinions we have to remark, that, when either the soil or the intended crop is essentially different, it may be very desirable that the manure to be employed should possess distinct properties, and therefore, in such cases, a portion of it should be separately kept, as well as differently prepared. Thus warm and cold soils require manures of a contrary nature; an advanced stage of their fermentation is in some cases less favourable to vegetation than in others; and, in the instance of potatoes, it is well known that stable-dung is employed with more effect alone than when mixed. It may, therefore, be advisable that horse-litter in particular should be separately kept in the yards, not merely for the purpose just mentioned, but that, as being of a hotter nature than any common dung, it may be mixed with that of other cattle

* Blaikie on Farm-yard Dung, edit. 1828, pp. 3, 5, 6. See also the Nottinghamshire Report, p. 168.

in such proportions as may be thought best adapted to the purposes for which the compost may be required. If no better arrangement can be made, the litter should be placed within some dry ditch, which will answer the purpose of a more regularly constructed pit, where its moisture may be maintained without too greatly heating it, and without exposing it to the evaporating action of the air. Thus, if care be at the same time taken to prevent it from becoming dry, the fermentation will be checked; and should it be thought expedient to still further retard that operation, it may be effected by a mixture of hog's dung, which, though rich, yet being of a colder nature, is less fermentable. By this union the dung becomes decomposed into a soft and pulpy mass, which forms a very powerful manure, and, by a little judicious management, can be either promptly got ready or be kept back at pleasure.

Under other circumstances, however, and especially on small farms, where the quantity of materials may not be sufficient to allow of their being separated without incurring the risk of loss by the excess of evaporation, or by the want of due fermentation, it is found more generally expedient to spread together all the different sorts of the dung of the larger animals in different layers, so that each may be regularly mixed and partake equally of the common properties of all, by which means the faults of one species are corrected by another; the too rapid fermentation of the dung of horses is checked, while that of hogs and horned cattle is accelerated, and thus the whole mass acquires the enriching properties of the most fertilizing compost.

Preparation of Manure. — Dung, thus indiscriminately thrown together, being composed of every species, whether from horses, pigs, or black cattle, bedded with a litter of straw, to which every vegetable substance that can be collected round the house and premises should be added, forms a combination of fermentable matter of various kinds, which, with due care, may soon be brought into a fit state of preparation. Instead, however, of laying it in a regular manner, it is too often suffered to remain in different heaps, in whatever part of the yard it may have been carried from the barn and stables, in which condition it is left during the winter; and being thus imperfectly fermented, its value is, in all such instances, very materially injured: whereas, if spread as equally as possible over the entire yard, the different materials becoming thus

well mixed together, their different properties are blended, and a compact mass of manure is produced of equal quality.

It should, however, be observed, that there is in every farm-yard a proportion of hot and pungent dung, produced by poultry and pigeons, which should be separately kept for top-dressings, for which purpose it may be found very useful: if scattered over the common heap, it will, however, have the effect of increasing the fermentation, and hastening its decomposition. That of swine, also, when thus mixed, has the same effect; and it was proved, after repeated trials, when the temperature of the air was 40° of Fahrenheit's thermometer, that of common farm-yard dung was about 70°; a compost of lime, dung and earth, 55°; and a portion of swine and fowl's dung, 85°. Care should also be taken that, if any other substances than those commonly employed be added to the heap, they be of such a nature as will render them equally susceptible of decomposition; if not, a small quantity of quicklime will have that effect; but it should be applied separately. Lime should also be added to all weeds which have ripened their seeds, as well as to the roots of docks and other noxious plants, which long retain the power of vegetation, and spring up when laid upon the land, unless they are destroyed. The better way, indeed, is to place them in a spot away from the yard, and to mix them into a compost, as will be hereafter mentioned.

On what has been said respecting the *removal of dung and litter from the farm-yard*, it should also be remarked, that their being retained during a long time in the yard is inconsistent with the comfort of the cattle and the due preparation of the manure; for if straw be added in sufficient quantity to keep the former dry, although the lower layers of the manure may be in a good state, yet those at the top cannot. Straw, flung out to the yards in considerable portions, becomes, after being compressed by the trampling of cattle, rather like a well-packed stack than a mass of dung in a good preparatory state. Except where a considerable stock is soiled, the small quantity of urine and dung made by the animals is barely sufficient to cause a slight fermentation in the heap, which brings on fire-fanging, after which its original powers can rarely be restored. To prevent that injury, no measure can be so successfully used as a frequent removal of this unmade dung, especially if the weather be wet at the time; for there is in such cases so much straw that has not passed through the entrails of the cattle, as renders it almost impossible to do

injury by an excess of moisture: if, therefore, its removal be deferred to any distant period, a proportionately greater length of time must necessarily be devoted to its turning and being got in order for the field. Unless over-year muck be used, if the manure be required for turnips, it will be found necessary to lead it from the farm-yard as soon after Christmas as the weather and the state of the roads will admit of it; or, if wanted for beans, that should be done much earlier. No period is more advantageous for this work than a frost; and if much manure is wanted early, it may be led from the yard a second time in the month of February. It should not be forgotten that the lighter it is laid upon the heap, the more rapid will be the decomposition; and that it may be retarded by compactness of form and pressure on the top with a heavy coat of soil. This, however, must depend upon the quantity of litter and of cattle, on the extent of the yards, the state of the weather, the condition of the manure, and the intention to which it is to be applied, all varying according to circumstances, for which no precise rule can be laid down, and which must therefore be left to the judgment of the farmer. Yard-dung, made in winter, if trodden by cattle, will not be found to ferment much. It ought, if possible, to be kept neither too wet nor too dry; if in the former state, it will injure the stock, without forwarding its own decomposition; and if in the latter, it will become mouldy, or fire-fanged, and lose its most valuable qualities: in order to prepare it in the best manner, it should therefore be preserved in a mean between the two extremes.

Throughout most counties the general plan is, after foddering is over, to carry out the dung from the farm-yard, and to place it in large heaps, in order to occasion a due fermentation, and to render it quite rotten before it is laid upon the land. There are, however, many circumstances which render practice and opinion at variance on this point, in consequence of which a great portion of the manure is carted directly to the fields, and applied to the intended crop, either fresh, or perhaps after being once turned over. The apprehension that dung loses much of its virtue by evaporation is not entirely unknown or unattended to; but people think differently on the subject. Several farmers maintain that ploughing in the manure as soon as it is laid upon the land is unnecessary, if not injurious; because they say that it absorbs the nightly dews and other substances from the atmosphere, by which its quality is im-

proved; that the rain will wash in the salts, while the sun only exhales the water; that, when spread upon the surface, the soil also thus becomes gradually impregnated with its juices; and that clay land in particular is rendered mellow and free to plough. Thus with many it is the practice to carry out yard-dung in its long and hot state, and to suffer it to lie both upon arable and grass land for perhaps a month or six weeks after being spread, before it is ploughed in, though it is knowledged to encourage the growth of weeds. Others cover it with a slight coat of mould. On the other hand, although the process of fermentation, by disengaging a quantity of carbonic acid and ammonia, causes an evaporation, by which the bulk of the manure is much diminished, yet its power is thought to be thus increased. This apparent diminution in bulk has indeed been too much insisted on by the opponents of rotten dung, as proof of its decrease in value; for, although the size of the heap thus evidently becomes smaller, yet its cubical contents are, by its condensation, increased in weight.* After about six weeks it assumes a saponaceous, greasy appearance, in which soft and sappy state, when neither fresh nor too rotten, but in the medium between those states, it is generally applied to the land by the best farmers. When very rotten, its effect is more immediate and powerful; but when only moderately rotted, its effect, though more gradual, is found to be more durable.

On this *subject of evaporation*, which has justly engaged so much of the attention of scientific agriculturists, we, however, add the following extracts from the work of Von Thaer, whose practical knowledge cannot be too highly appreciated. He says, that not only does theory teach us, but during his

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* The weights of putrescent manures will depend much upon the progress of their decomposition at the time, as well as the proportion of moisture which, from accident or particular treatment, they may contain. From an experiment on the subject, recorded in the Farmer's Magazine, we learn that the comparative weight of the following substances, was as follows:—

	cwt.	qrs.	lbs.
One cubical yard of garden-mould	19	3	25
Ditto of water	15	0	7
Ditto of a compost of earth, weeds, lime, and dung, that had lain nine months, and been turned over	14	0	5
Ditto of new dung	9	3	18
Ditto of leaves and sea-weeds	9	0	7

Thus, a cubic yard of water is to that of new dung nearly as 3 to 2.—vol. xiv. p. 162. Von Thaer calculates the weight of a cubic foot of any strawy farm-yard manure at only about 46 lbs.; while one which has been partly decomposed will weigh from 56 to upwards of 60 lbs., without being compressed.—*Principes Raisonnes d'Agriculture*, tom. ii. p. 326.

own experience he has had frequent occasion to observe, that it is hurtful to remove farm-yard manure while it is in a high degree of fermentation; for according to all appearance, an essential portion of the most active substances of which it is composed are evaporated when exposed to the air while that process is going on. But, before the fermentation has arrived at its height, or after it has passed, the dung does not seem to lose any thing by exposure to the air; or, at least, nothing but what it regains by some other means.

That an evident advantage attends the spreading of fresh strawy dung upon the surface of the soil during the winter, and leaving it there in that state until the spring ploughing (it being, at the same time, well understood that no declivity of the land allows of its being washed away by the rain)—for this method of covering the ground occasions it to absorb the juices of the dung, and thus renders it not only friable to work, but extremely productive: so much so, that the straw has been afterwards raked off the land at the close of the season, and yet the soil has appeared as much improved, as that in which the whole of the litter had been buried—an effect which is also apparent in meadow ground which has been similarly treated. Not alone has this occurred in many such instances; but in others, in which both long and short dung have been spread upon land already sown with tares and peas, and though left there during vegetation, have produced the most beneficial effect upon the crops, especially when sown late, and applied to ordinary land of a light and warm nature; but what appears more extraordinary and difficult to explain—the land which has been thus managed has evinced a decided superiority in the subsequent crops over ground on which even a larger quantity of dung had been regularly ploughed in.

That, as one proof of this, in the spring of 1808, rape was sown along with clover upon a poor soil, and was afterwards covered with fresh dung: in the autumn of 1809, the clover-ley was broken up, and rye was sown; the crop of which in the following year was distinguished by its superiority over that of an adjoining field which had been dunged upon a summer fallow. Indeed, after a number of comparative experiments, made by himself as well as by other farmers, it appeared to him beyond all question—however incredible it may seem to those who have not also tried its effects—that dung which has already passed the extreme point of fermentation, not only loses nothing by being exposed upon the land, even during the

summer, but even gains. The evaporation may, indeed, be not so great as it is generally supposed; for, although it is true, that when the dung is carted out and spread, it then effects the air with a strong musky smell, yet there is no mode of avoiding that; and even if there were, the vapour which is thus diffused is so tenuous, light, and expansive, that doubts may be entertained whether the quantity of sap which is thus evaporated can be very considerable, as, after a short period, the dung does not exhale any odour. According to the experience of M. Thaer, it does not lose in weight; and he remarks, that, if laid during a few weeks upon a sammer fallow, a number of young plants of a very vivid green will be seen to spring up, even upon spots which have not come into contact with the dung; which proves that its fertilizing properties were spread around, even before it had been buried in the soil.*

We have thus entered at large into this discussion, because we consider it important to throw every light upon the subject of which it may be susceptible; and it besides contains some strong reasons for the application of long dung.

There are, however, many farmers who persist in the use of *over-year muck*, or that which has been kept perhaps a twelve-month, or more, until it is completely reduced to a pulp, in which state it is very commonly applied to turnips. It thus loses perhaps half its bulk; but it is considered peculiarly favourable, and even necessary to the growth of that crop, as its power upon vegetation advances it so rapidly as to put it promptly out of the reach of the fly.† When, however,

* Principes Raisonnés d'Agriculture, tom. ii. p. 315, § 600. It is difficult to ascertain the precise degree of evaporation arising from fresh dung; but, by an experiment made by the Rev. St. John Priest, Secretary to the Norfolk Agricultural Society, in the presence of Mr. Curwen, of Workington, it was found that steam was evaporated by a piece of moist ground held under a large glass during a quarter of an hour, in the month of October, at the rate of about 1½ cwt. per acre. Survey of Buckinghamshire, p. 274.

This, indeed, appears a large amount within that space of time; but, had the experiment been longer continued, it would have been much diminished, and would, no doubt, in a short time, have entirely ceased.

† Mr. Young, indeed, says, 'that long stable-muck has been carried out for turnips in March, without any stirring, and that the crops were as good as from short muck, though the growth of the plants was not so quick; but then 15 loads of the former were laid on instead of 12 of the latter. Long and short dung have also been mixed together, and laid upon strong land, with good effect. It was carted from the yard late in the spring, forming heaps, which in three weeks were turned over, and, within a fortnight more, were laid upon turnips; but the practice is not common, nor very likely to be generally followed.—Norfolk Report, chap. xi. sect. iii.; Essex do., pp. 229, 240.

the process is carried too far, and the manure has been frequently turned,—until, as said by some farmers, '*black butter* becomes *black snuff*:' it has then, indeed, been found so completely deprived of its nutritive sap as to produce no effect whatever upon the land. On the whole, there is reason to believe, 'that there is, in the management of dung, as in all things else, a certain point which constitutes the maximum of profit, beyond which there is nothing but loss.

The *management of farm-yard manure*, upon light and heavy soils, should differ according to the use intended to be made of it; for it is generally employed in different seasons and applied to different crops. For light land, on which the most common crop in the commencement of a rotation is usually turnips, it requires to be highly fermented; because, if not incorporated with the ground in that soft and sappy state in which good spit dung ought to be, the plants will not receive such immediate nourishment as will serve to push them into rough leaf before the attacks of the fly. But for clays and other strong soils generally, whether the manure be applied to a fallow under preparation for an autumn sowing of wheat, or in the early part of the spring for beans, as it has a longer time to decompose in the soil, a less degree of putrefaction is necessary than for turnips. Potatoes, also, though grown on light land, may be raised by the use of fresh unfermented manure, because they do not require the same nutriment as turnips during their early growth, and because they are also supposed to be assisted by the action of long dung in opening the soil.

When, therefore, a farmer looks chiefly to a prompt return through immediate benefit to the next crop, the manure should be thoroughly rotted to the condition of spit dung; 'but if his views extend to subsequent crops, or if the soil be of a nature to receive benefit by the fermentation and heat produced by the application of long dung,' then it has been affirmed 'that preference should be given to that in a fresh state, provided it be immediately ploughed in and totally covered.' This, however, although the opinion of the author whom we have just quoted, as well as that of several practical men, should yet be received with a certain degree of caution; for, besides the objections already stated to manure of this description, there is such difficulty in ploughing in the straw, that much of it is necessarily left upon the surface of the soil, where its virtues are in a great measure lost; or, if buried deep in cold

and retentive clays, it becomes locked up in the land, and its fermentation is prevented. In order to bring it into such a state of decomposition as we have already stated, the information which we have collected on the subject may be thus condensed.

On most farms the *yards are commonly cleared* towards the middle, or the latter end of April; though in some this does not prevent the work from going partially forward during the winter, and thus preparing some of the manure in succession; at whatever period it may, however, be done, the following is the most advisable method of proceeding.

The most usual mode is to carry out the dung from the yards, either to some waste spot adjacent to the homestead, or into the field to which it is meant to be applied, and there to leave it exposed to the weather, without any other preparation than turning it over, until it be completely rotted, or else until such time as it may be thought requisite to lay it upon the land. The better plan, however, is to lay a bottom for the dungstead, consisting of a bed formed of clay or sand, ditch and road scrapings, marl, or any similar substance, which must be well mixed and pulverized, and then spread to the extent in length and breadth which it is supposed the heap will cover, and from a foot to 18 inches in depth, but raised at the sides and sloped to the centre, so as to absorb the liquor which oozes from the dung during the heating and putrefaction which always take place while it lies in the heap. The yard dung is then carted out, and shot upon the bottom; one end of which is at first left lower than the other, in order to render the ascent easy to the cattle—a practice, however, as we shall afterwards see, which is not always to be commended. It is then thrown slantingly up until the heap rises to four or five feet above the foundation; after which, careful farmers raise a coating of the same materials as the bottom, a couple of feet in thickness, which is spread round the heap to its full height: or, when the mixen is raised upon the field in which it is intended to be applied, the soil may be ploughed around the heap, and plastered or faced up against the sides by the back of the spade. The dung is then allowed to duly ferment, which may be seen by its sinking, and easily ascertained by thrusting a few sticks, of the common size of broom-handles, into different parts of the heap, as well as by its steaming and offensive smell, which, however, subsides when it is thoroughly decomposed. Dark-coloured putrid water is also drained from

the heap, and there can be little doubt that this discharge of vapour and fluid will, if permitted, occasion the loss of some portion of the virtues of the manure; in order to guard against which, a thin coat, of the same kind as the sides, and made as fine as possible, is laid regularly and lightly over it, so that its weight may press equally and not heavily—for, if left in lumps, their cumbrous weight would force the dung into holes, and prevent its regular fermentation.

By this covering of the dung with a due proportion of earth, or of other coating, that loss is, however, in a great measure prevented; and the bringing of the heap into a state of preparation either sooner or later, as circumstances may require its application to the land, can be effected by the denseness and compression of the covering. The operation therefore requires considerable delicacy; for, if dung, already in an unfermented state, be so closely pressed as to effectually exclude the air, it will be found, perhaps at the distance of several months, in a state very little different from that in which it was put up; or, when it is thought to be in a perfect state of preparation, it will, upon examination, be discovered to be only decayed, and, instead of abounding in rich mucilaginous substance, to consist almost entirely of mere vegetable earth.

This also leads us to remark on the common practice of *driving carts, with their loads, upon the dunghills;* the consequence of which is that, as nearly the same road is followed by each cart in crossing them, it is not possible to draw load after load upon such a heap without compressing those parts where the horses tread, and thus, instead of the dung undergoing a regular fermentation, which every part necessarily would if it had been thrown loosely on the heap, and of one uniform thickness, it is, in some spots, consolidated into a mass which, in most instances, greatly retards, and in some entirely prevents, the process; 'becomes mouldy, from want of air, caloric, and moisture,—acquires a musty, turbid smell,—generates fungi,—and is, in that state, injurious to vegetation.' The system has indeed been defended by some very able men, one of whom insists 'that the dung should be drawn out of the yards, and placed upon the bottoms, though not in the usual way of throwing it up loosely, to cause fermentation, but, on the contrary, by drawing the carts, with their loads, *upon the heaps*, for the purpose of compressing the dung, and thereby *preventing fermentation;*' and another conceives that 'a positive benefit will be gained by this slight compression.'

This difference of opinion may however have arisen from attention not having been paid to the different qualities of the dung, as well as to the use intended to be made of it. When the materials removed from the yard consist chiefly of litter in a fresh or rough state, not sufficiently saturated with the urine of cattle, or when the manure is not intended to be immediately applied to the land, no serious damage can ensue from driving the carts—which are usually drawn by one horse—across the heap, when the dung has risen to some height upon the foundation; but if that operation be performed before some considerable portion of the dung be laid on, the inevitable consequence will be that the bottom, which consists of either of earth or of other matter devoid of elasticity, will thus be kneaded into solid and unequal lumps, which will occasion the effect complained of. Care should therefore be taken to make the heap so narrow, that, by driving on each side of it, the carts may be backed, and the dung shot upon the pile, which may then be levelled with grapes, or forks, and laid compactly together. Much labour of the teams will thus be saved: if the object be to prevent fermentation, the dung may be regularly and closely trodden down by the men employed in spreading and levelling it; and the quantity of earth to be laid over it may be regulated accordingly. If, on the other hand, the manure be intended for immediate use—then the dung should be thrown lightly together without treading, and the quantity of earth on the sides and top should be reduced; or, if the dung be of a hot nature, from which too sudden or violent fermentation may be apprehended, a portion of the earth may be intimately blended with it, and it will thus be soon brought into a fit state for application.

It must not, however, escape observation, that store cattle are often kept in straw-yards apart from other stock; or else that, when the same yard is used, the stable litter of horses is thrown separately out, and thus produces two very distinct species of dung. Attention should therefore be paid, in clearing the yards, to take a few cart loads from each kind alternately, so that the whole may be, as nearly as possible, equally mixed, and heat alike. It will thus also be seen if any portion of the dung is too dry, in which case it should be distributed among that which is wet; and if there be any general deficiency of moisture, or if the external parts of the heap become dry during the process of fermentation, they should be thoroughly wetted. The heaps, too, should be of moderate size,

by which means they can be turned and got ready at different periods, as occasion may require.*

These *pies*—as they are provincially termed when thus crusted over—if ready by the 1st of May, may be reasonably expected to be in a fit condition to be laid on the summer fallows by the latter end of July, though the time required for their preparation must be governed by the strength of the dung, the weather, and the exact period of its intended application. Those formed during the summer months, unless the dung be produced by horses and cattle kept in the yards by soiling on green food, can seldom be collected and got ready for use within the same season; but when intended for turnips, the manure should be carried out and lightly raised about six weeks or two months before it is wanted, within ten days or a fortnight of which time it should be very carefully turned.

The *operation of turning* is also one that requires circumspection. This is often neglected until the heat of the mixen is quite spent, its fermentation passed, and it is become entirely rotten. To which glaring error is to be added the carelessness employed in that labour by servants, who, in turning it over, usually begin at one end, and throwing layer upon layer as they cut them through, place them again in the same order in which they found them, with this only difference, that the part which was at the top now becomes the bottom. Thus it has been justly observed by Mr. Malcolm, that 'the benefit which might have accrued to each ingredient by their proper admixture is infallibly lost, because the dung has been prevented from infusing any of its saline particles into the mould, and when laid upon the land, instead of being a body of invaluable manure, they are little better, as such, than as if each ingredient had been immediately drawn from the beds out of which they were originally taken.' All this may,

* On this subject Mr. Cook is said to have lately expressed himself, at a public dinner in Norfolk, to the following effect:—'Having made a platform of marl, I placed the inferior muck upon it; the manure of the fat cattle formed the third coating, and upon that the horse-dung as the fourth, and in about equal quantities. I then ploughed round it, threw up the earth, and made a kind of coating over the whole to keep in the gas. Just before sowing, the heap was turned over; and thus, when the muck was in a state of fermentation, it went into the drill. Let farmers follow this plan, and give plenty of seed, and they will not find their crops of turnips to fail; the warmth of the manure would force the turnips out of the way of the fly in less than eight-and-forty hours.' In Dr. Rigby's account of Holkham, it is also stated that, by preparing manure in this manner, Mr. Coke saves no less than 500*l.* per annum in the purchase of rape-cake as top-dressings.—3d edit., p. 56.

however, be easily avoided by cautiously observing the probable state of the fermentation of each heap, and by turning it completely over, either when it requires lightening or pressure; by narrowly watching the process, so that every part may be thoroughly shaken up, the clods and lumps in the bottom, top, and sides well broken, the adhesive parts of the dung separated, and moisture added if necessary. When this process has been attentively performed, it has been recommended by Mr. Blaikie 'to immediately plough several furrows of the natural soil all around the heaps, and with the loose earth ploughed up again, coat the heaps all over: the pies will then take a gentle fermentation; the earth intermixed with and covering the dung will absorb the juices and gases of the dung, and the compost will come out in a fine state of preparation for using on turnip land. From manure of this description, in which all the materials are intimately blended, soaked with putrid water, and decomposed to a degree of mellow consistence, different sorts, to suit different soils and crops, cannot indeed be taken; but perhaps, with the single exception of potatoes, this one sort of farm-dung, managed as above, may be successfully applied to every crop, and to every kind of soil.

Long-dung.—Such is the most common practice with the generality of farmers regarding *fermented dung;* but there is another system of management advocated by some eminent chemists, who recommend that it should be used in a *fresh state*—that is to say, after it has begun to ferment; for it is well known that dry vegetable and animal matter cannot be properly made to serve as manure until that process has commenced. On the effects of the fermentation of farm-yard manure, and the length to which the operation should be carried before it be applied to the soil, there exists indeed an extraordinary difference of opinion among the written authorities on the subject, and the practice of many eminent farmers is equally at variance. It was long ago asserted, that 'there was good reason to believe, from many facts, that putrefaction was no way necessary to the nutritive power of animal and vegetable matter, but in so far as it diminishes their cohesion, or destroys their texture, and renders them fitter for absorption; and as there is considerable waste in gases and ammoniacal and nitrous salt by their putrefaction, it is of importance not to allow the putrefaction to take place at all where it is not required to break the texture.' In support of that theory, various other authorities were quoted by the late Secretary to

the Board of Agriculture, in the treatise on manures which gained him the Bedfordian medal of the Bath and West of England Agricultural Society. Many who previously doubted it have been since persuaded of its superiority by much practical as well as theoretical evidence then brought forward; to which there has been since added the powerful arguments of Sir Humphry Davy, who thus expresses himself:—

'Whoever will refer to the simplest principles of chemistry cannot entertain a doubt on the subject. As soon as dung begins to decompose, it throws off its volatile parts, which are the most valuable and most efficient. Dung which has fermented, so as to become a mere soft cohesive mass, has generally lost from one-third to one-half of its most useful constituent elements; and that it may exert its full action upon the plant, and lose none of its nutritive powers, it should evidently be applied much sooner, and *long before decomposition has arrived at its ultimate results.*

'A slight incipient fermentation is undoubtedly of use in the dung-hill, for by means of it a disposition is brought on in the woody fibre to decay and dissolve when it is carried to the land, or ploughed into the soil, and woody fibre is always in great excess in the refuse of the farm. Too great a degree of fermentation is, however, very prejudicial to the composite manure in the dung-hill; it is better that there should be no fermentation at all before the manure is used than that it should be carried too far; for the excess of fermentation tends to the destruction and dissipation of the most useful of its parts, and the ultimate results of this process are like those of combustion.'

The sentiments of this celebrated chemist are certainly entitled to great weight; but though we admit that the fermentation of farm-yard manure may be rendered injurious, both through the waste which occurs in bulk, as well as by the loss of some portion of its nutritive properties, if that process be carried to excess, yet we are inclined to doubt the correctness of that position which says 'that it should be applied long before decomposition has arrived at its ultimate results.' We think also, that some distinction should be drawn between the different kinds and qualities of dung, as well as of the crops to which it is to be applied, and of the season in which it is to be used, before any such unexceptionable rule should be adopted for its preparation. Thus, to recommend the application of fresh manure for a crop of

turnips, in like mannner as for another of potatoes,—for heavy clay equally as for a light sandy loam, or to draw no distinction between the time in which it is to be laid upon the land,—rather affords evidence of theoretic generalization than of sound conclusions, drawn from a multiciplity of well-supported experiments, and established by practical effect.*

There are perhaps few agricultural subjects on which theory and practice are so much at variance as in the management and application of putrescent manure. There is hardly a farmer who will not admit that a crop of turnips may be altogether risked if short muck be not employed; and though some of them are often under the necessity of applying a portion of long-dung, perhaps to the same field on which the former has been laid, yet the very drill on which the two kinds meet may in general be distinctly pointed out, while potatoes, on the contrary, are almost invariably planted on fresh farm-yard manure: though neither of these instances prove either that fresh dung gains any fertilizing power by fermentation, or that short muck loses it; for these facts apply only to the mechanical action of the manures, and to the natural economy of the plants. It is also generally admitted that long-dung is more suitable to clay lands than to light soils, which are rendered too porous by its application; and, in like manner, fresh manure is objected to for all spring crops, because it is found to keep the land in too open a state in dry weather, and liable to be burnt up in the summer.

Sir Humphry, however, adds—'that the *dry straw* of wheat, oats, barley, beans and peas, and spoiled hay, or any other similar kind of dry vegetable matter, is, in all cases, useful manure. In general, such substances are made to ferment before they are employed, though it may be doubted whether the practice should be indiscriminately adopted.'

On which it may be observed that although in another passage he admits 'that a great objection against slightly fermenting dung is, that weeds spring up more luxuriantly where it is applied,'—which forms in itself a strong impediment; yet that is not the only fault to which it is exposed—for it also occasions foul husbandry. It is scarcely possible in

* On this it has been observed, that, in the instance of turnips, Sir Humphry only meant to say, 'that the manure should be applied *long before decomposition* had arrived at its ultimate results;' but this does not weaken the general force of our remark, which refers to the indiscriminate use of long dung.

any soil to plough down effectually a large quantity of rank strawy manure; for even the stubbles, when cut high, are found difficult to bury, and more especially on light land this fresh stable-dung slides along the ground before the breast of the plough, and thus clogs the furrow. The harrows also drag up considerable quantities, which not alone impede their action, but a large portion of the manure is thus scattered over the surface of the ground, and uselessly left there to perish; and litter that had been ploughed down fresh has, in numerous instances, been turned up in the following spring without any apparent change. Objections such as these are not easily obviated, but even were they surmounted, the value of the dung in that state of preparation still remains to be considered.

Of the mysteries of nature in her supply of food to plants we have no certain information, and it is even probable that they will ever elude discovery. Some experiments which were made by Sir Humphry Davy, however, favoured the opinion 'that *soluble matters pass unaltered into the roots of plants;*' in support of which he says—'that the great object in the application of manure should be to make it afford as much soluble matter as possible to the roots of the plants, and that in a slow and gradual manner, so that it may be entirely consumed in forming the sap of the organized plant;' in order to attain which effect, he admits '*that it must undergo chemical changes.*' Now, the materials of which the great bulk of farm-yard manure is composed, consist chiefly of straw or other litter, which, being fibrous, can only be rendered soluble by fermentation: but chemical theorists assert that this process should be perfected at least, if not commenced, underground; for they insist that, if completed in the dung-hill, it would occasion a great loss of nutritive matter; and it must be admitted that several practical men of considerable judgment have become converts to the same notion. Thus, one of the latter body says—'that, although half-rotted manure will sooner disappear in the soil, and that the crop sown along with it may often be better than on fresh dung improperly applied, there may be little doubt; but there can be as little that, during the time the latter is visible, it has afforded the greatest share of nourishment;' and he then asserts, 'that the ravages of fermentation and exhalation are more to be dreaded, and ought to be more guarded against, than any other waste to which a heap of dung is liable.'

In contradiction to this, however, another writer upon the same subject thus expresses himself:—'The object of applying all kinds of manure is to nourish the seed which is sown in the earth; and we know from observation that its development is much accelerated by the immediate assistance of manure. If manure requires to be in a soluble state before plants derive benefit from it, it is evident, the greater state of solution in which the manure is, the more easily will the plant be enabled to derive benefit from it. This point is finely illustrated by the quicker efficacy of liquid than solid manure in nourishing the plant, when both are applied in equal strength. Now, if there is no way of making manure soluble but by fermentation, it is also evident a great degree of fermentation will dissolve all the fibrous portions of putrescent manures the more easily. This point is also well illustrated by a fermented dung-hill, the materials of which, if properly commixed, will ferment strongly for a time, and then the fermentation will subside to a low degree, leaving the whole mass in that pulpy, sappy state, than which nothing can give a better idea of a soluble state of a fibrous body. Whether any really nutritive matter is driven off by fermentation before the mass is brought to that pulpy state, may be doubted; for the evaporation from such a dung-hill appears to be just the steam of water in a highly elastic state, glimmering like a hot haze in a sunny day, on looking across a ploughed field. But even should some gaseous matter escape during fermentation, this undeniable fact remains untouched—that this fermented, pulpy, sappy mass of manure will go much farther in maintaining the fertility of land than the *same bulk*, or *weight*, of recent farm-yard manure.'

On the latter point we think there can be no rational doubt; for it is very generally allowed that an equal quantity of short muck, or that which has been merely reduced to the state of spit-dung, is more immediately effectual as manure to the present crop: but the question still remains to be decided—Whether the same amount of substance, if laid upon the land previous to its diminution by the loss of fluid and of gaseous matter, has not a more lasting effect on the improvement of the soil? It can only be determined by long experience upon different soils, seasons, climates, crops, and rotations; and we agree with Mr. Finlayson that, 'in order to make a fair trial, it might not be unworthy of the agriculturist's pains to place, for example, a ton of fresh dung in a favourable situation for fermentation; to turn it over once or twice; and when rotted

down to the bulk, weight, and consistency thought most expedient, or usually allowed, to put it and a ton of fresh dung of the same sort on equal spaces of very poor land, and weigh the produce of the three following crops; by which means the matter would soon be set at rest, and, with the majority of farmers, a greater uniformity observed in the management of this division of their business.' We accordingly extract a comparative experiment made by an intelligent practical farmer on three kinds of manure, and on a cultivated soil without manure—half a rood of ground being allowed for each—as follows:—

Successive Crops and Produce from a single application of the following Quantities, viz:—

	Fresh stable-dung in a strawy state, 3 tons.	Rotten dung, 8 months old, 2 tons.	Dry Barley-straw burnt on the ground, 15 cwt.	No manure.
	PER ACRE.	PER ACRE.	PER ACRE.	PER ACRE.
1st crop Turnips,	18cwt. 6st. 6 lb.	16cwt. 1st. 4 lb.	8cwt. 3st. 7 lb.	1st. 8 lb.
2d crop Barley,	30 bush. 2 pks.	36 bush. 3 pks.	30 bush. 1 pk.	14 bush. 3 pks.
3d crop Clover,	20cwt.	21cwt.	18cwt.	8cwt.
4th crop, Oats,	38 bush.	40 bush.	18 bush.	32 bush.

As to the feed after the clover, it was about equal to the expense of getting in each crop respectively, with a small surplus on the plot manured with rotten dung.

To complete this experiment, there should, however, have been a notice added of the proportion of weight which fresh stable-dung would lose within eight months; for three tons would scarcely, at the expiration of that time, amount to more than half that quantity of completely rotted dung; though when farm-yard manure is reduced one-third in weight, the fermentation may be, in most cases, considered as far enough advanced for the general purposes of agriculture. Supposing the original quantities to have been equal, the above experiment would be, in every part of the rotation, in favour of rotted dung, with the exception of the inferiority of the turnip-crop, which, in this instance, remarkably contradicts the practice of its application; though, without more clear information regarding the soil, the culture, and the weather, no positive conclusion can be drawn from that fact.

In his remarks upon the *formation of dung-heaps*, Sir Humphrey justly observes—'that an immeasurable quantity of substance disposed for conversion into food for plants is suffered to escape in the form of drainings and vapour. During the violent fermentation which is necessary for reducing farm-yard manure to the state in which it is called "*short-muck*,"

not only a large quantity of fluid, but likewise of gaseous matter, is lost; so much so, that the dung is reduced one-half, and from that two-thirds or more, in weight. Now, the principal elastic matter disengaged is carbonic acid, with some ammonia; and both these, if attracted by the moisture in a soil, and retained in combination with it, are capable of becoming nutriment.' Reasoning on which, he says—'that, within the last seven years, Mr. Coke has entirely given up the system of applying fermented dung; and he informs me, that his crops have been as good as ever they were, and that his manure goes nearly twice as far.' He then sums up his arguments with directions for the management of putrescent manure, in the following terms:—

'Where farm-yard dung cannot be immediately applied, the destructive fermentation of it should be prevented as much as possible. For this end the dung should be kept dry and unexposed to the air; for the moisture and contact with the oxygen of the atmosphere tends to excite fermentation. To protect a heap from rain, a covering of compact marl, or of a tenacious clay, should be spread over the surface and sides of it. Watering dung-hills is sometimes recommended for checking fermentation; but this practice, although it may cool the dung for a short time, is inconsistent with just views, for moisture is a principal agent in all processes of decomposition: dry fibrous matter will never ferment. Water is as necessary as air to the process, and to supply it to fermenting dung is to supply an agent which will hasten its decay.' 'If a thermometer plunged into the dung does not rise above 100° of Fahrenheit, there is little danger of much aeriform matter flying off; if the temperature is higher, the dung should be immediately spread abroad.'

There is no ground for contesting the fact that a large quantity of fluid and of gaseous vapour is allowed to escape during the common process of reducing farm-yard manure to the state of short muck; but the practical inference deduced therefrom can only be proved by experiments on a much broader scale than those which have been yet submitted to the public.

The separation of a rich fluid substance, drained from a mass of dung, must, doubtless, diminish the fertilizing power of the manure in the proportion in which it has been extracted; but these drainings can either be preserved in tanks, and afterwards either thrown over the heap or applied to the

land in their liquid form; or, should the construction of such reservoirs prove inconvenient, the waste of the liquor may be prevented by raising the dung-hill in the manner already stated in our account of the preparation of farm-yard manure. The application of such moisture cannot be considered as a loss; and we have already seen that even that of watering dung-hills is sometimes necessary to prevent them from becoming fire-fanged.

The escape of gaseous matter is caused by the heat created by fermentation; and if we look to the state of a farm-yard, we shall find that the moment the dung is thrown out, trampled upon, and wetted by the cattle, that process is commenced, although the temperature of the heap should be far below 100°. But although the bulk of the manure is thus diminished by the evaporation, yet the effect upon vegetation of the ammonia contained in the vapour has not been conclusively ascertained; nor is there any proof that animal and vegetable substances, while in a state of fermentation, contribute to its support; for it appears from numerous experiments, that rank manure, although forcing the early growth of living plants, yet eventually contributes to their premature decay. Practice has long since decided that it is injurious to turnips, to which crop it is more profusely applied than to any other:* it renders corn crops foul; and on light and poor land, which, containing but little nutriment in the soil, requires all that can be furnished to it by the manure for the support of the present plants, its effect, though often seen to occasion them to push forth with great apparent vigour, yet frequently leaves them deficient in grain and subject to rust. The potato is, indeed, almost the only plant to which it has been found decidedly friendly; but even that is in many soils known to succeed better with short dung.

Respecting the *effect of unfermented dung on Mr. Coke's*

* Mr. Walker, of Mellendean, who rents about 2800 acres of arable land, has found by the experience of thirty years, that a small quantity of rotten dung is sufficient for a crop of turnips, and that all the succeeding crops, in the common rotation, are also generally good; but he could never raise a full crop with long fresh dung, which, from its openness, tends to admit drought, instead of affording moisture and nutriment to the roots, while they are young and tender. He is therefore at considerable expense in carrying out, turning and re-turning his dung-hills, so as to have the dung in a putrid state when laid upon the land in the month of June. After all, he is every year obliged so to manure a part of his turnip land with fresh dung, *and whenever that is laid on, the crop is invariably much inferior.*—Husbandry of Scotland, vol. i. p. 161.

crops, it has been observed, in the treatise to which we have already alluded, that the statement is only entitled to weight upon the construction either that some of the manure made on the farm that was expended under the old system is disposable for some other purpose under the new; or that some expense in fetching manure from distant places, that had used to be incurred, is saved. For, if the assertion 'that his crops have been as good as ever they were, and go nearly twice as far,' means only that the dung when now expended is nearly twice as much in bulk or weight, and covers the surface of the field more thickly in the same proportion, the benefit is merely illusory, as the crop does not thus appear to be increased; but if the meaning is, 'that twice the surface is manured as effectually with the same quantity of dung'—then, indeed, we should say that the new plan may be fairly considered as entitled to the most serious consideration.

The same author, indeed, mentions an instance—cited in Dr. Thomson's System of Chemistry—of an experiment, from which it appears that the periods when putrescent manures begin to produce their effects, and the length of time during which they continue to operate, are proportioned to the degree of putrefaction under which they are applied. Two pieces of the same kind of soil were manured—the one with a mixture of dung and straw highly putrefied, the other with the same proportions of dung and straw newly mixed, and the straw almost fresh. It was then observed that, during the first year, the plants which grew on the putrefied dung produced a much better crop than the other; but the second year, the ground which had been manured with the fresh dung produced the best crop: the same result took place in the third year, after which both pieces seemed to be equally exhausted. This, however, only showing that the one was productive of the best crop in the first, and the other in the second year, proves nothing more than an equality of final effect upon the land: upon which it cannot escape reflection, that when the state of the soil does not require progressive improvement, the first crop is generally the main consideration with the farmer; he naturally, therefore, wishes to place it beyond the reach of those contingencies to which it might be exposed by any deficiency of effective manure. A knowledge of chemical principles, indeed, leads to the inference, that dung ought to be used in a recent state; and it has been thence assumed, 'that any disappointment which, in practice, may have at-

tended the adoption of that inference, will be found to have arisen, not from a defect in the theory, but from a want of due observation of circumstances in its application.' But whatever may be found in the writings of scientific agriculturists in favour of unfermented manure, the experience of practical men may, in most cases, excuse a doubt of its expediency.*(*a*)

Regarding the *application of straw*, which the Professor thinks 'should be ploughed into the soil in a fresh state, and that, in order to facilitate its mixture with the earth, it might be chopped small with a machine,' we deem it almost unnecessary to add any thing more to the observations we have already made, except the record of an experiment made upon dry wheat straw, which was regularly laid in the hollows of drills, and potato-sets placed over it. The straw and sets were then covered with earth, yet very few of the potatoes ever appeared above ground, and these only towards the end of autumn. When the ground was ploughed up, the straw seemed to have undergone no change, nor did it impart any sensible benefit to subsequent crops. Had the same straw, however, been previously subjected to only a moderate degree of fermentation, there can be no doubt that its effects would have been very different; for, in most soils, potatoes thrive in dung which abounds in litter that has been very slightly fermented.

In fine, although coinciding in the opinion that the decomposition of putrescent manure may be—and is very generally—carried too far, and that its value is materially lessened by an excess of putrefactive fermentation, yet experience proves that, to a certain extent, it is absolutely requisite, though its

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* In the papers selected from the Correspondence of the Bath and West of England Society, there are queries proposed by the Board of Agriculture on several subjects connected with cultivation. The answer by one of their most distinguished members to that regarding manure, is as follows:—

'*What are the effects of dung and other manures upon the taste, flavour, and wholesomeness of vegetables?*'

'If the dung be completely rotten, the effects will be quickness of growth, succulence, crispness, and delicacy of flavour. I strongly suspect that the application of ill-digested manure to land is an evil productive of very great injury. Worms and grubs are multiplied thereby—the most noxious vapours are propagated; and probably, the diseases in our grain crops may originate in this circumstance. I cannot believe that the delicate fibres of a root, making an effort to penetrate a clod of putrefying dung, can escape uninjured; and vegetable diseases, I presume, often commence at the root.'—Vol. ix. art. xix. p. 235. 'I have known recent manure check vegetation.'—Ibid. p. 232.

(*a*) [The rankness of fresh manure does not affect Indian corn, or most root crops; but injures wheat and other grains—increasing the liability to blight or mildew.]

positive effects upon vegetation are still so doubtful that the degree can only be ascertained by observation. The main agents of the process are water, heat, and air. If a dung-heap be much wetted, the operation proceeds very slowly; but when only moisture is retained sufficient to condense it, then it presently heats, and the fermentation proceeds so violently that, if not checked, a large portion of its bulk seems to escape by evaporation; though, if this be only the effect of the condensation of its materials, and if its weight be not also reduced, the residue may perhaps be thus rendered more nutritive. The opposite result may, however, be the fact; for it may be observed that, if a quantity of farm-yard dung be removed from a dung-hill and turned loosely to the air, though it may be cool at first, yet, if moderately wet, it will soon generate heat; it will smoke violently, and emit a very pungent effluvium: from which it may be conjectured, that the nutritive properties of the manure would have been better preserved if it had not been exposed to further fermentation. Care should therefore be taken to preserve those exhalations from being dissipated, and it will be probably found that the object will be sufficiently attained if the vegetative power of seed-weeds be destroyed, and the fibres of the straw be reduced to the state of spit-dung.

Some fermentation will necessarily be ever going on in the dung-heap; but there is little danger of its being carried too far if the ingredients which it contains be well and properly mixed. If horse-dung alone be employed, it will soon proceed to an excess, occasioned by its own internal heat, that will deprive it of every fertilizing quality; but if mixed with the cooler dung of horned cattle, that risk will be in a great measure avoided. Then, if the dry contents of the covered sheds be also added to the mass of wet litter in the straw-yard, the whole mixture will undoubtedly not ferment beyond the point best suited to render it immediately available. 'In a large dung-hill, of such a mixture, the heat of the active fermentation subsides in it long before any of its useful parts are destroyed, and long before even all the water which it contains is evaporated out of it; for, on examination, the manure will be found to be quite short, and easily lifted with the fork or shovel; while, at the same time, it will be saturated with the richest black-coloured juices, which appear to be the essential parts of urine deprived of their water.' We, therefore, consider it as the opinion of a large majority of the most intelli-

gent farmers, that dung should not be laid upon the land until it has undergone such a change as may be sufficient to destroy the seeds and insects which it may contain. This, however, cannot be effected except by a putrid fermentation, which, under common farm management, cannot be completed until the heap be decomposed and cool; for otherwise, the operations of cartage, spreading, and ploughing in the manure, while in a state of heat, would dissipate the gaseous matter, and thus occasion the loss of that in which its nutritive powers are partly supposed to consist.

Produce of Straw and Dung.—The *quantity of straw grown per acre* depends upon such a variety of circumstances touching soil and cultivation, season, and kind of crop, that it is quite impossible to form any precise calculation on the subject. Estimates have however been made of the average weight of different sorts produced by the various species of grain, from which a general idea of their gross amount may be formed. Although it is clear that nothing like accuracy can be expected on that point, yet it is in the power of every farmer to form a tolerably exact notion of the weight of all the straw actually grown upon his own land; and coupling this with the number of his live-stock and the nature of their food, he will probably be able to make out such a rough calculation of the *gross quantity of farm-yard manure* as may not be far from the truth. Such an account may indeed appear at first sight to be more curious than useful; but crops depend in a great measure on yard-dung, and their rotation must be regulated, on most soils, by its amount; it is therefore important to ascertain, as nearly as possible, the quantity on which a man who is dependent upon its production alone, without purchased manure, can rely, before he lays his plan for the ensuing year. The following are some of the estimates alluded to:—

31 cwt.	or 3472 lbs.	. .	wheat	. . . .	160st.	or 3520 lbs.
25 "	2810	. . .	beans and pease		130 "	2860
25 "	2800	. . .	oats	. . . .	130 "	2860
20 "	2240	. . .	barley	. . .	100 "	2200

Rye, about 3 loads of 36 trusses each, or 3888 lbs.

The yield of different years varies the proportion which all grain and pulse bear to the straw; but the average of wheat is about 12 bushels to the *load*, which, according to the practice in most parts of England, consists of 36 trusses of 36lbs. each, and weigns 11cwt. 2qrs. 8lbs.; but according to the above statement, the whole average of the kingdom is supposed to be about 1¼ ton per statute acre.

It has however, been calculated by Dr. Coventry, the Professor of Agriculture in the University of Edinburgh, that arable land of a medium degree of fertility and management, is capable in ordinary years, of producing, in round numbers, per imperial acre, about 28 bushels of wheat, 36 bushels of barley, and 42 bushels of oats; and that the average quantity of straw yielded by those crops will amount to 21 cwt. He then states that, supposing this dry straw to be moistened and rotted, it would thereby gain an addition to its weight equal to two-thirds, or between three-fourths and two-thirds of its gross weight—thus producing about 3½ tons of manure: and admitting that some corn is consumed in the feed of horses, as well as that the refuse of the grain, the chaff and light corn, besides the straw, go ultimately to the dung-heap, 'one cannot reckon the amount of the putrescent manure gained from an acre of such produce at more than 4 tons.' But, judging by the like proportion of moisture of different parcels produced by straw, pulse, hay, or herbage of any sort, 'it is likely that a full produce of turnips, potatoes, or cabbages, would furnish even a considerably greater weight.' By an experiment very carefully made by Mr. Dudgeon, of Prora, in East Lothian, it however appears that dry straw had only increased by absorption from 300 to 719 stone, during a period of seven months; which is materially at variance with the Doctor's estimate of the addition to its weight. It seems, however, from the statements of several eminent farmers, that 1 ton of straw, when augmented in weight by the dung and urine of turnip-fed stock, will, if properly managed, produce about 4 tons of farm-yard manure;* but others, with more justice we think, are of opinion that such a quantity can only be produced when the common number of cattle on farms in the ordinary course of cultivation are also fed in the usual way—upon hay, clover, and corn, as well as turnips, besides being well littered with straw. Its weight and value will of course be affected by its state of preparation, as well as by the nature of the soil and its cultivation. Meadow land which produces 1¾ tons of hay per acre has been calculated to give 6 2-5, or rather more than 6 tons of manure per acre, and the fallow crops produce a large

* Sinclair's Code of Agriculture, 3d edit., pp. 215, 440; Scottish Husbandry, 2d edit., vol. i. p. 379, and *passim*. A Berwickshire farmer gives a single cart-load of turnips per day to eight or ten cattle in the straw-yard. He finds that, on an average of three years, from 2½ to 3 acres of straw will winter one of those oxen; and in this way each acre of straw will produce about four double cart-loads of rotten dung, of from 30 to 35 cubic feet each.

amount; the land, therefore, without assuming any extraordinary degree of fertility or management, should yield, upon an average, at least 4 tons of manure per acre; to which if be added the extraneous substances which may, with due care, be collected without expense from the roads, the ditches, the ponds, and from refuse of every kind about the house and premises, the acreable amount should be amply sufficient for a full supply of manure once during every course of the four-years' system of husbandry.

We fear, however, that, looking to the system of cultivation pursued on most farms, the quantity of manure produced falls far short of that amount. Much, indeed, depends upon its judicious management, for a good farmer will accumulate perhaps nearly twice as much dung as his more indolent and inattentive neighbour, and apply it in better condition to the land, though their opportunities are, in this respect, the same. No means should, therefore, be neglected to supply the deficiency; in which view, besides the extension of the soiling system, we should strongly recommend that corn crops should be cut as low as possible, so as to increase the bulk of straw. When the stubble is left high and ploughed in, it retards the operation, renders the land foul, and is, on some soils, injurious by rendering them too open. It is, indeed, in many places mown, and converted into walls for the comfort of the cattle. In Derbyshire a paring plough is used, by which the roots of the corn and weeds are cut, and the stubble and other stuff is then carried home to be trodden into muck; but the produce does not pay the expense, and it has been found a more economical practice, when it can be carried into effect, to burn the stubble on the ground, by which insects and the seeds of weeds are destroyed. Even when raked up, it has been considered advisable to spread and burn it on the land, as it is thought to have a great effect in preventing the ravages of the fly on turnips.*

Compost.—We have already observed upon the expediency of mixing the bottoms and crusts of dung-pies with the other materials of which they are composed when they are turned over; but the quantity may not only be greatly augmented by

* See the Surveys of Essex, vol. i. p. 325; Huntingdonshire, p. 128; Derbyshire, vol. ii., pp. 124, 131, 406. In a work published about a century ago, and ascribed to Lord Belhaven, it is asserted that the goodness of the East Lothian crops was attributable to the length of their stubbles. 'A good crop of corn makes a good stubble; and a good stubble is the equalest mucking that can be given.'—The Countryman's Rudiments, p. 23.

a larger addition of earth, but, by imbibing the juices of the dung, a *compost* is thus formed, of excellent quality in its application to most crops, as well as soils, and especially to grass-land. It has indeed been objected to this, that the mixture of earth increases the size of the dung-hill without adding to its virtue, while the expense of carriage is also thus unnecessarily incurred, and that the more manure is reduced to its essence the better. But, although this may, in some instances, be true, yet experience proves that a compost of this nature becomes converted into a very fertile mould, and in some sorts of unkindly land, small dressings are of little benefit. On such soils, portions of pure rotten dung get fast locked up in large clods, and are rendered useless to that crop; but the increase of bulk, by the addition of earth, admits of a much larger heap being applied, as well as of being more readily united with the ground by the plough, so as to render the tilth more manageable. In many cases, the mixture has been therefore found essentially useful; and though the charge of cartage is certainly an object of moment, yet that may be lessened by forming the composts upon the headlands of the fields to which they are to be applied. They may also be put together at any time of the year, which, especially in summer, is of itself an incalculable advantage. The ground should, however, in that case, be previously summer-fallowed, unless it be entirely free from weeds; or a small quantity of quick-lime may be added to the earth, but it should not be allowed to come into immediate contact with the dung. When, however, the economy of carriage is not thought an object of so much consequence as to confine the raising of the compost to any particular spot, it will be advisable to select earth of the alluvial sort, which is always of a rich, greasy nature, often mixed with marl, and well calculated to invigorate poor soils of a light and open texture: or loam: or, if nothing of the kind is to be had on the farm, then with earth of a quality as opposite as possible to that which predominates in the soil on which it is to be laid; and the whole should be well turned, so that it may be suitably fermented. The operation is thus performed:—

A bedding is formed of earth, or of sods with the grass uppermost, upon which a layer of fresh dung is placed—the fresher the better—about a foot in thickness; upon that another layer, equally as thick, is laid,—if of sods, doubled, with the grass sides turned back to back, so as to present one

surface to the dung underneath, and the other to the next uppermost. In this manner the heap is raised to the height of 5 or 6 feet, when it is entirely covered with earth, but formed narrow, as well as high, in order to expose a large surface to the air. Sometimes lime is added, but, in that case, it should be either placed between two layers of earth; or, if between the sods, the grass should be reversed, and the lime be deposited between them, or between the earth and another layer of any other ingredient not so easily decomposed as the dung. The heap then ferments, and in that state it is left until it be completely cooled to the centre. When the heat has entirely subsided, the compost is to be then turned in such manner as that not only the uppermost part shall be underneath, but also that the outward portion be put in the middle, and that the whole be intimately mixed. If any part of the dung be dry, it should be well and equally wetted,—if possible with urine, or with the drainings of the farm-yard,—as each layer is removed, and previous to their mixture. The number of turnings must depend upon the state of putrefaction of the dung, as well as that of the turf, if sods or other materials have been added. The proportion of dung, or other putrescible substance, to earth, must be governed by the qualities of both, and by the judgment of the farmer in their selection and use. The following—which has been adopted in Norfolk—will afford a general idea of the mixture of such a compost, when confined to mould and farm-yard dung:—

Mould for the bottom	160 loads.		
Dung from the bullock-yard and stables, a load of each alternately			112 loads.
Mould for the next layer . .	42		
Dung for ditto			48
Mould for the top and sides . .	42		
Total	244	+ 160 =	404 loads;

which, after being turned twice over, produced 300 loads of manure, and was intended for 20 acres.

Another practice prevails among many farmers, which, so far as the production of manure is concerned, has the advantage of allowing the compost to imbibe the whole of the urine in the yard, but which is also attended with the inconvenience of bedding the cattle in a manner which, without great care in its frequent removal, must expose them to much want of comfort. It is as follows:—

Turf, or any other species of earth, is spread over the yard to the depth of upwards of 2 feet, except around the buildings, to the

extent of perhaps 6 or 7 feet, which is left as a path. It is then laid over with straw, to which the litter from the stables is also added, and upon this bed the feeding-cribs of the store cattle are placed. In this manner the dung is often allowed to accumulate during the entire winter, or until it rises to such an inconvenient height as to compel its removal; it is then either piled in the yard, after being mixed and covered over with earth, and left there until it may be wanted in the autumn, or else carted out to the mixen, and there treated as already stated.

In using turf, or any kind of grass, in the mixture of a compost, it will be proper to recollect that, if taken up during most parts of the summer and autumn, it will not only be found generally impregnated with the seeds of weeds, but that grub-worms, wire-worms, and various other insects, usually select dry banks by the road-side, hedge-rows, or dry pasture, in which to deposit their eggs. When turf or earth is carried from such places, and added to the compost without having been previously subjected to the processes of tillage, the greatest care should be taken, either that it be turned up a full twelvemonth before it is applied to the land; or, as we have already observed, that quicklime be strewed between the sods, in order to guard against every chance of their propagation.

The Application of Dung to different soils and crops, though matter of wide discretion to the farmer, is yet a subject which admits of a few general directions. Notwithstanding what has been already said respecting the practice of those farmers who allow this manure to lie for a long time upon the surface of the land, we however agree with the opposite opinion—that it should be spread the moment it is taken from the cart, and completely incorporated with the soil; for by tillage it becomes amalgamated with the inert particles of the earth, through which means both that and the dung form one substance in the fittest state of nourishment to promote vegetation.* It should not, however, be deep buried in the soil at first; for, though it is the prevailing opinion of many persons,

* This has been exemplified by the observations of Marshall upon a crop of wheat of 4 quarters the acre obtained from his own farm, after peas, which had been dunged and thoroughly incorporated with the soil: while another field of wheat, sown at the same time, and fresh dunged with fine spit-dung, superior both in quality and quantity, but which had been ploughed in large lumps along with the seed, only produced 2 quarters.—Min. of Agric.

that, by deep covering, the dung is defended from the injurious effect of exhalation—that the roots of plants soon find their way to it—and that it will be raised higher by after-ploughings,—yet there are men of accurate observation who, from long experience, have found that, if dung be only just covered, the nearer it is to the surface, the greater are its effects in promoting fertility, for then it lies near the roots of young plants at the time when they need the most cherishing aliment. They also declare, that dung never rises to the surface after it has lain mixed for a season with the soil; but, on the contrary, that, as it dissolves in the earth, the solution descends as low as the soil has been stirred by the plough.

It is another rule in the application of farm-yard manure, among good farmers, not to use a greater quantity at one time than may be supposed capable of producing a good crop; for, although land can hardly be rendered too rich for the production of green crops, yet wheat, barley, oats, and rye have often been so much injured by a profuse supply of dung, that they have run almost entirely to straw. We have lately seen wheat, on good and well-tilled land, in the possession of an extensive coach-master, which has scarcely yielded two quarters the acre, in consequence of the application of stable-dung; and it is well known that a good crop of grain cannot be grown upon a dunghill. It should not, however, be too sparingly administered, for if an insufficient quantity be laid on, it may not reimburse the expense; whereas a full supply will probably have the effect of producing an abundant crop. A medium should therefore be observed; but so much depends upon circumstances,—upon the strength of the manure, the nature of the soil, and the intended crop and culture,—that no precise amount can be stated. Various calculations have indeed been made by different writers upon the subject, but they are generally so vague, that they only estimate the quantity in *loads*, by which no precise meaning can be defined, for it must depend upon the size of the cart; and even when calculated in cubic yards, the weight will differ according to the state of the manure, though one cubic yard of well-rotted dung may be generally supposed to average about 11 cwt. A well-heaped one-horse cart will carry nearly a ton, and those drawn by two horses about 1½ ton; a small wagon is also commonly supposed to contain two cubical yards, each consisting of 27 bushels, when estimated by strike-measure, and twice as much if heaped; or a proportionate quantity in weight.

On *strong soils*, farm-yard manure is very commonly applied to a summer-fallow for wheat; and when that process forms part of the rotation, it is the opinion of most intelligent husbandmen that it can at no time be more profitably employed. The season is then so far advanced as to have afforded time for the preparation of the winter dung, which, on clay-land, where green crops are not generally grown, and the practice of summer soiling is not adopted, is otherwise a difficult matter; but when applied to corn-crops, it should be either already decomposed, or, if fresh, it should be allowed to remain so long in the ground, previous to the seed being sown, as to allow of its fermentation being completed; for it will otherwise occasion the growth of weeds, which, if not eradicated, may ripen before the ensuing harvest, and thus infest the land with future foulness. When the operation has been well performed, and the ground has been thus completely cleansed, it is then found to be so well divided, that, if minute attention be also paid to the spreading of the dung, it becomes so thoroughly intermixed with the soil as to insure a greater return than if it had been laid on during any other periods. The practice is also not uncommon of laying it upon clover leys preparatory to a crop of wheat, or of spreading it upon green-sward a year or two before the land is broken up; but the advantages of this latter mode have been doubted by some, though many experienced practical farmers highly recommend it.

On *light land*, on which the rotation of crops usually commences with turnips, it has been found by experience that the dung should be well rotted; it is therefore generally mixed twice, in order to get it into a fit state; but, as Swedes are commonly put in the ground by the middle of May, the manure cannot be properly prepared by that time, unless the yards have been cleared during the winter, and much of that which is thus applied is over-year muck. This, when the crop is drilled, is laid as evenly as possible in the hollows of one-bout ridges, which are afterwards split by a double-mould-board plough, which covers the dung, by turning them over, and the seed is immediately sown above it; but when sown broadcast, it is regularly laid over the land, generally before the last ploughing, though some farmers give it a second stirring. When potatoes are planted, the manure used is almost invariably stable-dung, when it can be procured in sufficient quantity, which is laid in a shallow seed furrow, immediately under—or,

in some cases, over the cuttings; but care should be taken that it be put so deep in the ground as to be out of the way of the harrows, or, otherwise, their hold of the straw might occasion the sets to be removed from their seed-bed.

Even when bare fallows become necessary to clean the land, soils of this description are rarely dunged when followed by corn; for they are thereby rendered so open—especially if long dung be used—that the plants are apt to be thrown out by slight frost in the spring, and perish for want of a sufficient hold of the ground. This necessity for the employment of rotten dung not only lessens its bulk, but it must be also borne in mind that the same quantity of straw is not produced as upon rich clays; and although the deficiency of manure thus created may be partly made up by feeding sheep upon turnips, as well as by a smaller quantity being used than upon strong land, yet the exhaustion of light soils is more rapid; they therefore require more frequent replenishment, and no pains should be spared to increase the amount of dung.

On *grass land* in the neighbourhood of London, where the finest meadow-hay in the kingdom is grown, dung of every kind is laid on in all states, both fresh and rotten; and much town-manure, or street-slop, partly in a liquid state, is thrown over the ground in the same condition as when taken out of the carts and barges. It is a cold, clayey district, lying on the north side of the Thames, in Hertfordshire and Middlesex, and has been brought to its present fertility solely by the aid of an unceasing application of manure; many of the farmers being under covenants in their leases to lay on a thick coat of stable-dung, thoroughly rotten, in every third year: others apply it fresh,—in which state it is said that, 'load for load, it is to the full as good as when rotten,'—and after it has been washed in by the rain, the straw that remains is raked off and added to the dung-hill. There can perhaps be little doubt that dressing the land with dung in a state of fermentation, when diluted with water, is the surest way of imparting nourishment to plants; and in that view, after the hay has been carried off the land, farmers watch for a change of weather, and, when the barometer indicates an approaching fall of rain, they lay on whatever manure they possess; but, if the season continues settled, the dung remains untouched until about the end of September, at which time it is applied while the ground is sufficiently dry to bear the drawing of loaded carts without

injury, and when the heat is so moderate as not to exhale its volatile parts.*

In all these cases the product is abundant, because the land, though cold, yet grows good grass, and, whatever may be the nature of the manure, sufficient is always laid upon it to secure a crop; but it is only in the vicinity of the metropolis, or in other great towns, and through means of purchased manure, that such a supply can be obtained as that given to the land in question.

The use of compost of earth and farm-yard dung has been used as an argument against its employment upon meadow-land, because of the difficulty of its entrance into the soil, and that pure dung has a more immediate effect upon the crop. Upon land such as that just mentioned, the objection is well founded; but upon soils of a loose texture, the mixture of earth —particularly of clay—with the dung, by increasing the bulk to be laid upon the land, tends to bind it, and thus giving a firm hold to the roots of the grass, the finer sorts, which either have not strength enough to penetrate the ground, or the seeds of which have lain dormant, suddenly spring up, and the sward is thus improved. Of this a striking instance in point has been related by Mr. Dawson of Frogden, who, 'having occasion to carry a quantity of very fine black loam from a head-ridge of old in-field land, to give the surface-water a free passage, it was laid upon out-field bent-grass-land adjoining, of which it covered about a quarter of an acre fully an inch thick. No grass-seeds were sown upon this new covering, yet white clover and other fine grasses sprung up, and gradually increased upon it; and the bent, upon which the loam was laid, diminished so speedily, that very little of it remained in the third year thereafter.' It is, however, well known that the effect of dung is proportionately greater upon good than upon bad land, and the difference is still more considerable upon that which is under grass than what is arable; for it is observable that the dung of animals has scarcely any effect upon coarse pastures, but it perceptibly improves those which are covered with the finer grasses, and is of more or

* Middlesex Report, 2d edit., pp. 286, 287, 377. In the Leicestershire Report it is also said, 'Dung or compost should be laid on meadow-land immediately after the hay is carried off; for as at that time the ground is generally the driest of any time of the year, carting on it will not cut the turf: there is the least grass to destroy; it insures good aftermath; and the winter rains will wash all the manure into the soil, so that it will receive the whole benefit of the dressing.

less value, as herbage of the former or latter description predominates. This improvement is, however, far more sensible when aided by the application of lime, as we shall have occasion to notice when we come to treat of that fossil.

There is, indeed, evidently a mistaken practice throughout most parts of the kingdom with respect to the application of manure. The custom alluded to is that of laying it upon land of an inferior quality, while that of a superior kind is in equal want of improvement; the better part of many farms being thus in some degree impoverished by attempting to improve, at an evident loss, the poorer parts. Others, indeed, follow the opposite system; but, when justice is done to the land, every part in rotation should receive the manure arising from its produce. There are, however, some rare instances of ground of so rich a quality, that by laying any manure upon it an injury would be sustained; but, upon the whole, it is an evident fact that any manure whatever—if not of a nature unsuitable to the soil—will be always attended with a proportionately better return when laid upon good, than upon poor land.

In the *spreading of dung upon the land*, the common practice is to put it first out of the carts in hillocks, and afterwards to spread it upon the ground. Many farmers, however, take the opportunity of carting out their manure during a frost, and there leaving it in heaps until a thaw. The convenience of this is evident; and perhaps, during that weather, no great damage will happen to the dung, nor can much of its juices be imbibed by the soil: but if thus left, even for a short time, in open weather, the spots upon which it is laid get more than their share of the dressing, for the moisture is imbibed by that part under the manure, whilst the upper parts are dried by the action of the air, and lose some portion of their fertilizing power. Its effect is thus unequal; the crop will vegetate more luxuriantly on those spots, and the harvest will not be uniform. There is also this inconvenience in thus leaving it upon the soil—that, if the land lies upon a declivity, a considerable portion of the manure may be washed out by the rain, and either carried to the lower part of the field, or else lost in the ditches.

Another mode is for both the carter and the spreader to stand in the cart, and shake the manure out with forks; but although this has the advantage of a more ready distribution, yet, if the men drop a forkful by accident, or do not scatter a lump in the manner intended, they cannot stop to divide it,

and it must lie where it falls. The repeated stoppage of the horses also occupies much time. Both these modes are therefore attended with inconvenience.

When carefully done, the distance to which the dung is to be carried to the field should be ascertained, and such a number of carts employed as will give constant occupation to both the men and cattle: thus, supposing three to be sufficient, then two teams only—of whatever number—are to be worked, one going and the other returning, while the third cart is left standing at the dung-hill to be filled, and replaced by the one which has returned empty, the cattle in which are then taken off and harnessed to the other, so that no time is lost. It should be spread immediately, and can never be done at any other time so cheaply. It is, indeed, decidedly the most economical method for the carter to spread it from the carriage; but as he cannot do this with the minuteness which is requisite to separate it completely and spread it equally over the soil, such a number of women or children, attended by an overseer, should be employed to follow the carts, as will effect this in the most perfect manner. That number will of course be regulated by the condition of the manure, the quantity to be used, and the distance from which it is drawn. The farmer himself, or some trusty person in whom he can confide, should not only determine the number of loads that are to be spread upon each acre, but should carefully regulate the distance which each load should cover, by measuring the quantity of land: this, when it is laid on in regular ridges, is very easily ascertained by pacing them, and summing up the length and breadth of the ridges; and then it is only needful to direct the carter to make each load cover a certain space,—as one load upon one ridge, or three loads upon two ridges, &c. But if it is determined to lay down the manure in small heaps for the followers to spread entirely, in this case, the distance of each separate heap should be paced over and marked.* The regularity of the distribution of manure ought never to be intrusted to common labourers without superintendence. If the carter be employed, unless a boy be given him to drive, the necessary degree of equality can hardly be expected. It may also be sometimes advisable to lay a larger quantity upon one part than upon another of the same field, for the soils may

* A table, stating the number of heaps or bushels per acre, will be inserted at the close of the volume.

differ; or it may lie upon a declivity, in which case it will only be prudent to put more upon the upper part than upon the bottoms; for, even under the most careful distribution, they assuredly will receive an additional portion, which will be swept from the heights. Care is also requisite, in carting out dung and all manure, to make the drivers keep on the head-land till they come to the end of the land which is manuring, so as to make each ridge bear its exact proportion of damage; or, for want of such attention, the men, if left to themselves, make roads across from the gate in every direction, to the great injury of the crop.

Such is the most approved mode in the broadcast manner; but where the drill husbandry prevails, it is by no means unusual to lay the dung in the intervals of these small ridges, as practised for turnips throughout Scotland and the north of England. The drills are in this case generally formed at the distance of 27 inches, or thereabouts, from the centre of each; and by driving the carts along the middle one of the space intended to be manured, the dung is drawn out in such proportions as may be judged necessary. If the breadth of three drills be only taken at a time, the dung stands a better chance of being equally laid in them; for it often happens that, when a greater number are included in one space, the outside drills receive a less quantity than those which intervene. Others, however, thinking that by only taking three drills at a time, the travel of the horses is unnecessarily increased, take five drills into one space; but, in that case, the number of spreaders must be increased, as at least one is requisite to each drill, and unless care be taken in the superintendence, some inequality will occur in the distribution. It is, however, obvious that the labour of the teams, as well as the poaching of the land, will be thereby lessened; and if a sufficient number of spreaders be employed, the work will also be more speedily executed. Women and children, having light grapes, or forks, are strong enough—four are generally found sufficient for what is called 'a head of carts;' and the spreading is adroitly performed even by small boys and girls, after they have been a little time accustomed to the task.

It is obvious in the *ploughing down of dung* that, if it be not turned down accurately, it becomes partly exposed to the atmosphere, instead of being buried in the soil. Skim-coulter ploughs have been used to obviate this inconvenience, but—especially in the case of long-dung—there is great difficulty

in preventing it from choking the instrument, thus occasioning a great increase of draught to the cattle, as well as of labour to the ploughman, rendering the land foul, and defeating one of the main objects of good husbandry. It is also, by some farmers, thought expedient to bury fresh dung so deep below the soil as to allow it to ferment there without being disturbed by the harrows, or even by the shallow ploughing of successive tillage; but, independently of the objection which has been already raised against that practice, it is not, in any such case, found easy to make clean work.

Many attempts have been made to correct this fault, and considerable improvement has been effected in the construction of ploughs, particularly by the Scotch, some of whose iron swing ploughs have gone far towards a remedy of the defect.

As relating to the quantity of *farm-yard dung necessary for raising a course of crops* upon arable land of various soils, and under different systems of cultivation, with the proportion which they are capable of producing; this it is an object of primary importance to ascertain, as precisely as possible. Assuming some admitted facts as data upon which to ground our opinion of the quantity of putrescent manure which may be generally sufficient for an acre, we nearly agree in the opinion expressed by Doctor Coventry, and collected from many other accounts, that from four to five tons are yearly requisite of that kind commonly prepared, and in its usual state of decomposition, as spit-dung. According to that calculation, it must also be observed that the course of crops is supposed to consist—on light soils, of the alternate plan of corn and green crops,—on clays which do not admit of that system, that the holding contain a proportionate quantity of grass-land; and that the quantity of manure should be supplied, not in small quantities annually, but in large ones, at intermediate distances of four, five, or six years. Light soils, in the common course of husbandry, rarely require the application of putrescent manure oftener than once in four years, and in all cases where the clover is allowed to stand during two seasons, it may be deferred without disadvantage for another year. Heavy soils may run six years without it, provided that the land be laid one year in fallow, and that there be sufficient meadow to be reckoned at least as one crop in the course. It being, however, clearly understood, that—whether on light or heavy land—nothing but grain, seeds, and live stock is to be sold off the farm, unless replaced with an equal portion of

purchased dung; that the whole of the green crops, the haulm of pulse, and the straw of corn be used in the most economical manner; and that some of the live stock be either soiled or fattened upon oil-cake: which plan, if carefully pursued on good soils, with capital sufficient to secure an abundant working and fatting stock of cattle, ought, under fair management, to furnish an adequate supply of dung for any of the usual courses of culture.

Having thus submitted to our readers all that occurs to us of importance on the subject of farm-yard manure, we shall here recapitulate a summary of the chief points which we deem particularly worthy of their consideration:—

1. To bottom the farm-yard with any loose refuse that takes the longest time to dissolve; and over that to bed it deep with straw. 2. To occasionally remove the cribs of store cattle to different parts of the straw-yard, in order that their dung may be dropped, and their litter trodden equally. 3. To spread the dung of other animals, when thrown into the yards, in equal layers over every part. 4. To remove the dung from the yard at least once, or oftener, during the winter, to the mixen. 5. To turn and mix all dung-hills, until the woody or fibrous texture of the matter contained in them, and the roots and seeds of weeds, be completely decomposed, and until they emit a foul putrid smell; by which time they reach their greatest degree of strength, and arrive at the state of spit-dung. 6. To keep the dung in an equal state of moisture, so as to prevent any portion of the heap from becoming fire-fanged. If the fermentation be too rapid, heavy watering will abate the heat; but it will afterwards revive with increased force, unless the heap be either trodden firmly down or covered with mould to exclude the air. 7. To ferment the dung, if to be laid upon arable land during the autumn, in a much less degree than that to be applied before a spring sowing. 8. To lay a larger quantity on cold and wet lands than on those of a lighter nature; because the former require to be corrected by the warmth of the dung, while on dry, sandy, and gravelly soils, the application of too much dung is apt to burn up the plants. Stiff land will also be loosened by the undecayed fibres of long-dung, which, although its putrefaction will thus be retarded, and its fertilizing power delayed, will yet ultimately afford nourishment. 9. To form composts with dung, or other animal and vegetable substances, and earth, for application to light soils. 10. To spread the manure upon the land, when carried

to the field, with the least possible delay; and, if laid upon arable, to turn it immediately into the soil. 11. To preserve the drainage from stables and dung-hills in every possible way; and if not applied in a liquid state, to throw it again upon the mixen.(*a*) 12. To try experiments, during a series of years, upon the same soils and crops, with equal quantities of dung, laid on fresh, and afterwards rotted; in order to ascertain the results of their application to the land. The whole quantity to be first weighed, or measured, and then divided.

The fermentation of farm-yard manure is, in fact, a subject of far greater importance than is generally imagined, for on a due estimation of its value mainly depends the individual success, as well as the national prosperity, of our agriculture. The experiments to which we point cannot therefore fail to come home to the interests of every man; they may be made without expense, and without any other trouble than the mere exercise of common observation and intelligence. Leaving, however, aside the discussion concerning the disputed worth of fresh or fermented—of long or short dung—let the farmer sedulously bend his attention to the accumulation of the utmost quantity that it may be in his power to procure. The manner and the time of using it, in either state, must, however, be governed by circumstances which may not always be within his control; and every judicious husbandman will rather accommodate himself to the exigency of the case, than adhere strictly to his own notions of what he conceives to be the best practice. In fine, whether favouring the one or the other side of the question, let him collect all he can; apply it carefully to his crops; and then, trusting to events—'*let the land and the muck settle it.*'

(*a*) If it be not convenient to have stables with tight floors and a gutter, straw and charcoal, if kept in a cellar underneath, will be valuable for catching urine and retaining its volatile portions.

CHAPTER III.

PUTRESCENT MANURES CONTINUED.—NIGHT-SOIL—LIQUID MANURE.

Night-soil is not alone distinguished from the ordure of all animals by the extreme fetidness of its smell, but is also known to be of a stronger or hotter kind, and probably differs in its own qualities in proportion to the sort of provision from which it is obtained, as there is every reason to suppose that the excrement arising out of animal food is of a more active nature than that which is the produce of a vegetable diet. In all those places where the real value of this feculent matter is duly appreciated, and its preparation well understood, the aversion which its use excites is surmounted, and it is there preferred to all other manure. It has indeed been assumed that the excrements of a man, when used for this purpose, can be made to produce a sufficiency of corn and roots for his support; but, although that assertion has been exaggerated, yet were all the nourishment which could be extracted from this species of ordure made available, there can be but little reason to doubt that it would add largely to the production of the land; for it has been proved, by numerous experiments, to rank far before the dung of any animal. In this country, however, it is very commonly allowed to become decomposed through want of care, and vast quantities are carried off by rivers from the large towns, and lost in the bosom of the ocean—an inattention which has partly arisen from the disgust occasioned by its odour, and partly through a prejudice to which that disgust has given rise.

This repugnance proceeds from an idea that this manure communicates an unpleasant flavour to plants grown in the land upon which it has been used; and it has been also thought to have a bad effect upon the soil. Both of these objections are however groundless when due care is applied to its management. Instances are indeed said to have occurred, in which horses have refused the hay made from grass which had been manured with night-soil; but, if credit is to be attached to the assertion, it must have been produced by its having been spread in a fresh state, and upon grass of very forward growth. In proof of this is an instance, mentioned in

the Norfolk Report, of a field newly laid down to grass, every part of which proved very poor, except two acres on which four wagon-loads of night-soil were spread directly, without being mixed with any other manure. The field was fed off, and the effect of the night-soil is said to have been so great, that, 'while the rest of the field never seemed more than half filled with useful plants, this part thickened surprisingly, and grew most luxuriantly; so much so, that the cattle, neglecting the rest of the field, were perpetually feeding there, until by autumn it was pared down, like a fine green lawn by the side of a dusky, rough, ragged pasture.* In other accounts it is indeed reported as 'the most capital manure, of all other sorts, for pasture, two wagon-loads securing a carpet of herbage;'† and no bad effect is perceptible on vegetables, though kitchen-gardeners use it with profusion. It has been also asserted that nice judges of vegetables can distinguish a very unfavourable difference between the flavour of those grown in the vicinity of large towns or in the open country, and this they attribute partly to the use of night-soil; but it certainly communicates no unpleasant smell to the plants, nor even, after a very few days, to the ground on which it has been laid, for it is soon decomposed, and the effect complained of is doubtless more owing to the rapidity of the growth when forced by an excess of any stimulating manure, which renders them insipid; and were market-gardeners more sparing of the use of all dung, or were they to correct it into a compost by a judicious mixture of lime and earth, or a small portion of

* The same Survey also mentions the great improvement of a piece of sterile pasture by the application of night-soil mixed up with pond-mud, in the proportion of 7 wagon-loads of the former to 143 one-horse cart-loads of the latter. The soil was first laid upon the mud, the men then cut a trench through the heap, and throwing a small parcel into it, they worked it all to pieces. The compost was afterwards spread over the field at the total expense of 12*l.*; but at the present price of labour it would probably amount to half as much more.

† One wagon-load, containing 90 bushels of night-soil, costs in London 15*s.*, to which is to be added the charge of carriage to the farms, to which it is mostly conveyed by the Thames, or by canals. Much of it is used in Essex, mixed with five times the quantity of fresh earth, and sometimes together with an equal quantity of the muck and chalk, in which proportion it is commonly used, at the rate of one wagon-load of night-soil; and the whole charge, including that of spreading, is calculated to be from 2*l.* 13*s.* to 3*l.* 3*s.* per acre. The common price of stable-dung in London is 2*s.* to 2*s.* 6*d.* per hay-cart load, containing between 70 and 80 cubical feet: that of street-slop, called *cold manure*, is delivered by barges to the distance of about fifteen miles, by the canals, or within reach of one tide by the river, at about 3*s.* per ton.

slaked lime, the evil complained of would, no doubt, be removed.*

All unpleasantness of odour may indeed be prevented by the mere use of ashes; and were those thrown upon the night-soil, or into privies which have no communication with sewers, the ashes made in every dwelling-house would so completely absorb the fluid, that a solid heap of manure would be produced, that might afterwards be removed without difficulty or offensiveness. This, besides being common in many parts of the continent, is the regular practice throughout Hull;† and were it more generally followed in other towns, there can be no doubt that it would be attended with very beneficial effects to the agriculture of their neighbourhood. It is also collected in considerable quantities in London; and there was, a few years ago, a large manufactory for its preparation, in which it was dried and exposed to the sun by spreading it upon flag-stones gently inclined, to allow it to drain, after which it was broken into pieces, and removed under cover, where it was partially mixed with lime and completely reduced to powder. In this state it was packed into barrels, and exported even to our colonies, where it was used as a top-dressing, but was chiefly employed by market-gardeners, who used to sow it in drills along with their seeds, and, judging by the price at which they bought it, there can be no doubt that they found its use to be singularly advantageous; but the process has been abandoned, for, having been carried on in the heart of the town, it occasioned complaints of its offensiveness. This, from the inconvenience attending its conveyance, unless by canals, has greatly prevented its use: considerable difficulty has also been found in reconciling farm-servants to working at the preparation of this manure; but that objection can be easily overcome by a slight gratuity, and, considering its great value as a dressing, it ought not to be neglected. It is said

* Russell's Treatise on Practical and Chemical Agriculture, p. 205—Derbysh. Rep. vol. ii. p. 454. It is also contradicted by Count Gyllenborg, in his very erudite treatise on Chemical Agriculture, in which he mentions an instance of his having regularly watered a vine with putrid urine, but neither the grapes nor the wine contracted any bad taste.—Pilkington's Translation, p. 78. *Slaked lime* is, for this purpose, preferable to that which is *hot;* for the latter, when combined with animal matter, forms a manure which is not soluble in water.

† See a letter on the subject, detailing the practice, together with remarks on its extension, in the Farmer's Magazine, vol. x. p. 497. Also the General Report of Scotland, vol. ii. p. 525; and Communications to the Board of Agriculture, vol. i. p. 317.

that one load in its dry state, will be, in all cases, quite sufficient for three acres of drilled wheat.*

Its operation has been found quicker and more powerful than farm-yard dung; but not so lasting. Farmers who have used both on adjoining land have observed that the crops are always more exuberant in the first year where the night-soil has been laid, but that little or no difference has been afterwards perceptible.(a) Its effects, when spread alone upon field-crops, and directly ploughed in with a shallow furrow, are indeed so violent, that grain manured with it has been known to run entirely to straw; yet it has been used in that state as a dressing for turnips, and also for spring-wheat, upon the fallow, upon thin and chalky soils, upon which the largest crop and the finest grain was grown upon a very extensive farm, upon which it was laid to the extent of three wagon-loads per acre, though it probably was partly mixed up with the sweepings of streets. It should, however, be incorporated with other substances; and as it is very difficult to procure it in any other than a nearly liquid state, it is proper that every means should be taken to secure it. A mixen should therefore be made, consisting of fresh loam, decayed tanners' bark, peat, or any other like substance, to the depth of about two feet, to which the night-soil must be drawn, and then carefully thrown over it with scoops to a moderate thickness; after which another layer should be added of loam, or a compost of the same substances, and in the same manner, though not quite so deep as before; then another of night-soil, until the whole has attained the proper height, when it is to be covered with the same materials, to which if a small quantity of quicklime be joined, or mixed with the layers, it will assist the decomposition of the heap, and its nauseous effluvia will be destroyed. To every load of night-soil, about four or five times the same quantity of earth should be added, according to the nature of the soil, and to the degree of excitement intended to be applied to the land. It should then be regularly turned and thoroughly mixed, and may be used either for

* The following has been recommended as the best mode of pulverizing night soil:—'Spread it on a piece of grass; let it be well harrowed on a bright day; then put it under cover, and add a chaldron of lime to 4 loads of muck in that state, and it will become dry.'—Rigby's Framingham, p. 102.

(a) [Poudrette, prepared from night-soil, is fast superseding the latter, from its portability. It is applied at the rate of about ten bushels to the acre. On Indian corn it has been used with great effect.]

wheat or barley, in the proportion of one wagon-load of night-soil, containing as much as four horses can fairly draw, to the acre; but it should be used more in the manner of a top-dressing than buried in the soil. It has been laid on in the large proportion of 40 double cart-loads, and has afterwards been known to produce 5½ quarters per acre of spring-wheat, besides an uncommonly luxuriant crop of rye-grass and clover in the ensuing summer.* It is sometimes, also, mixed with the yard-dung for the purpose of exciting fermentation: this, however, is not advisable, for it produces its greatest effect in an unfermented state, and when thus mixed, its power is greatly lessened.

It is likewise converted into powder for the purpose of manure in Paris, and is also used throughout many parts of the Continent, but chiefly in the Netherlands, where, however, it is more commonly employed exclusively in a liquid state; of the preparation of which we extract the following account from the intelligent Report by Mr. Radcliff of the Agriculture of Eastern and Western Flanders.

Liquid Manure.—'This consists of the urine of cattle, in which rape-cake has been dissolved, and in which the night-soil from the privies of the adjoining towns and villages has also been blended. This is gradually collected in subterraneous vaults of brick-work, at the verge of the farm next to the main road. Those receptacles are generally 40 feet long by 14 feet wide, and 7 or 8 feet deep, and in some cases are contrived with the crown of the arch so much below the surface of the ground, as to admit the plough to work over it. An aperture is left in the side, through which the manure is received from the cart by means of a shoot or trough; and at one end an opening is left to bring it up again by means of a temporary pump, which delivers it into carts or barrels. Another cistern, of double that size, is, however, for the most part, formed under the range of stables, from each stall of which the urine is conducted to a common grating, through which it descends into the vault, from whence it is taken up by the pump; but in the best regulated there is a partition in the cis-

* Farmer's Magazine, vol. xiv. p. 161. It will not escape observation that the amount of this manure would have been better stated if the quantity had been accurately ascertained in bushels; but that is a trouble which few farmers take, and information can only be given in the same manner in which it is obtained.

tern, with a valve to admit the contents of the first space into the second, to be preserved there free from the later acquisition, age adding considerably to its efficacy. The smallest of them will hold 1000 barrels of 38 gallons each, and in that quantity from two to four thousand rape-cakes, of 2 lbs. each, will have been dissolved.

'This species of manure is indeed relied on beyond any other upon all the light soils throughout Flanders; and even upon strong lands, originally so rich as to preclude the necessity of manure, it is now coming into great esteem, being considered applicable to most crops, and to all the varieties of soil.'

The crop upon which it is, however, chiefly bestowed, is *flax*, in the following manner and proportion. 'The field, after two or three ploughings and harrowings, is backed up in the centre, and ploughed round in but one set, so as to leave it without any furrow. A heavy roller is then drawn across the ploughing by three horses, the manure is spread equally over the entire surface, and, when well harrowed in by eight or nine strokes of the harrow, the seed is sown, which is also harrowed in by a light harrow, with wooden pins of less than three inches, and the surface, to conclude the operation, is again carefully rolled, so that nothing can exceed the smoothness and cultivated appearance of fields thus accurately prepared.'

The manner in which the manure is applied is in one or the other of the following modes, according to the distance. 'Where the cart plies, the manure is carried in a great sheet, closed at the corners by running strings, and secured to the four uprights of the cart: two men, standing one on each side, scatter it with hollow shovels upon the ground. Or, where barrels are made use of, each is carried by two men with poles, and set down at equal distances across the field, in the line of the rolling. There are two sets of vessels, which enable the men who deposit the loaded ones to bring back others empty. One man to each vessel, with a scoop, or rather a kind of bowl, with a long handle, spreads the manure so as to cover a certain space; and thus, by preserving the intervals correctly, they can precisely guage the quantity for giving effect to any extent of surface.' It must, however, be admitted that this mode of application is somewhat clumsy, and that it might be improved. For the flax crop they are profuse, for they usually

allow at the rate of 2480 gallons, beer measure, to the English acre.*

It thus appears that the dissolution of the oil-cake and a sufficient time for the thorough putrefaction of the contents of the cistern is the only preparation of this manure; and it is stated that 21 acres, upon a farm of 200, are most luxuriantly manured for crops of flax and rape with the urine—exclusive of the dung—of forty-four head of cattle.† It must, however, be borne in mind that, although the Flemings have too just a sense of the value of money to lay it out without the prospect of a profitable return, yet the construction of such a building as that described is calculated at about 120*l.*: in this country it would probably cost considerably more; and, as it cannot be removed, it would not suit the means of every farmer to be at the expense, unless he can obtain the assistance of his landlord.

In another account, drawn up in consequence of an investigation upon a very extensive Flemish farm, by persons appointed to examine the plan, (which had been objected to by several intelligent practical men,) it was declared, 'that owing to the judicious concavity of the farm-yard, there was as much moisture as was necessary to ferment the straw; and it is now ascertained that liquid manure is the most efficacious of any, and produces a third more effect than what is spread upon the surface.' Hence, after the dung is fermented, they dilute it in water, and the liquid alone is carried to the field, and scattered over it. The earth immediately imbibes the liquid, which soon reaches the roots of the plants, and causes a rapid vegetation; whereas it is a long time before dung, in a solid state, fertilizes the soil. The straw that remains, after the

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* The average product of crops upon a sandy loam, and the quantity of manure for each per English acre, when applied to the land, is thus stated.—

Wheat, 22½ bushels . . .	Either dung or compost, 10½ tons.
Rye, 28½ do.	Farm-yard manure, do.
Oats, 51 5-6 do. . . .	Do. do.
Flax, 6½ do. of seed and stem, worth 17*l.* 16*s.* 9*d.* . .	866 cakes of rape, dissolved in 2480 gallons of urine.
Rape-seed, 32 2-5 do. . .	580 do. dissolved in 3200 gall's. of do.
Beans, 28½ do	14 cart-loads of liquid manure and the same quantity of stable-dung, equal together to 21 tons.
Potatoes, 8 5-6 tons . .	Do. do. do.

—Radcliff's Report of the Agriculture of Eastern and Western Flanders, pp. 90, 91.

† Sir John Sinclair, however, says, in his 'Hints on the Agricultural State of the Netherlands,' that in another farm it required the urine of 68 cattle, of various ages, and 32 horses, to manure 40 acres.

dung is thus washed, is applied as manure for potatoes. This mode has been, indeed, extensively carried on in other parts of the Continent, and its effects are considered as equally beneficial. There, by some farmers, water is regularly thrown over the dung-hills, the oozings from which are allowed to drain into pits constructed for the purpose, and permitted to ferment before they are laid upon the land; or, by others, the whole of the dung and stall-litter is immersed in water, which, after a certain time, is pumped up from the pits, and applied in a liquid form; in which manner it is contended that this manure is not only more powerful in itself, but the quantity is thus doubled, for the solid contents of the dunghill remain the same. Experiments on an extensive scale have incontestibly proved the efficacy of liquid manures upon sandy or other light soils, to which they impart consistency, and dispose them to retain moisture; nor can there be much doubt that in many cases the product of a single crop may be thus more than doubled, by its immediate contact with the plants.

On heavy land, we however coincide with the opinion of that eminent agriculturist the Baron de Thaer, from whom this account is taken, that it can never replace the solid contents of the dung-hill; and, although not contesting the advantages of which it may be susceptible when applied to those soils and crops to which it is peculiarly applicable, we yet doubt the extraordinary degree of power ascribed to it. Before this mode of preparing manure be generally adopted, it should also be well ascertained whether the pains and expense attendant upon it do not overbalance those of our own common management; for although it is possible that, in the former way, a more complete decomposition of the materials may be secured, and that thus new combinations of nutritive matter may be formed, of the precise effects of which we are ignorant, yet, in our usual method of preparation, when properly conducted, nothing should be lost: the liquid drained from the dung should be collected for further use: and it is only upon such a calculation of the charges, as well as experience of the effects of the manure, that a fair conclusion can be drawn regarding its real value.

There is, perhaps, no part of the world in which the preparation and the practical application of vegetable and animal manure is so well understood as in China; but owing to its overflowing population, almost the whole of the labour is performed by man, by which the number of working animals is so

much reduced, that night-soil forms the principal dependence of the farmer. It is extensively employed in a dried state, and is sold, as an article of commerce, throughout the empire, in the form of cakes, mixed up with one-third of their weight of marl. It is, however, in its liquid state, as urine, that it is chiefly used, in combination with other substances, the account of which, as furnished by a gentleman who was long resident in the country, is too curious to be omitted.

Into a cask or jar is put a collection of putrid animal substances, consisting of flesh, fish, blood, &c., to which is added a certain quantity of urine, but the vessel is not completely filled. A mandarin, or officer of government, then attends, who, upon the vessel being closed, affixes his seal, and in which state it must remain for six months at least. When this, or a longer period, has elapsed, the mandarin removes his seal, and grants a certificate as to the quality of the preparation, which is shown by the proprietor, who cries it through the streets as a manure for gardens, and it is sold in quantities as small as an English pint. Before using, it is always diluted with four or five times its bulk of water, and it is extensively used for garden-crops, but universally in drills. The writer adds that he was informed by several intelligent Chinese, that human urine, thus prepared, forms a fourth part of all the manure employed in China, and which is never used until it has reached a high state of putridity.

That an article considered of so much importance in that country should in this, where agriculture has arrived at such great perfection, be so much neglected, is not easy to be accounted for. The quantity of urine voided daily by an individual of moderate size has been shown, by a series of experiments, to amount to about half a gallon, which, if due attention was paid to the collection of it, would, according to the Flemish mode of its application, be a sufficient manure for half a rood of ground. Urine, when sufficiently diluted with water, forms a food highly conducive to the growth of plants; it is, indeed, thought to contain the essential elements of vegetables in a state of solution; but its state of putrefaction requires great attention. Thus, it may be observed that, in the hot months of summer, the pasture where the urine of cattle falls becomes marked by a rich dark green when rain falls soon after; but if the dry weather continues, the developement of the ammoniacal salts, arising from the putrefaction of the urine, then occasions it to burn up the grass; yet, on the con-

trary, an excess of moisture deprives it entirely of effect. Thus, the whole of the urine from a dwelling-house having been daily thrown on a piece of pasture during three months of the winter, it was found in the following summer to differ but little from the state of the rest of the field—it having suffered too much dilution from the rain to be capable of putrefaction. But, in the following June, a week's urine being put into a jar, and covered with a slate, where it remained until it had completely undergone that stage, was then mixed with four times its amount of water, and when sprinkled at proper times on the same quantity of pasture, it soon occasioned a luxuriant vegetation. It produces similar effects on green vegetable crops—nourishing them when applied in a diluted state, but scorching them and destroying their tender herbage so effectually when unmixed, as to impede their growth. There is indeed but little doubt that nutritious manure of any kind may be carried to an excess which becomes prejudicial to vegetation, particularly in its early stages. Naismith instances the steeping of three peas for twenty-four hours in a teacupful of strong dung-juice, and three in plain water: each three were planted half an inch deep in separate flower-pots filled with garden mould, and the liquid in which they had been steeped poured into the pots over them. Those which had been steeped in plain water appeared above ground thirty hours before the others. Both advanced, but those in the dung-juice had the most weakly appearance. When the plants were about four inches high, the lower leaves of those fed by the dung-juice fell off; and in about four weeks after, the plants died, though they were daily watered, while those to which the water only had been administered continued healthy. The haulm of a potatoe, too, the growth of which was pretty well advanced, fell off soon after it had been well wetted with urine in an advanced stage of putrefaction, and even the root itself was found reduced to a pulp. It is, in fact, of a scorching quality, and its application to growing crops is not advisable during hot weather, unless mixed with a large proportion of simple water: of course it will not operate in the like manner upon fallow land, and it may be applied whenever the ground is in a fit state to absorb it readily, but much of its effect may be lost if it be not laid on at the time of sowing.

There is probably no species of manure so generally neglected, and yet so deserving of attention; for although the

largest portion of what is produced in most farm-yards is there necessarily absorbed by the litter, and consequently profitably applied, yet large quantities are constantly allowed to run to waste. We have no means of ascertaining the amount of urine that may be voided by different animals in the course of a day, for the diversity of their size and of the kind of food on which they are supported would deprive such a calculation, upon a broad scale, of any pretension to accuracy. It has, however, been supposed that, if fed upon common white turnips, they yield about two-thirds of the weight—or about a gallon for every 12 lbs.*—besides the water which they drink; and we have seen that the cow which we have mentioned produced, when fed on two-thirds of brewers' grains, only 45 lbs. of dung out of 126 lbs. of food, the greater portion of which was accordingly voided in urine. It must also be recollected that the cattle upon the farm to which we have alluded, in Flanders, consisted of only forty-four head, of which eight were horses, fed during the greater part of the winter upon dry food, yet they not only converted the entire produce of the straw and stable-dung into well-prepared compost of the usual description, which could not have been effected without a large supply of urine; but the savings from the stalls also furnished an additional quantity of liquid manure of the richest kind, equal to the culture of exhausting crops upon 21 acres of ground. It has been calculated too, in Scotland, that the urine of six cows or horses will enrich a quantity of earth sufficient to top-dress an English acre of grass-land;† but considering the trouble and the prejudice attending it in this country, it is probable that the best way of preparing it for use is that recommended by a considerable farmer in Peebles-shire, who applies it in the following manner. He has a pit, about 12 yards square and 4 feet deep, which he fills with rich earth, or any such matters that may be at hand, and the urine of the cattle which he feeds is conveyed to the pit by a sewer, and spread equally over it. After this compost has received the greatest portion of the urine, which is about the latter end of April, when it is ready for the spring sowing, it is carefully

* The weight of pure distilled water is 8 lbs. per gallon: that of urine is heavier, in proportion to its composition.

† General Report of Scotland, vol. ii. p. 526. We cannot, however, avoid noticing the loose manner in which this calculation is supported; for the quantity of urine produced by six cows, or by the same number of horses, would be materially different.

turned over, when it shows symptoms of complete saturation; and in this way a large quantity of rich manure is raised, equal to about 280 cart-loads, 40 of which, per Scotch acre, when applied to the ground, he finds equal, if not superior, in its effects to his best dung. The expense of filling the pit only amounts to 6*l*.

Throughout a great part of the rich low-lands in Tuscany, the manure is chiefly procured from night-soil, and preserved in large cisterns, in which it is steeped for several months in about three times its quantity of water; though some farmers content themselves with a large ditch, which is applied to the same purpose as the cistern. Into this every kind of putrescent matter is also thrown, and the putrid water thus produced is found to possess qualities of a very fertilizing nature. It is however principally used for garden-ground, which is thus watered every fortnight; and the plants, but more particularly onions, thus acquire a prodigious size, without being in the least affected by any bad flavour arising from the manure. Neither is its smell, though most offensive for a day or two after it has been laid upon the land, ever known to occasion any prejudicial effect to the health of the peasantry.

In a paper addressed to the Board of Agriculture by Baron Schulenburgh, one of its honorary members, he states that in Sweden the urine is collected from the farm-offices, and pumped over dung and other substances while in a state of compost. The contents of the privies are likewise regularly collected by scavengers in all the great towns, and carried, in many instances, to the distance of forty miles from Stockholm. It is then diluted with water, and laid chiefly upon meadow-land; but it is also applied to green crops, and the effects on the soil, though gradually diminishing, are generally considered to last during four years.

In Switzerland, also, the *mistwasser*, or manure-water, is sprinkled over the surface of the meadows by means of large casks and perforated water-troughs, immediately after each cutting of the scythe, which makes the grass to spring up again with great vigour in a very short time; and it is well known that water, rendered fetid by the solution of vegetable or animal substances, is essentially serviceable to grass-land, as may be commonly perceived by its effects when thrown upon the fields in the neighbourhood of stagnant ponds, in which flax has been steeped. It is indeed highly probable that manures which are intended to act immediately upon the

soil when laid on its surface, will have more effect upon grass-land when applied in a fluid state than in a solid form. It cannot, however, be denied that there are many instances on record in which no such consequences of its application have been remarked. Marshall relates an experiment conducted on his own farm with considerable care, in which the common drainage of the farm-yard—of course including rain-water—was laid upon two separate fields of young tares and clover, grown upon a sandy loam, at the rate of about 2500 gallons per acre: the liquor was of middling strength, very high coloured and foul, but not puddly, and it was carried on in wet weather. No perceptible advantage was, however, observable on either those or the ensuing crops; but the weather was not favourable. Some farmers, indeed, think these washings from the farm-yards, though of a brown colour, are yet, in most instances, so diluted with rain, as not to be worth the expense of carriage;* though other accounts of dung-water say, that when permitted to trickle slowly upon the sward of meadow-ground, it renders the grass soft and luxuriant. In an experiment recorded in the Bath Papers, two spots of meadow were equally measured, and watered three times a week during a month together of nearly dry weather—the one with dark-coloured stagnant water from a pond, and the other with clear river-water,—at the end of which time, the first was far better than the other. The crop upon that part of the field which had the foul water was strong and succulent, of a deep healthy green, and 18 inches high; while the other, though thick and high, was yellowish, weak, and faint. On being made into hay, and separately kept, the former yielded nearly double the quantity and of

*It is stated in the Rutland Report by Mr. Parkinson, that the black water thus drained away from manure, has been tried frequently on land, without effect. He himself tried it, by having a dung-hill made with a grip cut round it, with a descent to a kind of reservoir at one end of the hill, for this water to drain into, and then had it thrown back on that end, thinking thereby to preserve the loss of strength in the manure. But he found that when the manure which came from that side of the dung-hill was laid upon the land, it was weaker than the other; and he therefore concludes,—'that when once this black water departs from the dung, that it is like blood let out of a vein, never to be applied again for the like purpose it was designed for in its original state.'—Surv. of Rutlandsh., p. 91.

This, however, was doubtless occasioned by fresh fermentation being occasioned by the dung being thus continually wetted, and thus losing its strength by repeated exhalation; but though it may be properly used as an argument for not thus applying even the drainage from manure, unless it should be in danger of becoming fire-fanged, yet that cannot be a motive for allowing it to run to waste.

superior quality to the latter; and the same effect was visible in the following year.* There needs, indeed, no argument to prove that it must possess some fertilizing properties, but, except it be rich in quality, as well as abundant in quantity, it may be doubtful whether it be a profitable object of team labour.

Some extensive experiments upon the application of liquid manure—when confined to urine—have also been recently made in Scotland upon various crops, of which the following is a summary.

A cistern was constructed in the dung-court sufficiently large to contain the urine of from thirty-five to forty, and sometimes of seventy cows. The supply generally amounted to 360 gallons a week. When intended for use, it was mixed with three or four times the same quantity of pond-water, and was taken out to the fields in a large butt containing 120 gallons, placed on wheels like a cart, to the hinder part of which there was attached a wooden box perforated with holes, through which the liquid ran out upon the ground in the manner of a common watering-cart.

No. 1.—When applied, in October, to *grass* which had been closely cropped by sheep,† the aftergrowth was not much increased, but the sward maintained a fresh green appearance during the winter, and it could be cut a month earlier than

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* In pursuance of this experiment, the pond was drained and lined with clay, to prevent the water from oozing through it; drains were then laid into it from the stables, and into it were also emptied the contents of the privy and the offal from the kitchen, by which means the water became very putrid. A water cart was then made, with a trough behind full of holes, and the meadow-land was watered with twenty carts-full, laid on either in the beginning of May, or after the cutting of the crop in July; the effect of which was superior, on both crop and rowen, to any other kind of manure.

Although the lining of the pond with clay was a good precaution, it might, however, be dispensed with; for, on draining the pond, the earth at the bottom would be found saturated with the drainage, and being scraped up, would make excellent manure.

† The account from which this was extracted says 'that the quantity allowed was 20,000 gallons per imperial acre: but on calculating the urine at 360 gallons per week, and presuming it to have been mixed with four times the same quantity of water,—as there stated,—the whole amount furnished during the year would only be 93,600 gallons; yet the extent of ground thus manured amounted,—in the year 1828, to 40 imperial acres; in 1830, to 46 imperial acres; in 1831, to 50 imperial acres; and in 1832, to 80 imperial acres—of which the one half was watered again after the first crop of clover was cut in 1831 and 1832: there must therefore be an error in the quantity of urine. See the Quarterly Journal of Agriculture, No. xix. p. 95—97.

that which had not been so treated. Even in March it afforded a full bite; but should the grass be wanted for pasture, and not for cutting, the manure should not be applied later than December, as, when deferred until February, the cattle are rather shy in eating it. No. 2.—The effect when applied to *clover-lea*, to be broken up for oats, was very perceptible; the increase of crop being about one-third. No. 3.—For *wheat* it answers well on a light soil; but on stiff or clay land it does no good. If laid on when the land is wet, it is also of no perceptible benefit to the wheat; but if applied under more favourable circumstances, that crop would probably be increased about one-fourth. No. 4.—To *barley* its application was found injurious; for, although the bulk of the crop was great, yet the straw was so soft and weak that it lodged. No. 5.—*Potatoes* grew to a large size, but they were watery and quite unfit for the table; though the application of a little dung along with the urine improved their quality. No. 6.—On *turnips* it was not found half so efficient as fermented dung.

It appears that this species of liquid manure applies best to grass; a doctrine which is corroborated by the experience of Mr. Harley, the proprietor of the celebrated dairy near Glasgow, who says,—'that the advantages of irrigating grass-lands with cows' urine almost exceeds belief: last season some small fields were cut six times, averaging fifteen inches in length at each cutting, and the sward very thick.' It was also found to succeed best after a shower, or when the ground was moist; but if laid on during sultry weather, it was advantageous to mix it with one-third of water; and although that was not thought necessary in spring or autumn, yet, judging from the quantity used, it may be presumed to have been rather profusely added. We learn, indeed, from Sir Humphrey Davy, that, 'during the putrefaction of urine, the greatest part of the soluble matter contained in it is dissipated.' He therefore recommends that 'it should be consumed as fresh as possible, but if not mixed with solid compost, it should be diluted with water, as, when undiluted, it contains too much animal matter to form a proper fluid nutriment for absorption by the roots of plants.' This theory, it will however be recollected, contradicts both the Flemish and the Chinese practice, which favours a protracted degree of fermentation; but he admits that 'putrid urine abounds in ammoniacal salts; and, though less active than fresh urine, that it is a very powerful manure.' It can-

not, indeed, be doubted that, in whatever state it may be found the most effectual, it is at least well worthy of attention, and we recommend it strongly to the consideration of all experimental farmers.

CHAPTER IV.

MINERAL MANURES.—CHALK—LIME.

The manures which we term *alkaline* and *calcareous*, consist chiefly of those substances which combine with acids, though generally with the loss of their distinctive characters, and out of which lime may be extracted by the process of burning. The extent of their utility is only ascertained by practice, which does not speak a uniform language in every place, for scarcely a farmer is to be found who is acquainted with the exact effect of their properties upon soils; from which it may be readily imagined that many will form erroneous opinions, arising out of the local circumstances of their own farms. Their chief advantage, in a natural state, seems, however, to be rather mechanical and alterative, than nutritive. They form a useful component part of the earth; and, in certain proportions, they are found to be essential to the fertility of most soils, or 'perhaps necessary even to their proper texture, as an ingredient in the organs of plants.' The primitive constituents of which they are formed are composed of chalk, of limestone, or of the shells of fish—and on being submitted to the action of fire, lime is produced.

[*Chalk*—Is a pure calcareous earth, having the same properties as limestone; but as it occurs in deposite to no extent in this country, we have omitted any beyond this casual mention of it.]

Limestone.—If employed without being burned, its effects upon the land are very slow: it acts upon the soil during many years as a mild calcareous earth, but its duration and effects are proportioned to its purity, as the less alloy which it contains, the stronger will it be, and the operation of changing it into lime is of no further use than as a mode of rendering it more promptly effective. As a gradual improver of the soil, it may even be rendered more useful than quicklime.

Fish-Shells.—The *shells of fish*, when burnt, produce the purest species of lime, but they are more commonly employed in a pounded state, in which they may be so advantageously used, that oyster-shells, when crushed and drilled upon 27-inch ridges, at the rate of 40 bushels per acre, produced as fine a crop of turnips as another field of the same land, manured, for the sake of the experiment, at Mr. Coke's, at Holkham, with farm-dung at the rate of 8 tons per acre; nor was there any apparent difference in the succeeding crops of barley and clover. The powder has also been tried at the same farm, for wheat, in competition with rape-dust—both powder and dust at the rate of 4 cwt. per acre, each drilled on a light gravelly loam, in both spring and autumn. The crop was not, in either case, measured, but there was no perceptible difference in either. The field was afterwards sown with turnips, and the produce proved a good crop. Yet, notwithstanding the result of these experiments, no fair conclusion can be drawn from them regarding their respective effects, as manure, in that sense in which it is understood to mean nutriment; for, although lime may excite the powers of other nutritive matter in the soil, and thus promote vegetation, it possesses no substance, within itself, which can impart nourishment.

In some places these shells are found in large beds almost entire, and they may be then either ground by passing them through the oil-cake crusher, or broken into pieces by repeatedly drawing a heavy stone or iron roller over them when spread upon a floor of flags or clinkers. There is, however, a more economical mode of attaining the same object, which is by merely making them the lower tier of a dung-hill, or by spreading them at the bottom of the farm-yard, in which the drainage of the urine will decompose them, and in that state the manure will possess all the advantage of a compost with lime. They may also be used whole on stiff land or clay, on which they act mechanically, opening and loosening the clods, and by that means making way for the roots to penetrate their fibres. To such land they will be found very serviceable, and as they moulder gradually, every year a little, until they are quite spent, they wear down slowly, and their effects, when laid on in sufficient quantity, are long perceptible; but they should not be applied to sandy ground.

On many parts of our coast, *shell-sand* also forms a valuable species of manure, for the shells which are deposited at the bottom of the sea become there in time decomposed, and the

sand which is within reach of the tide, being thrown upon the shore in storms, is, in some places, carted off, and laid upon the land with considerable advantage, though in other parts the practice seems utterly unknown. Being finely attenuated, it blends intimately with the soil, and thus produces very sensible effects in the correction of cold clays and cohesive loams, on which it is usually laid to the amount of about twenty tons per acre. Its chief value will, however, be proportioned to the quantity of calcareous matter, or of shells, which it contains, and this is in some places found to be so large as nearly to equal the common properties of lime.

It is also found in strata, imbedded in sand-cliffs, at the height sometimes of 40 or 50 feet above the level of the sea, in which places it is generally denominated *crag*, and was, no doubt, deposited in former ages, ere the water had receded from the shore.

Lime—Is applied to a great variety of uses: it is employed in medicine as an antacid; mortar is composed of it, when combined with sand; and it serves as a manure, which is the only view in which we now have to regard it. When used for the purposes of agriculture, it is formed by exposing the substances we have mentioned to a certain degree of heat in the furnace, or kiln, of the lime-burner. When this has been continued for a sufficient length of time, their weight becomes considerably diminished, though they retain their former shape and bulk; and either limestone or chalk, when thus reduced, is in most places known by the name either of *lime-shells*, or *shell-lime*, or simply *shells*. In this state it is called *quick-lime:* the materials of which it is thus composed possess hardly any active property, but when burned, it then becomes caustic to the tongue, and effects the speedy decomposition of most vegetable and animal bodies. When applied in this form—either in the way of compost, or spread over the soil by itself—it is so far from affording nutriment to any thing that may be there growing, that, were its effects to be long continued, it would consume it. But if water be thrown upon it, a great degree of heat is in a short time generated; the burnt shells begin to crack and burst asunder, and the mass gradually crumbles down, or falls, as it is more commonly said, into a fine powder, which becomes white, of whatever colour it may have been before it was calcined. Or when it has been exposed for a short time to the influence of the atmosphere, it is also found to lose this caustic power, and it is thus recon-

verted into a substance of the same mild nature as that from which it was obtained—in all its properties exactly resembling chalk.*

This operation is called *slacking*, or *slaking;* and lime, when deprived of its scorching quality, is termed *slaked-lime*, or, in the language of chemists, *effete*. Instead of watering it in heaps, the practice which generally prevails is to lay the shells upon a fallow, in small hillocks of about a bushel and a half each, either thrown up around the circumference of each heap, or covered up immediately with some fresh soil made very fine, which, when laid on moderately thick, should be clapped close down with the back of the spade, so as to exclude the admission of either air or rain. In this state it may remain for a few days, care being taken during that time to keep every part of the heaps tight and sound, when it will be found that the moisture of the earth will have completely slaked it. Although it may be thought that this covering of the lime is unnecessary, it yet has this use—that without it the rain would form crusts over the heaps, which would not only prevent the moisture from penetrating regularly through them, but would also hinder them from being pulverized without considerable difficulty. It will then be fit for use, and when spread over the field it should be immediately ploughed in with a shallow furrow, and well stirred with the harrows in every direction. Upon an 18-feet ridge these heaps will be the same distance, or 6 yards asunder, from centre to centre, if about 200 bushels be laid on per acre; and so on when other quantities are applied. Instead of slaking the lime in this manner, it has however been recommended 'to lay it down in a long heap, or mound, on one side of the field on which it is to be applied. Two labourers are then employed to turn the mound, and a third waters it. When the whole has been thus gone over, it is allowed to lie for four or five days, after which it is again turned, and if any part of the lime should be found to be still unslaked, more water is added.'

From this it will be perceived, that one chief cause which renders the burning of lime necessary, arises from the extreme difficulty of obtaining the powder without the process of grinding; but by being thus more finely divided, it can also be more evenly diffused over the soil, with which, therefore, it

* When moistened with sea-water, lime yields more alkali (soda) than when treated with common water; and is said to have been used in some cases with more benefit as manure.

becomes more evenly mixed, and more prompt in its effects upon the land; and when laid upon it in its hot state, it not only occasions the destruction of weeds, but powerfully stimulates the action of manure. An idea, indeed, generally prevails, in consequence of burning being the mode usually resorted to in the employment of lime, that calcination is necessary to render it fit for use as manure, but this, as we have already remarked, is a mere mistake.

One very strong reason for applying it instantly is, that, if spread immediately after being turned, and while yet in a powdery and caustic state, a smaller quantity may suffice to cover the whole surface of the ground, and to come into contact with more minute particles of the soil; whereas, if suffered to lie for any length of time exposed to the atmosphere, it imbibes so much moisture, that it runs into clods, and can never again be so equally divided into small parts, wherefore a much larger quantity is required to produce the same immediate effect. It is in this state, also, that it acts the most powerfully upon all organic matter which may be already lying undecomposed within the soil—insects, the fibres and roots of obnoxious plants, and the seeds of weeds, which it dissolves and transforms into mould. It is also more efficacious than effete lime in its influence upon what is called *sour land*, though simple chalk, if applied in large quantities, will correct the evil. Neither is it improbable that, during its process of slaking, the heat which it generates by the absorption of moisture causes it to swell in a manner which the tenacity of the soil cannot resist: thus producing fermentation, it not only eventually makes the land mellow, but renders matter which was comparatively inert, nutritive, and is probably more beneficial to land containing much woody fibre, or animal fibrous matter, than any calcareous substance in its natural state.* If, therefore, quicklime really possesses superior qualities as a manure, it seems only fair to infer that, the greater the strength and vigor of such properties, the more assuredly will they effect its purpose when in that state, than after it has been rendered effete.

* In its *first effect*, burnt lime decomposes animal matter, and seems to accelerate its progress to a capacity of affording nutriment to vegetables: gradually, however, the lime is neutralized by carbonic acid, and converted into a substance analogous to chalk; but in this case it more perfectly mixes with the other ingredients of the soil, and is more pervadingly diffused, more finely divided, than mere chalk artificially applied.—Sir Humphry Davy, Elem. of Agric. Chem., lect. vii.

Considerable judgment is however requisite in this mode of its application; for, although it promotes putrefaction, and converts the pulp, or saponaceous substance, of vegetable matter into the food of plants, yet, if too great a portion of lime be added, it may have a contrary effect; and it always destroys, to a certain extent, the efficacy of animal manures, either by combining with certain of their elements, or by giving to them some new arrangement. It is necessary to the reduction of carrion, or for qualifying the noxious effluvia of night-soil; but is so injurious when mixed with any common dung, that it tends to render the extractive matter insoluble: thus, if a sufficent quantity of quicklime be added to a heap of stable-dung in a state of fermentation, it will set it on fire, and the whole will be consumed. It should never, therefore, be mixed with farm-yard manure, unless a small quantity be found absolutely necessary for the prompt destruction of seed-weeds, or the decomposition of roots; but when laid upon the land during the same season, the dung should be ploughed down alone, and the lime afterwards harrowed in with the seed-furrow. It may, indeed, be observed, that the dung dropped from horses in their work about kilns is usually so completely destroyed by the lime which falls from the carts in filling, that it is generally found useless to apply it to the land. It also consumes the growing herbage; but, if prudently used, it does not appear to reach the roots, as a fresh verdure soon after arises, and seeds which had previously lain dormant in the soil are brought into action.*

By neutralizing the acids combined with the mould, this manure qualifies the vegetable and other soluble substances also present in it, and occasions the whole to be converted, by the influence of the atmosphere and of water, into nutriment for plants; but in poor soils, having less vegetable matter to convert into mucilage, it acts so powerfully as not only to exhaust such land by its final effects, but to be prejudicial to the

* A circumstance has been related of mild and quicklime having been separately laid upon land, with the following effect:—the spot upon which the former was laid was soon covered with white clover, but on that on which the latter was left, no vegetation whatever took place for a considerable time, when it at length produced couch-grass, which is accounted for by the hot lime having retained its causticity so long as to have entirely destroyed the seeds of the clover, which are generally diffused in calcareous soils, and consequently flourish through the application of mild lime; while those of the couch were either more difficult to eradicate, or were spread from the adjoining land.—Sinclair's Code of Agric., 3d edit., note p. 235.

immediate crops.* We have, indeed, the opinion of a very experienced farmer, who is also well versed in chemistry, 'that, should much rain immediately succeed the ploughing, and any considerable portion of sand be either in the lime or in the soil, it is almost a moral certainty that such soil will be in a worse state than it was before the lime was put on, because, the moisture being retained by the lime and the soil, and the tenacity of the sub-stratum not suffering the superabundance to pass quickly away, it causes the whole to run together, and form a compact and impervious bottom, which before, however, might have been pervious in a slow degree. That this must be the case is evident from this consideration, that quicklime, mixed with a certain portion of sand, and duly moistened, contracts and forms a substance which we call mortar, or cement; in proportion, therefore, as the quality of these materials is more or less perfect, so does the substance become more or less compact, hard, solid, and impervious: such must be the condition of the soil; and it is but reasonable to suppose that a great part of the seed sown upon it must perish.'

It may indeed be alleged that the caustic action of quicklime can never be exerted to any great extent, as it attracts fixed air too strongly not to become immediately slaked; but its effects are found to be powerful even in that short period, provided that it be promptly and intimately mixed with the soil; for though the land should contain an abundance of vegetable matter, yet if it has been injudiciously cropped, or insufficiently manured, the lime will only add to its infertility.

As the dust of quicklime is prejudicial to health, care should be taken by those who spread it over the land to work upon the windward side. Precaution should also be used, when it is ploughed in immediately after being spread, to do so when the soil is quite dry, as well also as to prevent the horses from passing through any wet places when going to field; for though the powder of dry lime, when in a caustic state, does not take any apparent effect on the skin, and the hands of a person who has wrought in it are not in the least injured, yet

* 'All the experiments yet made render it probable that the food of plants, as it is taken up from the soil, is imbibed by the extremities of the roots only; hence, as the extremities of the roots contain no visible opening, we may conclude that the food which they imbibe must be in a state of solution at first; and, in fact, the carbonaceous matter in all active manures is in such a state of combination as to be soluble in water whenever a beneficial effect is obtained.'—Dr. Thomas Thomson's Chemistry, 3d edit., vol. v. p. 376.

it very soon corrodes the hair and flesh if it has access to water, and horses have been thus irrecoverably lamed. When unharnessed, they should, therefore, be kept dry until thoroughly brushed over, so as to completely remove the dust which may adhere to their coats, and more particularly to their feet and legs. They may thus work without any danger; but, in case of accident happening to either men or horses through being scalded by the lime, the part affected should be immediately washed, either with vinegar or with very sour milk, by which its irritation will be prevented. After the lime has been slaked, it will become effete in about a week, and will then be as little corrosive as any common kind of earth, so that the horses may work among it with entire safety: but if it has been suffered to run into clods before it was spread, these, if not broken into small pieces, will be longer in absorbing a sufficient portion of air, and therefore will remain longer in an acrid state, so that the ploughing will be better deferred for another week, or even longer.

When quicklime has been deprived of its causticity, it is called by chemists *carbonate of lime*, and in that mild state it does not act upon animal or vegetable matter with the same violence as quicklime, but instead of dissipating any portion of the substance which may be contained in the soil, it facilitates its reduction into that state by which it the most effectually assists vegetation. Neither has it the same tendency to combine, as it were into a mortar, with the sand of poor clay.

Lime, however, *whether quick or slaked*, when used by itself, without any addition of earth, is not possessed of any vegetative quality: thus, 'seeds planted in a flower-pot filled with powdered carbonate of lime, regularly watered, vegetated feebly, made little progress, and died without coming to perfection; but when partly filled with garden-mould, and carbonate of lime 1½ inch thick over it, the plants put down their radicles straight through the lime, without ramifying or stretching sideways, till they arrived at the mould. Even in a mixture where lime was only one-fifth, the plants were poor and sickly, and made no progress; and when quick, it, with the aid of water, suddenly destroys all vegetable substances.' It may even be hurtful to vegetation when laid in too large a quantity upon very light and warm soils, for, by quickening evaporation, it dries the land too much, by which means plants are deprived of the moisture necessary to their sustenance; therefore it is that calcareous earths are frequently

known by farmers as 'burning soils;' and, by its injudicious use or repetition, without the aid of animal or vegetable manure to supply the nourishment of which they have been deprived by crops, the growth of which has been thus forced, land, though of superior quality, may at length become exhausted. Thus experience teaches that lime, when applied to land, has different effects upon some soils than it has upon others: on many there is a rapid and permanent improvement, on others there is less benefit, and on some it is said rather to retard than to promote vegetation. This is, no doubt, chiefly influenced by various unascertained properties in the soil, and partly also by differences in the qualities of the lime itself, arising from its mixture with other earths.

Whether it possesses any further properties, through the stimulating effects of light and heat upon the vegetable fibre, has been conjectured, but has not been supported by any positive fact, and seems to be contradicted by the slow effect of effete lime in its operation upon the soil. It is, however, worthy of remark, that calcareous earth is found in the ashes of all vegetables; that it is present in a larger proportion in wheat, clover, and some other plants whose growth is especially promoted by the use of calcareous manures, and many are said not to ripen in ground in which it is entirely wanting. We may therefore conclude that it is of the highest importance in the process of vegetation, and that an accurate investigation of its mode of action, by enabling us to judge with more certainty of its powers, would greatly tend to the improvement of agriculture. It is indeed much to be regretted that the subject has not been more fully investigated, and that some more definite judgment has not been framed regarding the properties of lime, the effects of which in its application to the soil are exposed to the most contradictory results. Much money has thus been uselessly expended and labour thrown away, which, under better information, might have been saved; and without scientific analysis of the component parts both of soils and of lime, we remain much in the dark regarding their effects on vegetation; but judging from the faint lights with which we have been furnished, we shall still endeavour, by comparing science with practice, to obtain such instruction as may guide us to an economical and useful application of this manure to field culture.

Application of Lime.—Those purposes appear to be—first, to render whatever substances may be lodged in the soil, or

matter which forms part of it, and which may be injurious to vegetation, either harmless or useful; and thus to prepare the soil for the reception and nourishment of seeds and plants: and secondly, to facilitate the decomposition of putrescible matter, so as to furnish food to vegetables during their growth. It has been proved by careful experiment, that the application of lime is the only known alterative which, upon poor, weak, and weeping clays, has power to heal the soil. With the assistance of water, it suddenly decomposes all animal and vegetable bodies, and when thus spread upon neglected ground covered with heath and moss, the old turf is decomposed, and a saponaceous matter is formed, which sinks into the soil and covers it with sweet herbage. We also know that it imparts a certain degree of vigour to some peculiar plants,—as, for instance, sainfoin, the roots of which penetrate far into the interstices of chalk, and grow luxuriantly, though only covered by a slight coat of inferior soil.*

It is, however, an error,—though entertained by many farmers,—to suppose that lime in any state comprises fertilizing properties within itself: and that, without operating upon the soil, or upon the substances which it contains, it is an enriching manure. It does not possess any fertilizing principle in its own composition: it is merely a calcareous earth combined with fixed air, and holding a medium between sand and clay, which, in some measure, remedies the deficiencies of both. But though, when alone, unfavourable to the growth of plants, yet experience shows that it is an ingredient in soils which, whether naturally forming a component part of their substance, or judiciously mixed with them by the husbandman, adds greatly to their fertility, for it has the power of attracting much both from the earth and from the air, which occasions the decomposition of plants; and thus converting them into nutriment, it gives power as to vegetation which, without its operation, would otherwise lie dormant. It also appears to act with great force upon that substance which, being already converted by the decomposition of plants into a species of earth, we call *mould*.†

The other causes with which we are acquainted regarding

* See Naismith's Elements of Agriculture, p 334. Thaer, Principes Raisonnes d'Agriculture, 2nde edit., tome ii. p. 387; and Anderson's Essays, No. vi., Aphorism iv., in which it is stated, that calcareous matters act as powerfully upon land that is naturally poor, as upon land that is more richly impregnated with those substances which tend to produce a luxuriant vegetation.

† Respecting the formation of mould, see the chapter on soils.

the operation of lime as a manure would lead to a chemical discussion, which could only prove uninteresting to the generality of our readers; we shall therefore confine ourselves to the following observations:—There can be doubt that it is a most powerful stimulant when applied to deep loams and heavy clays, which contain mould of a nature so sour as to appear to unfit them for the purposes of vegetation; or to land which has been previously either more or less manured with animal or vegetable substances, without any addition of lime or other calcareous matter, in which case it often produces effects far more fertilizing than the application of dung, for its active powers render every particle of the putrescent manure useful; but if the latter be not afterwards repeated at no great distance of time, the soil will, in the course of a few years, become considerably exhausted. In all arable land, however impoverished it may be, either by nature or bad management, there yet always exists some portion of mould, and, on this, a first dressing of lime occasions a sensible improvement of the soil, which soon becomes apparent in the increased product of the crops. A second dressing will also be attended with some apparently good effect; but unless that, and every succeeding repetition, be accompanied with ample additions of farm-yard manure, or other putrescent matter, to supply the loss thus occasioned by the exhaustion of the vegetative power, every future crop will be diminished. The land is then necessarily thrown out of cultivation, and left for a series of years to recover itself under pasture, which, in the course of time, may be effected according to its former condition: but in the interim it is rendered nearly fruitless. It is thus that many thousands of acres in every part of the kingdom have been run to a state of almost total infertility; and it is even said, that the too great use of lime, though apparently judiciously employed by some of the first farmers in the Lothians, has been lately found very detrimental to their crops.

Marsh lands, however, which have been drained, will generally support a repeated and abundant application of lime, because they usually contain a large proportion of matter upon which the stimulating powers of lime are peculiarly adapted to act; and it will be found much better suited to the purpose than dung. On all rich, deep, dry, and loamy soils it may also be applied with effect; for although they contain within themselves the component parts of the best soils, yet they are frequently found to be sluggish and inert; and dung, whether

through imperfect fermentation or owing to the want of calcareous matter, often remains dormant in the land until roused by moderate quantities of quicklime, which, if applied at distant periods, will effectually operate to bring it into activity. It should, however, be turned into the ground some weeks before the dung, in order that it may become thoroughly slaked by mixture with the soil, or otherwise it would have the effect of abstracting some of its nutriment. Such soils, after the application of lime, produce much heavier crops with a much smaller proportion of dung than if no lime had been used, because the operation of the latter, acting upon the dung, renders every portion of it useful.

Clay land shows an evident disposition to combine with lime, and it bears the repetition of this species of amelioration better than lighter soils. When applied to heavy tillage land, either for the purpose of reducing its cohesive properties, or of supplying an additional quantity of calcareous matter, small dressings of lime will have but little effect; and if sand or calcareous earths are to be employed, it is recommended, by a practical farmer of known experience, as more economical to apply them separately than as a compost. It powerfully assists all adhesive soils; and when laid hot from the kiln upon deep clay, it has been known to occasion a very large increase in the former crops. It has also been often observed, in fallowing clayey soils, 'that, in wet weather, when a dose of lime has been just given, the land continues more friable, and is less apt to bind up on the recurrence of drought, than where it has been neglected. The grain growing on the well-limed ground preserves its healthy appearance in wet seasons, while that growing on land that has not been limed is yellow and sickly.'

Upon *sandy soils*, which seldom abound much in vegetable matter, lime has a mechanical operation, which, by combining with the finer particles of the soil, gives consistence to the staple of the land, and, attracting the moisture from the atmosphere, it imparts it so gradually as to be less liable to be hurt by drought in those parching seasons by which crops are injured. It is therefore said to be cooling to hot land; but if it be not also mixed with some portion of clay, with which it may combine, it then is apt to unite itself with the sand, with which it composes a kind of mortar, the effect of which has been already described, and which cannot be dissolved without much difficulty, and the plough often brings hard lumps to the

surface of the soil which cannot be easily broken. Thus, when such land has been frequently limed, nothing can restore it but the abundant and reiterated application of putrescent manure; the demonstration of which is perceptible throughout many parts of England, where, from possessing a chalky soil without strength to maintain a sufficiency of live stock to furnish dung, the land has in many places been worn out through the inconsiderate use of lime.

On the *exhaustion of land by the application of lime* there is, however, much difference of opinion. It is indeed evident that the continuation of cropping, without an addition of nutritive manure, will ultimately exhaust the best soils; but though their natural fertility be thus aided, it yet cannot depend entirely on that support. This must be apparent if we reflect that land, without any addition of animal or vegetable substance, will still produce crops: for pure sand, clay, and chalk, though each in themselves separately barren, yet, when mixed together, exert chemical influences upon each other, which, by the attraction of the air, the dews, and the rain, the force of the sun, and the generative powers of growing vegetables, effect the production of corn and fruit. It is therefore clear that the land alone is capable of vegetation; but every day's experience proves, that the amount of its products, its fertility, in short, depends in a great degree upon the decomposition of the substances which have been previously converted into vegetable mould, or which are added to it by manure. Any thing whatever may be called manure which, when applied to the soil, either rectifies its mechanical effects, corrects any bad quality, and either stimulates it to yield, or stores it with nutriment. Thus, if lime be laid upon pure sand, although the latter would be rendered more tenacious, and would thereby become more favourable to the germination of vegetables, yet seeds could find no nourishment from either the lime or the sand, and putrescent manure would still be necessary to produce a crop. But if the soil consist of clay and sand, containing animal or vegetable matter in a torpid state of decay, then lime would be preferable to dung. The state of the soil should therefore be minutely inquired into before lime is employed, and it should be only used to give effect to the inert substances with which it may be combined.

By the analysis of soils, we find that all productive earth contains a certain portion of lime; and although we learn from experience that its stimulative powers upon the roots of

plants are very great, yet we are but imperfectly acquainted with the extent or the exact manner in which its influence is brought into action, and 'we are in a great measure ignorant of the actual changes that are produced upon the earth after this manure has been applied.' It would, however, seem, that where it exhausts, it is only by hastening the putrefaction of the animal and vegetable matter in the soil, and by that means applying a larger portion of those substances in a given time than could be otherwise afforded to the growth of plants. It is thus known to produce more luxuriant crops, and it will also consequently enable the farmer to continue his land in tillage, during a certain time, with more effect than if no calcareous manure had been laid on; but, although it may not tend to the deterioration of the original staple of the soil, it can hardly be doubted that it must be thus more promptly deprived of its fertility than if the exhaustion of that vegetable mould with which it had been supplied by nutritive manure were occasioned by a more gradual process of decomposition.

That this is the only way in which effete lime can exhaust land, seems probable from the large quantities of neutralized calcareous earth which are often applied without any bad effect in the form of chalk, shells, limestone-gravel, and the whole tribe of marls. A larger quantity of these is oftener laid on in one year than would be used of lime in half a century, were the land in tillage to be managed according to the custom of some countries; yet it is not generally impoverished, and, in many cases, it is permanently improved. This, however, is probably occasioned by its combination with other substances, which either counteract its exhausting powers or supply the waste of nutritive matter. It must, however, be admitted, that this is not apparent in regard to chalk, which is commonly applied in large quantities without any bad effects; and there are many instances of soils more naturally fertile than perhaps any others that are known, and which seem to consist almost wholly of calcareous earth; but were their properties critically analyzed, it is still possible that they might be found essentially different from those which they are commonly supposed to possess.

A very eminent writer on agriculture, when treating of stimulant manures, which are generally supposed to be only of use when applied to rich soils, and when applied to poor land would produce hardly any, or even hurtful effects, says, in contradiction to that theory,—that 'he is 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 and more lasting degree of fertility than dung alone.' That, however, does not throw any doubt on the assertion, that it acts with as great *proportionate* power upon land that is naturally poor, as upon that which is more fully impregnated with those substances which tend to promote a luxuriant vegetation; but we believe that the experience of farmers will prove that its application to poor land, and especially to that which has been previously limed, if it does not eventually tend to its complete exhaustion, will at least never be found to repay the expense.

The employment of lime seems to be of the greatest service in the *breaking up of fresh and coarse land*, on which it acts more powerfully than on soil which has been long in cultivation, and indeed the most striking improvements have been effected by its means on moorlands and mountain; but it should be given for the first time abundantly. Such is the usual effect of lime upon arable: upon *grass-land* it is laid in smaller quantities; and in this top-dressing, perhaps the preferable mode is to apply it in a compost with earth; except when the soil consists of clay. When thus spread upon the surface, its action upon the sward is productive of the most palpable improvement, and continues perceptible during a long period. No other manure will create so rapid a change; for it is such an excellent corrector of acidity, that it tends to produce the sweetest herbage where only the most unpalatable pasture was formerly to be found. This, indeed, is so apparent, that if a handful of lime be thrown upon a tuft of rank, sour grass, which has in former years been invariably refused by cattle, they will afterwards eat it close down. Now, animal dung, when dropped upon coarse benty sward, produces little or no improvement until limed; it then, however, not only augments the crops, but the finer grasses continue in possession of the soil, and the land is thus doubly benefited; for the dung dropped by the stock on which it is pastured, is both increased in quantity, and improved in quality.* Farmers

*In Derbyshire the farmers have found that, by spreading lime in considerable quantities upon the surface of their heathy moors, after a few times the heath disappears, and the whole surface becomes covered with a fine pile of grass, consisting of white clover and the other valuable sorts of pasture-grasses.

should never consider lime as the food or nourishment of plants, but as an alterative of the soil; never to be used but when nature requires it, either to dissolve noxious combinations, and to form new ones; to bind loose soils, or to diminish excessive cohesion; and to reduce the inactive vegetable fibre into a fertile mould. For such purposes there is not, perhaps, a more valuable article in the whole catalogue of agricultural remedies; but some farmers, who do not reflect upon the subject, when they perceive that lime has once excited the dormant powers of the soil into action, and that good crops succeed for a few years, are apt to draw from thence very false conclusions, and continue liming and tilling without the assistance of putrescent manure, until their land at length is rendered incapable of the production of corn. It has indeed been pertinently observed by a good judge of such matters, 'that there is an analogy between the treatment suitable to the animal and vegetable creation. When medicines have removed the cause of their application, they are discontinued, and the patient, rendered weaker by the application, requires some invigorating aliment: in like manner, some time after an effectual liming, the soluble carbon of the rotten dung, or some such restorative, should be applied to the soil to replenish it with what it may have been robbed of by the action of the lime.'

In fine, lime should always precede putrescent manures when breaking up old leys for cultivation, for, if the land contains acids, or noxious matter that is poisonous to plants, they will be decomposed and rendered fit for vegetation; and hence the superiority of lime to dung on new lands. But calcareous and putrescent manures operate very differently: 'the former being more stimulant and corrective, help the farmer to an abundant crop at the expense of the soil alone; while the latter furnish the land at once with fertilizing fluids, and will insure a good crop on a place perfectly barren before, and after the application of lime.'

Much uncertainty prevails among farmers *regarding the state of lime:* some contending that it should only be applied when hot and powdered, and that when it has been slaked, its effect is comparatively trifling; others maintain the contrary. But these disputants consist chiefly of men whose experience has either been confined to one kind of soil, or who have only used it under particular circumstances, and as they only condemn the system of others because their own has turned out

successful, or the reverse, it is not improbable that, in the view they take of the subject, each may be in the right. It will therefore probably be found, that in all cases where the land is constitutionally disposed to receive benefit from a calcareous dressing, that is to say, when it has not been previously limed, or when it has been long laid down and refreshed by grass, or enriched by the application of dung, it is of little importance whether the operation take place when the lime is quick or effete. Upon waste lands, however, its causticity has an evident and necessary effect; for the undecayed vegetables, which abound in all soils in a state of nature, should be speedily decomposed, and it should therefore be spread hot from the kiln. In point of economy, too, there can be no doubt but that it is most thriftily used when laid upon the land in the latter state: for the labour is less; and a smaller quantity will serve the immediate purpose. It is, however, obvious that the choice of circumstances and season is not always in the farmer's power; and that necessity often obliges him to lay it on when completely effete. It has been said, indeed, upon high authority, that caustic lime exhausts the land; but repeated trials have shown that its ultimate effects are equally beneficial in the one state or the other, though there is a more immediate advantage in the employment of quicklime by the destruction of weeds. A common method is to leave it spread during some months upon clover or sainfoin, not intended to be broken up until the following year,—a plan which is advisable with regard to marl, which partakes of some of the qualities of lime, and is the better if allowed to remain during a season exposed to the atmosphere; but the stimulating properties of quicklime will be thereby lost, as it will be converted into mere chalk. Opinions are also much divided respecting its effects when laid upon pasture land which is intended to be kept in grass. There is indeed no question that, in either state, if applied in moderate quantities to a dry soil, or to land that has been completely drained, such a top-dressing will have the most beneficial effect upon the herbage; but it must be admitted, that when laid on quick, it requires more circumspection in its application, and should not be employed in the same quantity as when effete.

We learn, from the General Report of Scotland, that there, 'in the best cultivated counties, lime is now most generally laid on finely pulverized land, while under a fallow, or immediately after being sown with turnips. In the latter case, the

lime is uniformly mild: in the former, quicklime, as pernicious (in a certain extent) to vegetation, may be beneficial in destroying weeds; and some experiments have been recorded, showing it to have a very powerful effect upon the fly, to which we shall find future occasion to advert. Sometimes mild lime is applied in the spring to land, and harrowed in with grass-seeds, instead of being covered with the plough; and under this management a minute quantity has produced a striking and permanent improvement in some of the hill-pastures of the south-eastern counties. Its effects are yet perspicuous, after the lapse of nearly half a century. In some places lime is spread on grass-land a year or more before it is brought under the plough, by which the pasture in the first instance, and the cultivated crops subsequently, are found to be greatly benefited. But in whatever manner this powerful stimulant is applied, the soil should never be afterwards exhausted by a succession of grain-bearing crops — a justly exploded practice, which has reduced some naturally fertile tracts to a state of almost irremediable sterility.'

To point out the precise effects of lime, and the proper quantity to be applied, to the extent to which it has been already ascertained, would greatly exceed the limits of this publication; and were it possible to define its powers upon every gradation of soil, a series of experiments would be required which would occupy the labour of a long life. Its qualities, too, differ materially in various places, from the greater or less quantities of extraneous substances with which it is combined. It is very rarely that any farmer can obtain a choice of lime, and when only one species can be procured, he must be content with it; but he may, nevertheless, be benefited by the following observations:—

Qualities and Quantity of Lime.—Pure limestone, or *chalk*, when fully calcined, is reduced to a fine impalpable powder, that feels soft within the fingers, without the smallest tendency to grittiness: but such lime as contains sand is neither so soft nor fine, but feels more or less gritty in proportion as the sand is coarser or finer, and more or less in proportion. Commonly, the whitest lime is the best; when perfectly calcined, it is generally of a bright white, without any shade of colour, and if clouded, it is thought to proceed from a mixture of other matter; but the colour is not an infallible criterion, for dark-coloured lime has, in some few instances, been found stronger than that which was perfectly white. The

purer and the stronger the lime is, the lighter also it will be found when weighed. Hence it follows, that the best lime for the farmer's use is that which is the softest to the touch, the whitest, and the lightest.

The other simple tests for ascertaining its quality, which will be found sufficient to decide upon the comparative value of any two kinds of lime, and may be relied upon as sufficiently accurate for the common purposes of the farmer, are as follows:—If the limestone loses much of its weight in calcination, and the lime-shells are extremely light;—if the shells require a very large proportion of water to slake them fully;—if it is long before they begin to fall;—if the limestone is not apt to *run* (or to become vitrified) in the operation of burning;—if it falls entirely when it gets a sufficient quantity of water, after it has been properly calcined;—if it swells very much in slaking, and if the lime is light, fine to the touch, and of a pure white—he may be satisfied that it is extremely good, and he may use it in preference to other lime that is inferior to it in any of these respects. The presence of lime may also be discovered by its effervescence, or ebullition, on being exposed to common vinegar.

When quicklime, too, is completely sifted through a fine hair-cloth, that is the strongest which leaves upon the cloth specifically the smallest of earthy or sandy particles; and that, also, of which the smallest quantity, when spread upon the same space of ground in soils of equal quality, will the soonest burn up the surface of the grass. We may also add, upon the authority of Sir Humphry Davy, that lime, when slaked with sea-water, has been used in some cases with considerably more benefit than when wetted in the common manner.

The benefit which might be derived from the union of a slight portion of chemical skill with agricultural knowledge is perhaps incalculable. The present state of education among the generality of farmers is not such, however, as to enable them to reap much advantage from scientific experiments, and even chemists rarely have opportunities of applying their art to practical purposes of this kind. It may, however, prove useful to some to offer a few brief directions for the analysis of lime, which we extract from the recent work of Dr. Henry:

'To determine the purity of lime, let a given weight be dissolved in diluted muriatic acid. Let a little excess of acid be added, that no portion may remain undissolved, owing to the deficiency of the solvent. Dilute with distilled water; let the insoluble part, if any, subside, and the clear liquor be decanted. Wash the sediment with further portions of water, and pour it

upon a filter, previously weighed. Dry the filter, and ascertain its increase of weight, which will indicate how much insoluble matter the quantity of lime submitted to experiment contained. It is easy to judge by the external qualities of the insoluble portion, whether argillaceous earth abounds in its composition.'

The presence of *magnesia* in limestone has been considered pernicious to vegetation when burnt into lime. It had been long known to farmers in the neighbourhood of Doncaster, and other parts of Yorkshire, Derby, and Nottingham, that lime made from a peculiar species of limestone injured their crops; and that made from the Breedon limestone, in Leicestershire, which there goes under the denomination of 'hot lime,' is so powerful, that it is there seldom used in larger quantities than from 25 to 30 bushels an acre, unless the land be very rich. A series of experiments were made upon the former by Mr. Tennant, who discovered that it contained magnesia, and on mixing some calcined pure magnesia with earth, in which he sowed different kinds of seeds, he found that they either died or vegetated very imperfectly; he therefore came to the conclusion that its effects were prejudicial. This is thought to have been occasioned by its retaining its caustic quality longer than pure lime; and that, if used to excess, it has a poisonous effect on vegetables, though, 'on poor soils,' it has been said 'neither to receive water so rapidly, nor to part with it so freely, as lime; and in this respect it seems to hold an intermediate property between lime and clay.' Experiments have also been made by Sir Humphry Davy and other chemists, from which it may be collected that, although, when calcined, as lime, it may become pernicious to land, if laid on in too large quantities, yet that, in its mild state, it is a useful constituent of soils. One of the most fertile parts of Cornwall, in the neighbourhood of the Lizard, is a district in which the land abounds in magnesian earth. It is, indeed, one of the mildest absorbents with which we are acquainted, and upon ground which is infested with sorrel, its application is an immediate remedy. Magnesian limestone is usually of a pale yellow or brown colour, and is found in many parts of England, as well as Ireland; it effervesces when plunged in acid, though it only dissolves slowly.

Its analysis requires a process too tedious to be here stated, but its existence in lime, in a pure state, may be ascertained by the following test:—

Having taken out all the mineral oxide, next pour into the fluid a solution of neutralized carbonate of potassa, continuing to do so until it will effer-

vesce no longer, and till both the taste and smell of the mixture indicate an excess of alkaline salt. The precipitate that falls down is carbonate of lime: it must be collected on the filter, and dried at a heat below that of redness.

The remaining fluid must be then boiled for a quarter of an hour, when the magnesia, if any exist, will be thrown down combined with carbonic acid.

The *quantity of lime* to be applied to the land must of course be apportioned to the quality of the former, as well as to the nature and the condition of the soil which considerations must also be in a great degree governed by the expense. There is perhaps no country where it has been used to such an extent as in the improved parts of Scotland, where it is often carried to the distance of twenty to thirty miles, after having been imported from distant points of the coast, and even from Ireland; and although it has been laid on at prices varying in proportion to its strength, and the charge of burning, from 6*s*. to 18*s*. per chaldron of 36 bushels, besides the cost of carriage, and in quantities according to the nature of the soil, yet the improvement has, in most places of its first application, borne out the charge.* In Ireland, Chief Baron Foster has gone so far as 300 barrels, with manifest good effect. It is in that country, indeed, not uncommonly applied at the rate of 400 bushels per imperial acre; and immense crops of potatoes have been raised by its being laid upon strong old leys, broken up in July or August, and allowed to remain in that state until ploughed again in the spring. It has been laid on some of the moors in Derbyshire to the amount of 1500 bushels. Dr. Anderson says that 'he has himself had experience of it in all proportions, from 100 to above 700 bushels to the acre, upon a great variety of soils; and that he always found its effect in promoting the fertility of the soil to have been in proportion to the quantity employed, other circumstances being alike; yet an instance is mentioned, in the Nottingham Report, of twenty chaldrons, or 720 bushels, having been laid upon an acre of cold clay soil, without any benefit whatever. Experiments have also been tried of its application on heavy land, extremely

* In Scotland it appears that 192 bushels of lime-shells per Scotch acre (equal to 153 per imperial acre) have been applied with success on light soft land. From 240 to 360 are however generally esteemed proper for different degrees of clay. From that quantity up to 600 bushels have been laid with good effect on strong land, both arable and under grass; but it seems generally agreed, that from 300 to 480 bushels are quite sufficient for the greater part of the most fertile districts in that country; and light soils, which require less in the first instance, are said to have been greatly benefited by a frequent repetition.

retentive of moisture, to the extent of 300, 450, and 550 bushels, which, after eight successive years, showed no perceptible difference arising from the quantity laid on, and similar instances are too numerous to require mention; but these failures may, not improbably, have been occasioned by the imperfect state of the drainage. Lime has, however, been on so many occasions used at random, without inquiry being made or attention paid to the state of the land,—whether it has been over-cropped and worn out, or has been left under pasture and enriched by dung,—that, without regard to these particulars, much money has been uselessly expended, and many attempts at improvement have been rendered unsuccessful. A system also prevails in the cultivation of many estates in various parts of the kingdom, under which the tenants are bound by their leases to fallow the land at fixed periods, and to dress the fallows with a certain quantity of lime; which being thus repeated when the condition of the ground does not always require it, it necessarily follows that no beneficial result can be attained.

Such, indeed, is the variety of soils and circumstances, that no general rule can be devised for fixing the quantity of lime that may be properly laid upon an acre of land. The various accounts from the different county surveys, and other sources of information, state that from 80 to 180 bushels have been laid upon light soils with very palpable benefit, and that from 240 to 320 and even 400 bushels have been successfully applied to clays and strong grass land. It has, indeed, been found, that in maiden soils its use is so essential, on its first application, as to impart a permanent degree of fertility which could not be obtained by any other species of manure. In some parts of Scotland, which have been only of late years brought under an improved course of culture, and to which lime had not been previously applied, it was observed that the richest animal dung had but a weak effect upon the crops of grain. Peas, barley, and wheat, at first assumed the most promising appearance, but when the peas were in bloom, and the corn putting forth the ear, it was found that they had dwindled away in nearly fruitless abortion,—which, indeed, so far as the peas are concerned, ought not to excite surprise, for it is well known that they will not thrive in any soil which is not calcareous; yet the same ground, after getting a slight dressing of lime, brought any kind of crop, that was adapted to the

land and properly tilled, to full maturity.* Experience, indeed, proves that a certain portion of lime is necessary to bring all soils into a due state of fertility; but when they are once saturated with lime, or have got a sufficient quantity, whatever more is added only occasions useless expense. Many farmers have also learned, to their cost, that land which has received a complete liming should be either rested from severe cropping, or, after some short time, laid down to pasture. This, however, being not always convenient, the alternate system of husbandry should be adopted, even with the addition of a second year under clover, if the land be poor, and the green crops expended on the ground; and in no case should the soil be deprived of the usual dressings of dung.

In whatever quantity it may be employed, it is indispensable that every particle of lime be intimately blended with the soil; for if that condition be not complied with, its power upon the land will be so far lost as that operation may have been ineffectually performed. Although specifically lighter than any soil, it is, however, very commonly left in small lumps, which then fall into the bottom of the open furrow when the land is ploughed, and there remaining below the staple of the land, it naturally becomes useless for the purposes of the farmer: the operation, therefore, demands the most minute attention. When the lime, which may have been spread upon the ground, has been either already ploughed under, or only harrowed in, or both, it should be again harrowed and afterwards ploughed in. This must, however, be done as superficially as possible, in order to avoid burying the lime: and perhaps the best implement for that purpose is a scarifier, or one of the many scufflers now in use, as they mix the lime with the soil more effectually than can be done by the plough. The land must then be again harrowed and ploughed; but still not to a great depth; and in this manner it should get at least three ploughings and harrowings, if the soil be light, and four, or even five, according to the condition of the land, if it should be heavy: but, we repeat, that in no case should the lime be suffered to sink deep into the ground. We have, indeed, on

* It has been stated, in the General Report of Scotland, that soils of tolerable quality, in Lammermuir, only produce middling crops of oats and rye, and that the richest dung does not enable them to bring any other grain to maturity; yet the same soils, after being limed well, under proper culture, ripen every species of corn. The same effect is stated to have occurred on the Mendip hills, in Somersetshire, in Hereford, and Derbyshire, and various other counties.

this, the evidence of Mr. Dawson, of Frogden, which, after the experience of upwards of half a century, is too well known and too highly appreciated to admit of doubt, that in every instance, upon his own land, in which lime was only harrowed in, when laid up for pasture, the ground not only continued, for upwards of thirty years, to produce the fine grasses, but, when ploughed down, those parts of the soil which were not sufficiently mixed with lime, though sown with clover, became gradually covered with bent; and he also adds his testimony, that, when properly mixed with lime, the effects of dung are not only greater, but much more permanent, whether under tillage or pasture. It should, however, be observed, that the depth of the ploughing may also be made to depend, in a great degree, upon the quantity of lime that is used as well as upon the state of the soil; for not only is a less portion of calcareous manure requisite upon sands than upon clays, but as it sooner sinks into the former than into the latter, and the object is to keep a sufficient quantity mixed with the surface, it cannot, in that case, be ploughed with too shallow a furrow.

This renders a clear and well-wrought fallow absolutely necessary; but in this manner, if the lime be laid in the full quantity upon the proper soil, and if the future cultivation and manuring with putrescent matter be in all respects carefully conducted, it will produce the expected effect upon the land, the amelioration of which will last for a long series of years. This mode of application is approved by the most enlightened farmers; yet there are many who affirm that grass-land forms the best bed for the reception of lime. When grass-land is broken up, it is, however, very generally full of weeds, which nothing but a complete summer fallow can thoroughly conquer; but if the land be clean, and the lime can be got forward in time, the application may in many cases prove successful.

The application of lime to grass-land one or two years before it is broken up, as inculcated by several writers upon husbandry, is neither necessary to the soil, nor reconcilable with economy: as, in case of any declivity in the ground, much of the lime is washed off the surface by the rains, and lost before the land can be ploughed.

On the best consideration which we can apply to this important subject, we should say—Let the farmer, as a primary ground for determination, well weigh the nature and the condition of his land, as well as the amount of the cost, previous to the

application of a dressing of lime. If it is to be broken up from grass which has lain long in pasture, and without having been previously limed, and that he can afford the expense, let him lay on a round quantity at once; for if it be intended as a permanent alterative—a corrective and amendment of the properties of the soil,—it should get a full dose, and any thing short of that will be found little better than money thrown away. But if it is to be applied to ground that has been under tillage, and upon which lime has been previously laid, it can then only be used with advantage after a series of years have elapsed, and in small quantities; upon land also which has been kept under a proper rotation of husbandry, and has been regularly manured with stable-dung, bones, rape-dust, or other nutritious substances, upon which it may exert itself, as it will merely give increased effect to the riches which may have been thus added to the soil by superior management. In such cases, however, it may be usefully employed after every second or third dunging; for whether it be owing to an imperfect fermentation, or to whatever cause, it is certain that a portion of all the dung which is laid upon ground remains nearly in a dormant state until forced into activity by the application of some alkaline or calcareous matter.

On all land it decomposes nutritive matter, which may be supposed to lie otherwise in an inert or apparently insoluble state: it is advantageous on sands, because, so long as it remains well mixed with the soil, it attracts moisture from the air, which prevents them from burning; and if applied to clays, or other deep soils on which no calcareous manure has been previously laid, it renders them less cohesive, and more easily penetrable by vegetable fibres. On calcareous soils it necessarily has but little effect, because it there already forms a part of the matter of which they are composed; but when laid on grass-land as a top-dressing, it has greatly improved every species of soil, and has promoted the growth of the finer grasses; thus adding to the luxuriance of the herbage, and augmenting the productive powers of the soil when afterwards ploughed for grain.* As lime, however,—notwithstanding

* Calcareous soils have also been found to possess the advantage of guarding the sheep which graze upon them from the rot; and there can be no doubt that the application of lime, if accompanied by proper drainage, will materially assist in producing properties of corresponding efficacy. It is likewise known to be a great preventive, when laid upon pasture-land, of that destructive disease, the foot-rot.

the fact which has just been recorded regarding the similarity of its effects,—whether mild or quick—yet differs materially in its strength, inquiry should always be made on that point previous to its application. The following general rules may be taken as a summary of what has been already stated.

1st. Before the application of lime, the land should be thoroughly drained and laid dry. 2dly. It may be carried on whenever the teams are the most at leisure; but summer is the best season, and it never should be laid upon the land unless in dry weather. 3dly. It should be laid on while in a powdery state—the drier the better—and kept as near the surface as possible, as then best adapted to mix intimately with the soil. 4thly. It may be applied either quick or effete; but if in the former state, it will have more effect in the cleansing of the land, and a less quantity will serve the immediate purpose. It should, however, be carted upon the land as soon as possible, and spread directly before the plough, letting that follow so quickly, as that the body of the lime shall be slaked in the soil; and it must be cautiously applied to light soils. 5thly. As it has a tendency to sink into the ground, and it is important to preserve it near the surface, it should be ploughed with a shallow furrow. 6thly. When found, after a few years, in lumps, and much below the surface of the land, it should be ploughed up and repeatly harrowed, so as to insure its intermixture. 7thly. Clays and strong loams require a full dose; but for sands and other light soils, chalk, or a much less quantity of lime, will serve—each in proportion to the strength of the lime and of the land. 8thly. If the land be not supplied with the same quantity of putrescent manure that is usually laid upon other soils, the crops will suffer; and if it be not then laid down to grass for a long series of years, it will be worn out and exhausted.(*a*)

Lime-kilns.—Lime may be burnt without building a kiln, as follows: The site on which this substitute for a regular kiln is to be formed, should be circular—say five or six yards in diameter: the soil should be dug up from off the subsoil; and then the operation of burning is to be performed in the fol-

(*a*) [The ordinary trap rock, which abounds in parts of this country, if reduced to powder, is a valuable manure, used as a top-dressing for grass. It should be applied in the proportion of one ton per acre, with about ten tons of dung. If applied in the state of very fine powder, it is supposed that five cwt. per acre would be sufficient. Of this last statement we give no opinion. The experiment is worthy of trial.]

lowing manner:—In the bottom of the pit lay a large quantity of furze, heath, or ling, upon which place about two feet in thickness of the parings, in the centre of which begin to form a funnel, or flue, of furze, encircled by peats, and around this lay about 6 or 8 inches deep of limestone, broken in small pieces. Then carry the flue up a couple of feet higher than the limestone, adding afterwards another layer of furze and parings about one foot deep, and then limestone, layer after layer of each, but still continuing the funnel; observing, however, that the circumference of each layer is to be lessened, until the whole assumes the form of a cone, or sugar-loaf, with the flue for its apex, or point. When this is done, brushwood, furze, heath, or any combustible matter, must be piled around, with peats to keep all together; and if the soil contain clay, clods may be added. Then set fire to the furze at the top or point of the flue, and the whole heap will burn down to the bottom with such effect, that within twenty-four hours the limestone will be completely calcined. If clay be added, it will also become sufficiently hardened to be easily reduced to powder, in which state, as we shall hereafter see, it may be converted to valuable manure; and the ashes may also be used as a dressing. This method of burning lime has also the further advantage, that these pits may be dug on every part of the land where it may be wanted, as they may be filled up with the soil previously taken out of them; or if it be also an object to burn clay, the operation can be performed at the same time, and a great portion of the expense may thus be saved.

Compost.—Independently of the mixture of lime with the soil in the manner already stated, great advantage may also be gained by making a *compost of lime and earth*, which has been found to possess more fertilizing properties than when it has been laid naked upon the land; and a far less quantity is found to answer the purpose. The great objection raised by most farmers is the heavy expense of labour, and also cartage, which is, in many situations, so great as to prevent the operation. It should, however, be observed that the compost is, in many cases, chiefly composed of the scourings of ditches, and of pond-mud, in which instances the charge of labour must necessarily be incurred, and a great portion of the cost is thus saved. Another mode of reducing the expense is also to plough up the headlands of fields in which the compost is intended to be laid. This is effected by ploughing the land as deeply as it will admit; and if the subsoil be not of such a

quality as to occasion sterility, this mixture of fresh earth along with the surface-soil and lime will prove highly advantageous. Virgin earth, indeed, if not in itself a manure, readily unites with lime, and richer composts are thus made than with earth taken from the surface: the expense, too, is less, for a smaller quantity of lime can be made to answer the purpose. The lime should then be laid on in the state of shells, before it is slaked, and ploughed well in, to insure its complete combination; the loose earth which escapes from the side furrows should then be shovelled up and thrown over the heap, after which a fermentation takes place within a very short time, if the weather be damp and warm, and the compost should be immediately laid upon the land, in quantity according to the quality of the soil to which it is to be applied. From 40 to 50 double cart-loads have been found a full dose to ordinary land, of which only one-seventh part of the compost was quicklime, which was considered equal in force to one-third of that which had been slaked. Nothing, however, can be more uncertain than the quantity of lime required, for it depends both upon the quality of the lime and of the earth with which it is to be mixed, as well as the state of the weather; but, from trials which have been frequently made, it would seem that two bushels of lime-shells will be sufficient for a cubic yard of earth of average quality; and 64 cubical yards of the compost—when properly prepared and applied to the soil—may be deemed a moderate dose for an acre of land; indeed, 40 have been considered a good dressing for light land, though more might unquestionably be, in most cases, laid on with better effect.* A dressing of this kind has been frequently found more effectual than one of farm-yard dung.

We cannot close this chapter without also adverting to the very just opinion generally entertained, that '*soils ought to be crossed*;' or, in other words, that composts, of which clay is the basis, should be administered to light soils; and the reverse. The expense is, however, in most cases, so enormous, in consequence of the vast quantity which must be laid on to produce any sensible effect, as seldom to leave any profitable result.

* 'If 80 cubic yards are considered to be a good medium dressing for a Scotch, or 64 for an English acre, 160 bushels of lime-shells will be sufficient. Now, the length of a head-ridge opposite to four ridges of 18 feet is 72 feet, and its breadth 18 feet. If this space be ploughed 10 inches deep, it will produce 40 cubic yards of earth at each end of the ridges; while the whole work may be executed by horse-labour.'

When the earth which is required to be added is to be found in the subsoil, then, indeed, if it be not at too great a depth, it may perhaps be dug, at those seasons in which labour is cheap, at a moderate expense; but those instances are rare, and the charge of cartage from a distance must prevent it from being undertaken by any man, although the owner of the land, who is not possessed of large disposable capital, or by any tenant who cannot secure the return of the outlay within the currency of his lease. Composts, however, may be very advantageously formed in the manner we have stated—by a mixture of lime with the earth on which it is to be laid.

CHAPTER V.

MINERAL MANURES CONTINUED.—MARL.

Marl is a compound calcareous earth found in most parts of the world, and has been extensively used throughout this kingdom, where it is supposed to have been known to husbandmen at a very early period of our history. There are, indeed, leases on record, granted in the reigns of Edward I. and II., which compel the tenants to make use of it; but, though still employed, it has been in a great degree superseded by the more recent introduction of lime, of the properties of which it in some measure partakes. The term denoting it was formerly used in a very vague sense, for it is a substance consisting of various materials, and it has consequently happened, that what has been supposed to apply to one species, did not hold good when affirmed of another. Although principally deemed valuable on account of the calcareous matter which it usually contains, still its composition differs so essentially, that its influence as manure is but imperfectly understood; yet theoretic writings abound in general directions for its use, which are frequently found not to answer in practice, for their rules are drawn either from statements which have been made of the effect of its application on particular soils, or from analysis of its qualities, which, as these vary in innumerable instances, frequently lead farmers astray. Its real value can, therefore, be only ascertained

through the practical experience of those who have either actually tried its efficacy, or who have witnessed it in their own neighbourhood.

This ignorance of the distinguishing properties of marl has necessarily led to many mistakes in its application, which have occasioned the variety of opinions that are entertained regarding its use. In most places where it was anciently employed, and where its fertilizing influence was discovered to be eminently great, it was thought by many farmers that it could be made to supersede the use of dung; they, therefore, in many instances, sold their hay and straw, and although, notwithstanding this reduction of the quantity of putrescent manure, they still for a time obtained large crops, yet, eventually, the chemical effects of the marl exhausted the land. No second marling could operate upon it until it had been renovated by repeated applications of dung; and thus has arisen the old saying, cited by Barnaby Googe, who wrote so long ago as the middle of the sixteenth century, that '*lime and marl are good for the father, but bad for the son.*' In this manner, also, some valuable discoveries in agriculture have fallen into disuse through their mistaken application, when governed by local circumstances which were ill understood; but wherever marl of a kind adapted to the soil has been applied, and that a judicious system of culture has been pursued, without either over-cropping, or neglecting the use of putrescent manure, the proverb is so far from being well founded, that the contrary may be safely affirmed.

The common *definition of marl* given us by the best writers on fossils, is,—that it is composed of clay, sand, and lime, very intimately, but unequally mixed, slightly coherent, not ductile, but stiff, or viscid, when moist; most easily diffusible in, and disunited by, water, or even by exposure to the air, and by it reduced to a soft, loose, incohesive mass—for the most part composed of nothing more than calcareous earth—in which its chief value consists—combined with a little mineral oil, clay, and sometimes with ochre, or iron. It is also generally considered as a characteristic of marl, that it effervesces with acids, though to that various exceptions have been discovered; from which it has been supposed that, when deprived of that test, it contains no calcareous matter, yet it is found to produce ameliorating effects upon the soil.* Notwithstanding

* A bluish marl much used in some parts of Ireland, and long celebrated

this summary description, its appearance is, however, as varied as its properties, being of colour nearly pure white, to the darkest shades of brown and red, interveined with blue and yellow. It also exists in different kinds of land, is seldom found as a stratum of much length, but generally in detached masses at various depths, sometimes in wide and dense perpendicular layers, at others in streaks, running in lines parallel with the horizon, or again intersecting each other at right angles, usually resting on sand or gravel, and is classed, according to its qualities, into the following distinct species:

1. *Clayey marl*, which improves sandy land, and seems to act as clay in changing the nature of the soil. In land consisting of a mixture of sand and loam, or of sand and gravel, then, the application of this marl has been found peculiarly advantageous: and on all poor and thin sandy soils there is this further advantage in its use—that, from the large proportion of clay which it usually contains, it adds to their bulk and firmness, and thus has a tendency to bring them to that medium state which is the most favourable to the purposes of vegetation. It is more soft and unctuous than clay; indeed, upon slightly cutting it, it becomes so flexible, that it may be kneaded like dough, or paste, though, when the moisture evaporates, it falls into pieces: it therefore blends easily with the soil, and partaking more largely of calcareous matter, its effects, though slow, are in all the latter cases more fertilizing.

2. *Sandy marl*, which is far more frequent in Ireland than in any part of England, and is commonly found in pits of limestone-gravel, whence it is in that country usually called limestone-sand. It is seldom clammy or unctuous, like the clay marl, nor does it adhere to the tongue, but crumbles between the fingers, and feels gritty; when exposed to the air and moisture, it slowly chips and moulders; and it partakes of some extraneous mixtures. Its colour is sometimes like that of lead, or brown, approaching to black, and at others blue. As implied by its name, it contains an excess of sand over that of clay; for, upon analyzing it, the proportion of the former has, in most cases, been found to be from 60 to 80 per cent.; and it does not effervesce with acids so quickly as the calcareous marls. It possesses but a small degree of tenacity, and

as a manure, makes no ebullition with acids; neither do several of the red marls; yet many of them are known to be productive of great improvement to land.

it has proved an excellent manure for clayey soils, mellowing their stiffness, and rendering them easier to work.

3. *Slaty or stony marl*, to which class, also, properly belongs that which is called *rotten limestone*, is chiefly applied to heavy land. Its operation is slow, but very lasting; land, forty years after it has been laid on, having been found to bear a closer and a better crop of grass than that which had been recently applied.

4. *Shelly marl*, which is evidently produced by the remains of testaceous fish, which, dying in their shells, become, in process of time, converted into calcareous earth, and their bodies, when decomposed, furnish a kind of mould composed of animal substance, which is no doubt analogous to the effect of dung. It is, therefore, highly fertilizing when judiciously applied to soils of every kind, which are either in themselves dry, or which have been properly drained.

Such are the most common denominations by which marl is usually distinguished, though it is susceptible of many subdivisions by those who affect to treat the subject scientifically.

It is, however, more frequently classed under the sole characters of *siliceous*, *argillaceous* or *calcareous*, according as sand, clay, or lime predominates in its composition; but for all practical purposes, it may be sufficient to divide it into *earth-marl* and *shell-marl*.

Earth-Marl.—The former, though in substance, as we have already seen, sometimes principally formed of sand, is yet, in most cases, chiefly composed of clay, and of the carbonate of lime, intimately combined, but mixed in very different proportions, by which its properties are necessarily varied. It acts as manure physically, or substantially, through the effect of the clay in rendering soils tenacious; and chemically, by the operation of lime in the manner which has been explained in treating of that fossil.

Although it is very generally thought that extreme accuracy in philosophical experiments is useless in the practice of agriculture, yet it is particularly necessary to ascertain the precise difference between these modes of action; for, of course, either one or the other prevails, according to the greater or the less quantity of clay of which the marl is composed. Thus, to produce the first-named, or physical effect, a much larger amount must be laid upon the land than when the second is the object; for clay can only be advantageously employed in that view upon soils that are too light, and consequently the

marl must be laid in proportionate abundance, or it will not improve the condition of the ground; whilst a clayey soil would, on the contrary, lose some of its good qualities by the addition of marl, after the effects of the lime were exhausted. The intimate combination of these two substances in the composition of marl, affords it, however, this advantage—that it divides, and falls to powder, with greater ease than can be effected by any artificial mixture, and therefore unites more readily with the soil.

On the other hand, if the calcareous matter in the marl be combined with sand instead of clay, or that there are, as in many instances, veins of calcareous sand intermixed, then it suits a clayey soil. The proportion in which these substances are combined is, however, so different, that they often vary in the same vein, and it is generally found that the bottom part is more calcareous than the top. From 15 to 40 per cent. is not unfrequently the proportion of calcareous matter found in clay; that of a sandy nature generally contains a larger proportion.*

The stone marl of hilly countries is frequently still more abundant in calcareous substance; but it also, in many other places, contains such large quantities of extraneous matter, that it may be properly considered as belonging to the earthy species, and has, in some instances, been laid upon the land to the extent of 400 to 600 single horse cart-loads per acre, which heavy labour renders the use of lime more economical, although carrried from a greater distance, except in cases where the chief object is to loosen very stiff clays, on which it acts with considerable effect.

Shell-marl.—Shell-marl is usually of a bluish colour, soft to the touch, and somewhat resembling potters' earth; but when exposed to the air, it crumbles and falls into a powder, nearly in the same manner as lime does in slaking.

The nature of this marl is very different from that of earth

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* *Argillaceous marl* usually contains from 68 to 80 per cent. of clay, and from 32 to 20 per cent. of calcareous matter: but it has been found composed of 70 per cent. of calcareous, and 8 to 10 of sand, with clear signs of some iron.

Siliceous marl very often contains above 75 per cent. of sand, consequently chalk and sand are the predominant ingredients.—Kirwan on Manures, p. 13.

The analysis made by Von Thaer, of a quantity dug out out of pits at Oldenburg, in Germany, showed it to contain in 100 parts—

Of fine sand	36
Clay of a soapy kind	44
Mould	5
Carbonate of lime	14
Gypsum	1

or stone; for it contains both stimulant and fertilizing properties which do not belong to the former, and from its effects upon the soil it has been classed among animal manures, though it more properly resembles a compost formed of earth and lime, with animal and vegetable substances, for which reason it is justly considered preferable to the others. It exists at the bottom of most lakes, and under bogs and morasses, or other pieces of stagnant water which have been drained, and might, no doubt, be found in every place where water has originally rested: though, as it is usually under other layers of earth or peat, its depth below the surface is often too great to admit of its being searched for with advantage. Every farmer should, therefore, carefully examine the sides and bottoms of his ditches and ponds, for, by doing so, he may often find appearances of marl in places where it was not suspected, and large beds of the most valuable sort have been in that manner discovered, which might have remained unnoticed for years.

It is chiefly composed of those myriads of small shell-fish which, with other fry and insects, usually procreate wherever there are pools of water, and the remains of which have, in the course of past ages, been deposited along with sand and decayed vegetables, or other matter swept from eminences, or by the decomposition of aquatic plants. This process of alluvion has, in the lapse of time, produced those masses of shell-marl which display the most striking effects when employed as manure; for the shells, when decomposed, are converted into lime of such purity, that some moss-marl, examined by Dr. Coventry, was found to contain 84 per cent. of pure chalk—which is more than is generally possessed by the purest lime—and the mould formed of the other substances must be very rich.* It

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* By other experiments made by Sir G. Mackenzie, it appeared that some shell-marl was composed of

Lime	41 25	in 100 parts. (*a*)
Carbonic acid	32	
Silex	14	
Argil	4	
Oxide of iron	2 5	
Inflammable matter	2	
Loss	4 70	

(*a*) [The green sand of New Jersey is remarkable for its fertilizing properties. It goes under the name of marl; but it is differently constituted from the marl spoken of in this work. Its power depends upon its phosphates. Its effects in reclaiming worn-out sandy lands are well known in New Jersey, where its value is appreciated. In fact, it is sometimes too *much* appreciated; being relied upon to the exclusion of other manures, and applied to all sorts of land, and for all kinds of crops.]

may, therefore, be converted into quicklime, by burning, or it may be used in its natural state, but then it is not so minutely divisible, nor so soluble in water, and is, of course, more tardy in its operation; its effects, however, continue longer, and it is apparent that, as it contains more calcareous matter than the common qualities of lime, it may be used in smaller quantities. When spread upon grass, or clover, it is found to promote the growth of the herbage, for it partakes of the nature of pounded limestone, and possessing none of the caustic properties of quicklime, it may be used without hazard as a top-dressing. It also occasions heavy tillage crops; and if the land be not over-cropped before it is returned to pasture, the turf is found to be closer, more plentiful, and sweeter than before; but on cold damp soils, which have been heavily worked, the crops of grain have proved later, and the corn lighter, than on land which has been limed.

Application of marl.—Many farmers either lay marl upon land sown with tares, thus making a bastard fallow; or they apply it to grass land, or to a clover ley, to be broken up in the following year. The latter is certainly the preferable, as well as the most general practice, for it not alone produces an abundance of good pasture, but it affords time for the season to operate in bringing the marl into a fit state for future tillage crops, which cannot be done in the common course of cropping, because it becomes buried by the plough before it is properly mixed with the soil, especially if turned in deep the first earth. It should, therefore, be allowed sufficient time to sink and eat itself into the surface before it is ploughed up. This, however, is by some persons carried to an absurd length, as they occasionally spread a coat of marl upon the green sward, and leave it there unploughed for many years, in which case the grass receives considerable detriment, for the marl then sinks downwards in a body, without incorporating with the soil; though, when it has lain a long time in this state, the subsequent crops of corn have been found to be enormous. If laid upon grass, it may be carried out during all periods of the year in which the crop is not in a forward state of growth; but if applied to arable land intended for immediate cultivation, the months of June and July, or soon after the autumn seed-time, are considered the best for its application. If laid on a short time previous to winter, its effect is also generally prompt, because, except it be of a very tenacious kind, the action of the cold and rain commonly divide it in time to be

thoroughly amalgamated with the soil by the tillage of a summer fallow. If, however, it be only applied during the spring months, this cannot be so properly carried into execution, for it requires the winter's rain and frost to crumble it, and it consequently has but little power upon the year's crop. A complete summer fallow is, undoubtedly, the best mode of bringing it into perfect operation: but not only is the expense often objected to, but there is also a strong prejudice entertained by many persons against fallowing—into which it is not our present object to inquire, although we necessarily shall have occasion to notice it hereafter.

It is almost superfluous to add, that, in whatever manner it be applied, it must be equally spread over the land; and if there should be any large lumps remaining, these should be broken with mallets, or clotting-beetles, in the same manner as chalk, before it is ploughed in. This, however, is not usually done until the marl has partaken of both one summer's sun and one winter's frost; and should the previous season have proved unfavourable to the reduction of the marl to small particles, the process, in some cases, costs so much, that, when laid upon grass or clover, it is often found more advisable to leave the ground unbroken during another year. Then, when well crumbled, dry weather should be chosen for rolling and harrowing it—a first time with heavy rollers and drags, and a second after it has been exposed to rain, and has been again dried: in short, until it has been rendered as small as possible; after which it should be lightly ploughed in, again harrowed, and receive from two to four ploughings, according to the condition of the soil. The intermixture of the marl with the earth cannot, in fact, be too complete; for whatever proportion remains uncombined with the soil, will not alone fail of producing the intended effect, but will have one of an opposite and prejudicial tendency.

The *quantity of marl* which it may be prudent to apply to the land depends entirely on the nature of the soil, and the properties of the marl: the more calcareous is the latter, the greater is the effect which it will produce, as a stimulant; and shell-marl possesses, besides, the additional power of nourishing the soil by the vegetable and animal mould with which it is combined. This species was formerly profusely used on every sort of ground, but at present the average amount applied to land of the medium kind is from 30 to 40, or, if it be very light, only 25 cart-loads, of 16 cubic feet per acre. Land of the latter quality may, indeed, be readily over-marled;

as by repeated marlings, in large quantities, the surface of poor ground may be rendered so loose that, in some cases, it has not afforded a sufficient hold to the roots of corn and grass. Double the quantity may, however, be laid upon strong cohesive soils, for it is not so easy to give them too large a dose; but if cold, wet, or moorish, great circumspection is requisite in the application of this marl, for if the land be not previously well drained, it will only increase its tenacity.

The earthy marls, if much mixed with clay, are only fit for light soils; and, if applied to them, the quantity must be increased in proportion to the deficiency of calcareous matter. When of good quality, containing about 20 to 25 per cent. of calcareous or chalky substance, they are commonly laid upon such land to the thickness of an inch; which will require 135 cubic yards, or about 200 single horse cart-loads per acre.* Sandy marl, though generally more calcareous, yet being dug up with less labour, is often used upon clays with greater freedom; and we have already seen the great extent to which stony marl is sometimes applied.† In many parts, however, where the effects of marl have been extensively experienced, these quantities have been diminished one-half, with nearly, if not entirely, the same immediate effect upon the crops, though its power has been less durable, and has in most cases altogether ceased at the end of at most a dozen years; but then, it admits of the following advantages—a farmer may be able to afford half the expense, when the whole amount may be beyond his means; or, at the same time, he can marl double the extent of land, and he can reap all the probable benefit within the term of a moderate lease. Nor is this all; for, supposing him to have the freehold—it has been found, that when large quantities of marl have been laid upon the land, though its effects last longer, yet, unless cultivation be carried on with great intelligence and care, these are at length worn out, and by severe cropping to repay the expense, large tracts of marled land have been much exhausted. In such cases, too, a second application has been attended with very little benefit; whereas, when it has been laid on in moderate quantites, a

* Clay marl is not uncommonly laid upon light soils to the extent of two roods, each containing 64 cubic yards; but on heavy land, half that quantity per acre is considered a good covering.

† Throughout many parts of Scotland it is applied at the rate of 200 to 300 small cart-loads per Scotch acre,—equal to 160 to 240 per imperial acre. It it is there commonly applied to grass land, and allowed to remain one or more winters on the surface, until completely reduced by the frost.

second and further applications have been successful; the reason of which evidently is, that, in the first instance, the fertility of the mould was either exhausted by the chemical effect of the marl, or, that, the soil being of a heavy kind, and the marl containing too great a proportion of clay, this addition became injurious; while, in the second, dung had been applied in aid of the marl, or, its earthy properties being of a nature opposed to those of the soil, assisted in its amelioration. The latter of which suppositions is, indeed, supported by the fact, that when a second application of clay-marl has failed, lime has been laid upon the same land with sensibly good effects.

It has also been observed, in those places where marl is applied to the land in small quantities at stated distances of time, and where a sufficiency of dung is likewise used, that when weeds of any peculiar species push forward with extraordinary vigour, marl, if accompanied by a clean fallow, not only destroys them, but produces better corn than when dung has been laid on alone, though also upon a fallow, and instead of marl; which has been thought to be accounted for by the exuberance of the weeds proving that the soil is already abundantly furnished with nutritive matter for the promotion of vegetation, but that it is more appropriate to the production of the weed with which the ground is covered, than to cereal crops: whence it has been inferred, that the chemical action of the marl probably changes the nature of the mould.

The *durability of the effects of marl* necessarily depends upon its power over the soil. A very large dose of argillaceous, or clayey marl, ameliorates sandy soils to such a sensible degree by the consistence which it affords to the land, that, if proper attention be paid to its complete combination with the surface, and to the prevention by careful culture of its sinking to the subsoil, as well as to the employment of putrescent manure, the improvement thus effected will be found permanent. When laid on in smaller quantities, its effect and duration will, on those light soils, of course, be proportionate; but on clays, as its chief power consists in the calcareous matter which it contains, its greatest effect is apparent when the land is brought into the second course of tillage, after which it gradually begins to decline, and after six or eight crops have been grown, it usually ceases to operate.

CHAPTER VI.

MINERAL MANURES CONTINUED.—GYPSUM.

Gypsum, otherwise *sulphate of lime*, *or plaster of Paris*, as it is commonly termed, consists of pure calcareous earth, or lime, 30 parts or 33; sulphuric acid, 32 parts or 43; crystallized water, 38 parts or 24. It requires from 450 to 500 times its own weight of water to dissolve it; though reducible to powder in the fire, it is almost as difficult of fusion as limestone, and it loses about 20 per cent. by calcination. When pure, it does not effervesce with acids; it is insipid in taste, and free from smell; but there are other sorts which vary in purity, and hence the analyses of many chemists differ in their accounts of its properties. There is, however, a simple mode of trying its quality, which is common in America, and consists in putting a quantity of it pulverized into a dry pot over the fire; and when heated, it gives out a sulphurous smell. If the ebullition, or bubbling, which then takes place, is considerable, the plaster is good; but if not, it is considered indifferent; and if it remains motionless, like sand, it is thought to be hardly worth any thing. Another test of its goodness is obtained by putting the powder alone into an iron pot over the fire, and when it bubbles, like boiling water, it will admit of a straw being thrust to the bottom without resistance.

Application. (*a*)—When applied *in its raw state*, gypsum is prepared for use by first pounding it with sledge-hammers into very small pieces, and then either grinding it in a mill, or passing it under the crushers of oil-cake, by which about 20 to 25 bushels per ton are produced, according to its state of purity. By the latter process, however, it is not sufficiently pulverized, which is essential to its utility; for if this be not completely effected, not only will a larger quantity be required, but even that will not, in some cases, be found so effectual as the powder. When employed as manure, it is seldom burned, and if used either in its natural state, or *in proportionate quantity if calcined*, no perceptible difference can be discovered, unless heavy rain should fall soon after it has been spread, which gathers it into lumps, like paste, and hardens it;

(*a*) [It is now generally considered that it is best to apply gypsum in connection with animal or organic manures.]

but, if this be guarded against, the only sensible effect of calcination is to deprive it of its aqueous particles, and thus to reduce its weight; for the sulphuric acid which it contains cannot be expelled by the most violent heat of the furnace. The only object to be gained by burning it is, therefore, to bring it into as fine a powder as possible, which, when it has been submitted to the fire, is comparatively easy: lying also in a less compass, the carriage is besides cheaper. When sold in that state by the London dealers, it however costs about 4*s.* 6*d.* per bushel; though, when merely ground, without having been burned, but brought to the condition of coarse meal, which answers all its purpose as manure, it may be procured at 2*s.*: we shall therefore confine our observations to its application when raw.

The *soils to which it is the most congenial* are the light, dry, sandy, gravelly, and chalky: to heavy loams, strong clays, and to wet land, it seems to yield no benefit, unless the former happens to have been well limed. It was long thought that gypsum, being itself calcareous, could not be applied with any advantage to soils which were impregnated with similar matter; and as the analysis of its properties shows that it contains both alkali and sulphuric acid, which are known to become neutralized when combined in just proportions, it was also, therefore, generally imagined that its effects upon vegetation would, in certain cases, be scarcely perceptible. These conclusions have, however, led to much misapprehension in its use as a manure; for, in the first case, experience has proved it to be beneficial when laid upon limestone soils, or upon land which has been saturated with chalk or lime; and, in the second, although alkalies and acids, when acting solely upon each other, are rendered neutral, yet, when the resulting compound is applied as a dressing to land, its effect has in many instances been found eminently useful. The causes which have produced these effects are, however, far too obscure, in the present state of chemical knowledge as applied to the nature of soils, to allow of more than mere conjecture; and would lead to a discussion which could prove interesting to only a very limited number of our readers.

Upon exhausted land, or upon soils containing little vegetative mould, or deprived of putrescent manure, it will prove powerless; but it succeeds well after an application of dung, or of green crops ploughed down. It produces, also, *more effect in dry, than when laid on in wet weather.* A watery

temperature, at least, arrests its effects, and seems even to suppress them altogether if the gypsum has been calcined: but it should be observed, that this only occurs if rain falls soon after its application; for if it happens previously, its moisture upon the plants will be found useful. This employment of the gypsum, either during the prevalence of rain, or immediately before it has fallen, has given rise to many mistakes, which have occasioned much of the prejudice which is entertained against its use. Thus, in the Sussex Report it has been stated that equal quantities of French and English gypsum were laid, on the 14th of June, on six different fields of a sandy loam, sown with beans, peas, potatoes, and barley, besides natural grass, at the rate of 8 bushels to the acre. On the day it was strewed it was showery, and on the 15th it rained from 10 in the morning till the evening; yet neither in that, nor in the following year, could any greater appearance of luxuriance be perceived than on the surrounding ground. The experiment was also repeated in March and the middle of April upon some patches of red clover, wheat, and spring tares, with similar effect: on both occasions it rained heavily. Thus, not only, as we shall perceive, has it been applied to some crops to which it is useless, but in seasons which were inappropriate, and it has been washed off those plants, on the stems of which had it been allowed to remain, it no doubt would have been attended with good effect.

The *crops to which it is the most appropriate* are the artificial grasses and leguminous plants, though it has been also known to materially improve the sward of moss-bound pasture. It never appears to produce better effects than when it has been laid on red clover, already so far grown as that the leaves nearly cover the soil; for there seems no doubt that it acts with the greatest force when it adheres to them, and that the longer it remains upon them the better. It should, therefore, be used as a top-dressing, and applied in the latter end of April, or the beginning of May. Besides the effect attributed to its application to the leaves, it has not been found so advantageous when laid on during the cold months of winter, while plants are in a torpid state; though many people spread it in autumn upon the young clover of the first year, and others, after the first cut, which has thus been often known to produce a larger crop than the former. Perhaps, however, these plans might be beneficially combined were the quantity of gypsum divided; one portion to be used as an early sprinkling when the first

crop begins to appear, and the second as soon after it has been mown as the new leaves spring up. If, however, the plants of either clover, sainfoin, or lucerne, should stand very thick upon the land, and if the soil be sufficiently fertile to push those first crops vigorously forward, in that case the gypsum would probably be productive of such an excess of vegetation, as might occasion them to become so rank as to rot upon the lower parts of the stem, and its application should be deferred until after the second cutting.

In order to spread it, with the intention of covering the leaves, a calm day should be chosen; and it should be spread by hand, or rather through a sieve, either early in a morning in which the dew has fallen heavily, or late at night, or after a gentle shower, that thus the moisture may occasion it to stick to them. It should be avoided either on a windy day, or when the weather threatens rain; and the powder should be ground fine. The usual quantity varies from four to six bushels; if completely reduced, and of strong quality, perhaps the former will, on good soils, be found sufficient if laid on at once; or, if at two periods of the year, with a small increase each time upon half that amount. If coarsely ground, it will not be found effectual in its application to the leaves; and if used either in drills, or as a common top-dressing, at least the full quantity just mentioned must then be applied.

As lucerne and sainfoin are the only artificial grasses generally cultivated, which remain for a number of years upon soils adapted to their growth, it has, however, been found, in many instances, that by forcing a heavy crop in the first year, by the use of six bushels per acre, and repeating that quantity in the third or fourth, the plants have shortly afterwards become so exhausted as to admit of no alternative but the plough. It, therefore, merits consideration, how far the obtaining an increase of those crops, by such means, within a short period, is more advantageous, than by the application of only two or three bushels per acre, and afterwards repeating the same quantity at a future stage, to leave them longer in the ground; but it is a point which depends in a great measure upon the local circumstances of the land, or the particular resources of the farmer, and must be left entirely to his own judgment.

With respect to the *permanency of gypsum* as a manure for artificial grasses, it has been stated, in those cases in which its beneficial effects have been proved, that sainfoin dressed with it did not materially decline until the fourth crop, and

on sowing five bushels more per acre, it recovered, and became as productive as before, yielding, on a thin soil, about a load and a half; whilst another patch, dressed partly with soot, became so weak as to be scarcely worth mowing. Its durability, when applied to lucerne, has been found to produce very fine crops during five years; when the natural grasses appearing to gain ground, five bushels more per acre were again laid on, which forced such a smothering crop, that the grass could no longer make head until after the third cutting, when it afforded, with the last shoot of the lucerne, a very fine crop of rowen. Although much difference is observable in the results of the various experiments which have been recorded respecting the effects of gypsum on artificial grasses, yet there are none with which we are acquainted, in which its application has not been successful when applied as a top-dressing to the plants, conducted with due precaution, and not deranged by violent rain, or other accidents arising from the weather. In this we are borne out by the testimony of Dr. Fothergill, of Philadelphia, as well as by that of several eminent American farmers, mentioned by Mr. Parkinson, and supported by the more recent treatises on the subject, written by Mr. Russell, and Professor V. Thaer. We, therefore, do not hesitate to recommend it as an effectual means of promoting their growth, and more especially that of red clover, provided the soil be at the same time tolerably covered with plants; though, in confining that opinion to top-dressings applied to the leaves, as being the most decidedly effectual mode, yet, as there are numberless instances of its success when drilled along with the seed, we do not mean to preclude its being laid upon the land at the time of sowing.

The trials which have been hitherto made of its *application to corn crops* seem to prove that it does not operate directly on grain; but they are unanimous in showing that the stubble of a clover-ley which has been manured with gypsum, when afterwards ploughed up, produces a far better crop—especially of wheat—than when it had been omitted. There is, however, strong reason to suppose that this should be rather ascribed to the luxuriance of the clover—no matter in what way that may have been occasioned—than to the direct application of the gypsum; for it is well known that crops of wheat, and indeed of most grain, always succeed in proportion to the growth of the previous clover, which is not improbably occasioned by its keeping the ground moist, and preventing its

exhalation by the sun. We have, indeed, heard some recent instances of its having been used as a top-dressing to wheat in the spring—in some cases with great success, and in others without any apparent effect; but this may perhaps be not unjustly attributed to its having fallen, in the former case, upon the shoots when they had been moistened by the dew, which thus enabled them to retain the powder, and in the latter, by its having been either washed off by rain, or dispelled by the winds.

Its direct *effect upon crops of pulse* has not been sufficiently ascertained to enable us to speak of it with precision. Peas, indeed, have been known to succeed wonderfully after sainfoin which had been previously manured with gypsum, but they generally flourish in chalky soil, in which sainfoin is also commonly sown. It has, however, been remarked that both peas and beans frequently become hard in boiling, which has been attributed to the temperature of peculiar seasons, and, above all, to rain, which has impeded the usual course of harvest; this, however, has been found to be a mistake, for it has been shown that this defect is due either to the soil being naturally impregnated with gypsum, or to its having been laid upon the land as manure. As an instance both of its effect and of the prejudice which many people entertain against it as a manure, an anecdote has been related of a gentleman who, having recommended its use, ordered his servant to spread a small quantity of it secretly upon an adjoining piece of sainfoin, belonging to an old farmer who vehemently decried it. The crop proved surprisingly abundant on that spot to which the gypsum had been applied; but upon discovering its occasion, the old man, instead of profiting by the circumstance, grew peevish, and wondered why his neighbour should have taken the liberty of spreading this new-fangled manure over his sainfoin, which, for aught he knew, might do more harm than good. The laugh, however, going against him, he determined to get rid of it by breaking up the sainfoin and sowing peas; when, behold! they also rose in judgment against him so evidently on the gypsumed part, that he was constrained, though reluctantly, to acknowledge that 'it seemed good stuff:' yet he was never afterwards known to lay a bushel of it upon his farm.

Of its power, *when applied to bulbous roots*, the accounts are equally deficient; except, indeed, that Mr. Parkinson has furnished different statements of its application, on his own

farm in America, to turnips both sown along with them in the drills, and spread over the plants when they got into rough leaf; in each of which the superiority of the crops on those portions of the land on which the gypsum had been laid, was so evident in quantity, that in some patches spread with it in squares, in order to mark any difference that might arise, 'the ground was checkered like a floor of black and white marble, and the quality was so much more sweet and juicy, that none in Baltimore market sold for so much or so readily.' He however admits, in another of his works, that a small quantity of compost dung was laid on along with the gypsum, but 'where no compost was applied, the gypsum by itself was of no avail;' and in some other trials made in this country, when laid upon alternate lands of oats and turnips, it has produced no visible effect. In his other experiments on potatoes and onions, as also on carrots and cabbages, and on various crops of white corn, no perceptible difference could be observed in the application of gypsum; except that, in one instance, 'the plastered rows of potatoes were rather worse than the others;' and that 'on old land newly ploughed up, but not pared and burnt, the gypsum was found to act as a corrector of the soil, and thus to give more grain and less straw.' Mr. Parkinson, indeed, attributes its chief powers to consist in its quickly cementing, and thus preventing the heat of the sun from exhaling the moisture or nutritious quality of the manure; by which means the plant, being kept moist at the root, consequently grows well, and quickly gets a shade from its own sprouts. This would, however, tend to prove that its application would be serviceable to all crops in dry weather: an opinion which is not borne out by what has been already stated of its effects.

Such are the chief points regarding its *practical application* to which some objections have been made. 1st. As tending to render the land stiff under the plough. 2d. As exhausting the soil by forcing vegetation. 3d. As being confined in its effects to particular crops, and becoming, perhaps, prejudicial when those are followed by others of a different nature. To which it may be answered:—

1. That the increased tenacity of the soil can only be occasioned either by some extraordinary excess in the application of the gypsum, or by its being laid upon heavy clay, to which it is unsuitable; but, if applied to light porous land, unretentive of moisture, the firmness of the texture thus imparted

would become a real advantage. 2. That this stimulative property is common to every substance that merits the name of manure. That, although gypsum may not be possessed of any nutritive quality in itself, yet, if the land be properly dunged, or otherwise supplied with a sufficiency of other putrescent manure, or of nutritive compost, to support the increased powers of vegetation,—and which, in common prudence, should never be neglected,—the soil will not, if discreetly managed, suffer any diminution of its accustomed fertility, but will be improved by the large addition made, through the greater luxuriance of the green crops, to the size of the dunghill. 3. That its beneficial effects being confined to some peculiar species of crops, is no real disadvantage; for, when applied to those of a different kind, it has not, in any known instance, been found prejudicial. Its powers appear, indeed, to apply more to the specific crop on which it is spread, than to the state of the soil; and when it has been laid in various quantities—from two bushels to two-and-thirty—on crops to which it is inappropriate, it has been found in all cases wholly ineffectual.

It has been assigned by Sir Humphry Davy, in the *theory by which the operation of gypsum is governed*, as a general standard for its application, that it is the most beneficial to those plants which always afford it on analysis: thus, the ashes of lucerne, sainfoin, rye-grass, and clover, contain considerable proportions of gypsum; but only a very minute quantity is to be found in crops of corn, pulse, or turnips. It is, therefore, essential to the vegetation of the former; and land which has grown tired of clover, may be restored by being dressed with it, or with peat ashes, some species of which hold a large portion of gypsum. But when the soil already contains a sufficient quantity of this substance for the support of the cultivated grasses, he considers that its application to them, or even to the natural pasture, cannot be advantageous; for plants only require a certain portion of manure, and an excess may be detrimental. The reason why its application to soils is not always efficacious is, probably because it is furnished by the common course of culture to most well-cultivated land in sufficient quantities for the use of the grasses, and perhaps to an excess beyond what other crops require for their growth; for although this may not be apparent to the farmer, it is contained in stable dung, and in the dung of all cattle fed on pasture. A

certain portion of it may also be discovered, upon analysis, in the natural composition of most soils.

It has been said, by Kirwan, to accelerate putrefaction in a higher degree than any other known substance; but this has been shown by some experiments of Sir Humphry Davy to be incorrect, and it, therefore, cannot be supposed to afford any direct nourishment to plants, either by the corruption of animal remains, or the decomposition of manure. It has been very generally supposed that, as sulphuric acid has a great attraction for water, gypsum acts by its power of attracting moisture from the atmosphere; thus cooling the air in summer, and being more efficacious to dry, sandy soils, than wet clays. It has even been confidently stated, that the dew has been known to stand two hours later in the morning upon plants which had gypsum spread upon them than upon others on which there was none. This, however, has been also contradicted by Sir Humphry Davy, who considers the argument in its favour to be comparatively insignificant; for, when combined with water, it retains that fluid too powerfully to yield it to the roots of plants, and its adhesive attraction for moisture is inconsiderable: yet, though thus opposed by scientific reasoning, the experience of farmers inclines to the support of the opinion already stated. It is even thought by many people that, when sprinkled over the leaves of plants in a damp state, the paste which it thus forms upon them must prove destructive to the propagation of many insects, and would probably prevent the fly in turnips; but that supposition has not been confirmed by experience. It has been likewise asserted, that its fertilizing powers are destroyed by the effects of sea air, and much of its failure in many parts of England has been attempted to be accounted for upon that principle; but this is in direct opposition to the trials already mentioned to have been made in Kent, and it has been found to answer in Norfolk when applied to land within two miles of the Northern Ocean.

The American farmers lay it upon land newly reclaimed from the forest: it may, however, be doubted whether gypsum contains any inherent property by which it can improve the soil, unless through the means of its fertilizing powers upon the peculiar crops to which it is appropriate, and there is reason to believe that, even upon these, its effects will be comparatively trifling if ploughed in. There cannot, however, be any question respecting its expediency when applied as a top-

dressing to artificial grasses at that period of the spring when the plants throw out their first leaves, if spread in portions of not less than four bushels of the finest powder, so equally sprinkled that every leaf should get some, and in weather that is perfectly serene and close. We have afforded the subject more attentive consideration than some persons may suppose it to merit, for it cannot be denied that, in consequence of the disappointment which it has occasioned to many who have tried it without being aware of its peculiar nature, the use of gypsum throughout England has been very generally discontinued; but on a careful review of the very contradictory opinions entertained regarding its effects, we are persuaded that no dispassionate and intelligent farmer can entertain any doubt of its being rendered a source of very important benefit, when used with due discrimination of its powers, and judgment in the mode of its application. We therefore strenuously recommend it to experiments upon a moderate scale; for even should it not be found in the immediate neighbourhood, the cost and carriage are so trifling that a sufficient trial can be made for a few shillings; and we should say that no man who grows a single acre of clover should fail to satisfy himself regarding its real properties. If successful, it may become the means of material improvement upon light loams, and poor chalky soils, which require amelioration through the manure afforded by green crops, as well as to land which, though in better heart, may have lost the power of repeating the production of clover so often as it might be found profitable. No one can justly assert that it is not worth the trial; and, *even if unattended with good effect, it can do no harm.*

CHAPTER VII.

MINERAL MANURES CONTINUED.—ASHES—SOOT—SOAPERS' WASTE.

Ashes of every description, including leached ashes, though not all falling strictly under the character of fossil substances, and, indeed, being partly derived from the vegetable kingdom, yet, partaking in a great degree of the same calcareous nature as

those of which we have already treated, may also be allowed to rank together under the general denomination of mineral manures. Those of coal, wood, and turf, when used for domestic purposes, are, in almost all country places, mixed up by the consumers with the dung-hill, and, unless they form an unusual proportion of the heap, occasion but little sensible difference in the properties of the manure; but, when applied alone, as top-dressings upon grass, they both strengthen the herbage, improve its quality, and encourage the growth of white clover; they are also generally used for many other crops, both of corn and artificial grasses, but chiefly upon clays and heavy tenacious loams.

The *ashes of coals*, and *cinders*, have, indeed, the very perceptible effect of loosening as well as stimulating those soils, and when they can be procured in sufficiently large quantities, in the neighbourhood of great towns and manufactories, they are also ploughed in with great advantage, to the extent of 50 or 60 bushels, or even more of the latter, per acre.

Those of wood, which forms the chief firing in the interior of this country, are also largely employed by many farmers, who contract with the cottagers for all the ashes they make; drawing home for them in return their faggots. The manure thus procured, being a powerful alkali, has a very considerable effect in correcting any acidity that may exist in the soil, but is, in almost every instance, employed without any distinction respecting the sort of timber from which it is obtained, though, as the trees contain very different qualities, they necessarily yield ashes corresponding, to a certain extent at least, with their original character; and were they classed, and farmers made acquainted with their relative properties, they would be much better able to judge of the due proportion of ashes which it might be expedient to apply to the ground.*

The *ashes of burnt straw* have also been found beneficial

* It is a well-ascertained fact, that the closer the texture of the wood, and the harder and heavier it is, the greater portion of vegetable alkali it will be found to contain. Thus, trees may be ranged, according to the value of their ashes, as follows:—Oak, ash, sweet chestnut, beech, pear, crab, broom, elm, maple, the pine and fir tribes, birch, alder, sycamore, poplar, hazel, elder, and willow. It therefore necessarily follows, that where the kind of timber which has been consumed can be ascertained, the proportion of ashes to be applied per acre ought to vary accordingly; for if six loads of the best and purest ashes from oak be sufficient, ten or twelve may not be more than equivalent to them when produced from hazel, alder, or willow; and by the same rule, if ten or twelve loads of oak-ashes were to be sown, because it may have been the custom to use that quantity of hazel, &c., the effect might be found, in a dry season, to burn up the crop

by many intelligent practical farmers, from some of whose experiments we select the following instances. Advantage was taken of a fine day to fire the stubble of an out-field soon after harvest, the precaution having been previously taken of sweeping round the boundary to prevent injury to the hedges. The operation was easily performed, by simply applying a light to windward, and it completely destroyed every weed that grew, leaving the surface completely covered with ashes; and the following crop, which was wheat, produced full five quarters per acre. This excited further experiment, the result of which was that in a following season, the stubble having been partly ploughed in according to the common practice, and partly burned, and the land sown with wheat, the crop produced eight bushels per acre more on that portion which had been burned, than on that which had been ploughed in. The same experiment was repeated, on different occasions, with similar results; and a following crop of oats having been laid down with seeds, the clover was found perfectly healthy, while that portion on which the burning of the stubble had been omitted, was choked with weeds. It must, however, be recollected, that, if intended to have a decided effect, the stubble must be left of a considerable length, which will occasion a material deficiency of farm-yard manure; though the advantages will be gained of saving the cost of moving the stubbs, the seeds of weeds and insects will be considerably destroyed, and the land will be left unimpeded for the operation of the plough.

On the wolds of Lincolnshire, the practice of not only burning the stubble, but even the straw of thrashed grain, has been carried, in many cases, to the extent of four to six loads per acre; and, as it is described in the Report of the County, has been attended, in all those instances, with very decidedly good effect. It is even said to have been found superior, in some comparative trials, to yard-dung, in the respective rate of five tons of straw to ten of manure! Although placing implicit faith in the results thus stated, we cannot, however, but feel strong doubts of the expediency of the practice; for we should hesitate to recommend any measure that tended to reduce the quantity of farm-yard manure—the application of which is always certain and always durable, whilst the most decided advocates for the burning of straw are compelled to admit that its effects are but transitory. Some intelligent farmers, indeed, consider the benefit to arise more from the effect of the fire in the destruction of weeds and insects than from the

small quantity of ashes that are produced, and its chief value must be supposed to consist in the superior degree of cleanness which it imparts to the land.

Soot.—The soot produced by different species of fuel is subject to the same difference in quality as those substances from which it is derived. The soot accurately collected from fires burnt in the house is generally good, while that commonly sold by the chimney-sweepers is in general mixed with dust and other trash, which lessens its power.

Soot is usually sown upon wheat if it be weak, or if the yellow cast which it sometimes assumes in the spring shows it to be sickly; in which cases it will improve the colour and strength of the plant, which will then tiller out and cover the ground with a great number of new shoots. Upon barley it is sometimes sown with the crop, and at other times a fortnight after; but it should never be deferred later, and if possible, should be spread in April. It is also occasionly applied as a top-dressing to clover and other artificial grasses, though it seems better suited to rye-grass than to any other species, for, when both that and clover have been sown together, and that the field has been dressed with soot, the former has become so rank as to completely overtop the latter. One of its most common uses among farmers is, however, for turnips, either sown along with the seed, or more usually, immediately after the plants appear, as it is so acrid and bitter as to become injurious or disgusting to insects, and has therefore been found very efficacious in preventing the ravages of the fly, as well as that of the wire-worm. The best time to sow it is on the evening of a cloudy but calm day, when there is an appearance of rain, for if the weather be hot and dry, its volatile parts are dispelled, and it becomes of no service to the crop.

Some farmers recommend its being mixed with an equal quantity of quicklime, and double that quantity (of those two combined) of fresh loam; the soot and loam to be regularly amalgamated by passing the latter through an upright screen, as practised by bricklayers, by which means the lumps will be either kept back, or broken and passed through it; and after remaining in this state during almost a fortnight, the lime should then be added by turning the heap and mixing all together; after which it will, in a few weeks more, become fit for use. The materials thus enumerated are all good, and doubtless will prove serviceable to those soils to which they are adapted; but we are not sufficiently acquainted with the

experiments which have been made upon this species of compost to speak of its effects with any degree of certainty; and we doubt whether the most beneficial mode of applying the soot will not be still found to consist in spreading it in a dry state, without any preparation as a top-dressing. As an application in that mode, to such crops as we have mentioned, it will be found useful, when used in moderation, upon soils of every kind; but if intended to be applied as an improvement to the land, it will be of very little benefit after the first year.

Soapers' waste. (*a*)—The use of the ashes produced by the manufacture of soap—the refuse of which is termed *soapers' waste*—has been much recommended as manure; and it has been supposed that its efficacy depends on the proportion of saline matter which it contains: this, however, is very minute, and depends upon the sort of alkali employed by the soap-boiler, two kinds of which are chiefly used—namely, kelp and barilla—which are much more effective than that which is the refuse of common pot-ash. [In this country, soap-boilers use ordinary wood-ashes to a great extent. Their waste is, in our opinion, of little value—certainly none to our farmers in the interior. Leached ashes do not act so favourably on heavy clay soils as on those of a lighter and more sandy character. We have seen 120 bushels an acre used with better effect than nearly twice the quantity on the same kind of soil.]

If applied in large quantities to the land, there can be no doubt that soapers' waste will be found to be a useful and lasting manure; it destroys slugs and vermin of every description; has been found to increase the product of hay by a ton an acre; and by some farmers the effect of a wagon load of the ashes is considered equal to that of five loads of rotten dung. This we, however, conceive to be exaggerated, if they are applied separately; but, if laid on together, we have witnessed some recent instances which lead us to conclude, that one load of ashes, combined with five of dung, would fully equal ten loads of farm-yard manure in immediate effect, besides producing more permanent improvement.

(*a*) [Soap, as a manure, is beginning to attract attention. A series of experiments, not as yet conclusive, are being instituted by one of our best practical farmers. So far, the results are surprising. Soapsuds, soot, and filth in general, are all valuable for manure. Yet about American farms they are generally wasted, instead of being placed in the dung-yard.]

CHAPTER VIII.

MINERAL MANURES CONTINUED.—PARING AND BURNING.

Paring and burning the ground, both for the purpose of getting rid of the rank vegetation with which land is sometimes covered, and of procuring the ashes as manure, is a practice of such ancient date, as to have been known to the Romans, and has been immemorially used by our ancestors. It is, indeed, supposed to have been introduced through the intercourse of the Italians with our southern coasts, and to have been first imparted to the inhabitants of the counties of Devon and Cornwall, whence it acquired the name of *denshiring*. It has since been very extensively practised in various parts of the kingdom, as well as throughout the continent; yet there is, perhaps, no portion of our husbandry, the merits of which have given rise to such wide difference of opinion. It is, however, of the highest importance to farmers that the principles upon which it rests should be clearly understood; for, on soils to which it is applicable, and on farms on which it can be carried into effect, it has been found, when managed with judgment, to be not alone an effectual, but a cheap mode of bringing land that has either lain waste or overgrown with root-weeds and other rubbish into a good state of cultivation: it is, therefore, deserving of their special attention. It must also be observed, that although this mode of preparing earth as manure is very commonly confounded with that of burning clay, yet they differ in this—that, in reducing the soil to ashes, it is supposed that much of its fertilizing properties must be dissipated, and all kinds of earth are thus burned; but, when burnt by the process of slow combustion, it is presumed that the clay—to which the operation is confined—retains a larger portion of its vegetative power, and also has a greater mechanical effect upon the land. We shall, therefore, consider them separately.

Paring implements.—There are various modes of performing this operation, by which the green-sward or turf, is cut in thin slices from the surface of the land.

Although performed by manual labour, yet such is the toughness of the sward in marshy ground, that horses are often employed; and in the fens of Cambridgeshire and the neighbouring counties, there is a plough much in use, that

was formerly brought from Holland. This *Dutch paring plough* is worked by a pair, and sometimes even by four horses: it was originally constructed with only one handle, from the hinder part of which projects a kind of crutch, horizontally disposed, and upon this the holder bears with his left hand, walking upright. From the same handle another crutch projects at right angles with the former, but much lower down; and this the holder uses occasionally with his right hand, for the purpose either of assisting to keep the plough steady, or to turn it at the land's end: latterly, however, it has been commonly made with stilts, in the common form Instead of a foot, or wheel, to support the beam of the plough, they use what they call 'a scaife,' which is a circular plate of iron turning constantly round, the edges of which are steeled, and, together with the edge of the share, are kept very sharp by means of a file, which the ploughman carries with him for that purpose, for the share goes so near the surface, that it meets with many strong roots and much coarse grass, which require keen instruments to cut them. The wheel coulter is found better adapted for ploughing among the rough sedge of those marshes than the sword one, and an appendage, called 'a boy,' is likewise sometimes added to lap in the rushes, which it does effectually.

In some parts of Berkshire they also have a broad share,—though now seldom used,—the frame-work of which rests upon a pair of large wheels, commonly the old fore-wheels of a wagon, one man driving, and lifting the share at the headlands, while another rides upon the frame, between the stilts. It is drawn by four horses, and being four feet long in the share, though it pares or hoes the ground commonly to the depth of full three inches, it yet goes over a large extent of land.

The last implement to mention, and, perhaps, in many situations the best for the purpose, is the common plough; for, by using it, the business proceeds with greater despatch, and is attended with less expense for the cutting part, though more for burning: but then there is the great advantage of having much of the soil, which is not burned, pulverized and prepared for the ensuing crops, which is an advantage not attainable in the other method.

The operation of paring with the common plough is, however, much facilitated by the addition of a share, of two feet in width, stripped of its mould-board. It is fixed by two standard

irons to the beam of any plough, before the coulter; in light soils it saves much labour in the cutting of pea, tare, bean, and other stubbles, at about two inches below the surface; and not turning any furrow, it leaves the weeds and roots all cut through, fit for being immediately harrowed out, raked into heaps, and burnt. The shim, or skim, has also been affixed as an additional coulter, in a peculiar form, to a plough much used in Oxfordshire, where it is found to answer the double purpose of both paring and ploughing. The tool is placed as a fore-coulter, and acts upon the sod, which it turns up from either side without effort.

Operation of Paring.—In ploughing turf, for it can hardly be called paring, when intended for burning, there are various modes adopted. Some plough it one way, and then cross-plough it, endeavouring thereby to cut it up in square cakes, and others, with a broad stripping share, cut the sod thin, and turn the whole over, with the grass downwards; this is done early in winter, and, after lying some time, the land is either cross-ploughed or worked with the tormentors, then harrowed, and such proportion burnt as the farmer may deem expedient: some burn a large portion of the earth, and others little beside the roots and weeds. A second method is, not to strip the leys clear, but to leave a narrow strip of ground whole, on which the furrow-slice is turned; which is provincially called in different places, either by the names of 'furrow and comb,' 'turning to rot,' 'ribbing,' 'raftering,' or 'baulking.' The third, which is common in Cornwall, when there is not time to permit the sod to rot, and is there called 'velling,' is performed nearly in the same manner as the former, excepting that, instead of being turned over, the furrow-slice is cut with its turf upwards: this is drawn out with small crooks by women and boys, or harrowed, then raked together in heaps, and burned.

Another plan, recommended by Mr. Boys, is, when the weather is set in dry in the spring, to plough the sod as thin as possible (unless it be a very old piece of turf, full of woody roots, which may, in such case, be broken up a tolerable depth) in baulks; that is, to turn the turf the contrary way to the common ploughing, with the turnwrest-plough, laying the land in narrow ridges, about 18 inches in width: when a piece of land is thus gone over, it should be harrowed slightly down, and immediately ploughed in the same manner crossways, at right angles, finishing the whole by splitting, or clearing with

the plough, these last made ridges down the middle. By harrowing the land thus prepared afterwards with a coarse harrow once over, the turf will be nearly all brought to the surface, and, after a few dry days, be in a good state for burning, at which time every possible expedition should be used to get it in heaps for firing.

Whatever may be the implements chosen for performing the operation of paring, it is rarely carried into effect to the depth of more than from one to about two, or, at the most, three inches. The judgment requisite in this stage of the process consists chiefly in determining the proper thickness of the sods. If they be pared too thick, they are difficult to burn; if too thin, the sward is not effectually destroyed, and the produce of the ashes is too small. A rough spongy surface ought to be pared thicker than one which is firm and bare of grass; and a light, shallow soil should be pared thinner than one which is deeper and more tenacious. Should the soil be clay of any description, the paring should rarely exceed an inch deep, but on peaty and sandy soils it may be carried deeper, especially if the land be rooty and fibrous; but if the soil be shallow, it cannot be cut too thin. No specific directions can, however, be given regarding the thickness of the sod, for it must be clear that, on the coarse ground to which the process is best suited, the main object to be held in view is to cut so deep as to reach the roots of the weeds; though some farmers carry it so far as to turn up a large portion of the earth, which plan more properly belongs to that of burning clay, which will be treated of in the following chapter. The best time commences about the opening of spring, the sharp winds of which season materially forward the process of drying; but the exact period must of course depend upon weather, situation, and circumstances which suit the convenience of the farmer, and it may be executed at any period of the year from the course of February until the close of October.

Operation of Burning.—The *process of burning* is a critical operation; for if the heaps be made too large, or if allowed to remain too long unspread, they get hold of the land, and if not carefully watched and extinguished in time, the fire takes such an effect upon the land that its force is apt to char the ground upon which they are made, by which means those spots are converted into brick, and thus great trouble and expense are occasioned, for not only is the action of the plough thereby impeded, but great unsightly holes are

formed in the earth, called 'pitting,' which become retentive of wet and injure cultivation; great care should therefore be taken, to guard against such accidents, by which much injury has been in many places done to the soil.

When the turf is dry enough to burn, it is often placed in large heaps, amounting from four to twenty cart-loads each, or even more, carried up with an opening, like a chimney, in the middle, and fired by means of faggots of furze, or any other fuel that happens to be most convenient. More or less firing is required in proportion to the kindliness of the soil for burning, of which an experienced workman can easily judge: some sorts are easily fired by a few red-hot ashes being thrown upon the heap and instantly covered with a piece of turf; while others require a faggot or two of wood, and no small degree of discretion in disposing it properly. The best method of placing the turf is to lay it as close as possible, in order to keep out any draught of air through the heap, as otherwise the force of the fire is apt to escape outwardly, and a partial burning only effected. The fire should also be applied to the sheltered side of the heaps; but if the sods lie close, and the fire is kept in by stopping any places where it breaks through, and covering the whole with fine mould and ashes, after the fire is thoroughly alight, it never fails to burn well: even if heavy showers fall, the great mass of burning matter will convert almost any quantity of rain into vapour.

Such is the Kentish practice; and this smothering process is recommended by most of the writers on manure, because the vegetable matter of which these ashes are chiefly formed is supposed to be thereby converted into a carbonaceous substance of a more fertilizing nature than when burned by a quick fire. In the East Riding of Yorkshire, where paring and burning has been very extensively and successfully practised, it is usual to pare the sods as thin as possible, and, so soon as they are moderately dry, to collect them partially into heaps, four or five yards distant from each other, forming them into a half-cone. In this state fire is applied to each heap, but it is prevented from breaking out into a flame by smothering it up with the remainder of the sods. As much burning is considered to be very injurious to the success of the operation, the best cultivators open out these heaps, when half burned, with a shovel, and spread what is then converted into ashes equally over the land. The heaps well on fire, fresh sods are laid from time to time, until the whole are expended; the

outsides, which remain unburnt, are then again heaped up whilst sufficiently on fire to be consumed. Thus all the sods are burned equally, but as lightly as they can be to be reduced to ashes.

In some instances circular heaps have been formed over large roots to the extent of 54 feet by 20, and found completely successful. The manner of forming these clamps was thus:—a quantity of large roots was laid upon the ground, and inclosed by a wall of sods three or four feet high, and at the bottom of each side wall were six openings, about twenty inches square, in which faggots were laid, so as to connect with the roots. When the inclosure was filled with sods, and the clamp raised to the height of eight feet, twelve fires were all kindled at the same time, and, in less than forty-eight hours, the whole mass, containing 400 cart-loads, was entirely burnt through to the top; by which mode of burning it has been computed that the ashes cost no more than threepence per cart-load of sixteen bushels.

The most common method, indeed, is to form the heaps about a yard in diameter, like small hay-cocks, a few yards apart, the sods set edgeways, with a bough of furze at the bottom, covered with some of the driest turf, keeping the sods on the inside as hollow as may be, but laying them flat and close on the outside to keep in the heat. The heaps made in this manner are kindled usually with a link made of tow dipped in tar, and wound round a small stake, the lighter running along the rows from heap to heap, and lighting them. Some skill is requisite in their formation, for, if the heaps be made too large at first, their own weight crushes them down, and destroys the necessary openness of the inner side, while, if too small, the fire, not being sufficiently confined, flies outward, and spends itself prematurely; yet, if the sods in the small heaps are damp, the force of the fires is so soon extinguished, that heaps of four and five cart-loads have been found insufficient; and to this want of precaution in the preparation of the ashes has been partly attributed the defects which some persons have assigned to the practice itself. Yet the weather is sometimes so unfavourable that means must necessarily be taken for increasing the heat of the fires, for which purpose a very simple apparatus has been contrived in Scotland. It is put together with merely a few small old iron hoops, the halves of which are placed so close together as to prevent the sods from falling through, and riveted to iron rods

which lie lengthwise upon the ground: thus forming a sort of portable furnace, about four feet long, so light that a boy can carry it; and when turf is laid upon it, an opening is left through the hoops, which increases the current of the air.

When the land is much covered with heath and furze, the operation of paring, which turns the sod upside down, keeps the turf raised so far above the ground that, in fine weather, it readily dries sufficiently, and is frequently burnt in that state. This is a saving of trouble and expense; the ashes are also thereby spread more equably, and the fire operates over the entire surface of the soil, which, if anything is to be attributed to the effect of heat, may be benefited by this mode of application. Thus, in a course of experiments made upon a farm in the West Riding of Yorkshire, the sward was burnt all over the surface in the state in which it was left when pared; when, without any further culture, or seed, a spontaneous plant of luxuriant grass sprang up, and afterwards continued permanent, upon black peat-earth, which formerly produced nothing but heath and ling. Similar experiments have been since tried with equal success, by only adding the seeds of white clover, trefoil, rye-grass, rib-grass, nonsuch, or any of the other grasses commonly intended to produce pasture, and merely harrowing them in without any ploughing.

The improvement of the bogs by the *operation of paring and burning in Ireland*, is thus described by Mr. Curwen: 'Round a space from six to ten feet in diameter, a trench of a foot deep, and of the same width, is dug, the soil from which is laid on the adjoining surface of equal breadth. Beyond this another circle of sods is taken out, and laid to dry in the same manner; and thus the work proceeds, until the quantity dug, with that which is left undisturbed for a floor, is as much as can be properly burnt on the space in the centre. As soon as the sods are sufficiently dry some are gathered together, the heap is set on fire, and additions are made of wet and dry sods from time to time, so as to keep a regular, moderate, and smothered fire, in proportion to the attention paid to which particulars the husbandman is rewarded by the quantity of potatoes he will procure.'

Effects of paring and burning.—The *quantity of ashes* thus made necessarily depends upon the nature of the vegetable matter which lies upon the surface of the soil, as well as that of the earth, and the depth from which it is extracted. When the object is merely to burn whatever is growing upon

the land, without mingling it with the earth, the ground is then well harrowed after it has been pared, and the loose stuff being raked up and burned, generally produces only from 30 to 50 bushels, which can hardly be considered in any other light than as a cleansing to the soil; except that, when much mixed with brushwood, their roots render the ashes of stronger quality. But it is seldom confined within such bounds; and, when performed in a workmanlike manner, upon rough ground of medium quality, to the depth of about two inches, the operation has been known to produce from forty to fifty cart-loads of 40 bushels each, or from 2000 to 2400 bushels per acre.

The *expense of paring and burning* has been variously calculated, and depends upon so many different circumstances, that it is impossible to form a precise estimate for any other than a particular case; for not only must the soil on which the operation is to be performed be considered, but also the kind of instruments and the skill of the workmen employed, the season, and the rate of wages, which generally bear a proportion to that of horse-labour.

Except on fen lands, the practice of paring and burning is mostly confined to poor districts, consisting of chalky downs, and wastes covered with heath and fern, or any rough land whatever, which is intended to be brought immediately into cultivation; the advantages attending which are thus described by Mr. Boys in the treatise to which we have already alluded.

When *old downs, heaths, or sheep-walks of a calcareous basis of soil*, are pared and burned early in the summer, and the land twice ploughed, however poor the soil may be, it becomes a fine tilth for turnips; the production of a full crop of which upon such lands, where they have never before been seen, and where they could hardly by any other means be obtained, is of such great benefit both to the farmer and to the soil, that it would be needless to say any more in recommendation of the process, were it not necessary for the information of those who are not acurately acquainted with the advantage to be derived from turnips in poor countries.

We have the authority of Mr. George Sinclair, for saying that "all the advantages here spoken of he has ever witnessed to follow the processes of paring and burning, however poor and rough; but the like texture (thin and poor) of soil containing very little, if any, calcareous matter, that is, wild lime,

or chalk, had not the like benefit—on the contrary, appeared injured by the effects of the burning."

The *success of paring and burning* may, indeed, be justly said to depend entirely on the nature of the land. Wherever the soil is already too light,—as in the case of most downs,—burning tends to make it lighter, and is then evidently wrong; but on clays and heavy loams, its effects can hardly fail to be beneficial. In the particular instance of burning land intended to be returned again to pasture, it is, however, indispensable to observe whether the practice has been proved, in that part of the country, to be favourable to the future production of natural grasses; for, on some soils, it is so—on others it is not.

Old worn-out sainfoin, and foul couchy leys of every description, may thus be speedily, economically, and thoroughly cleansed at far less trouble and expense than by any other method; and it is the only effectual mode of bringing fen land under immediate cultivation with any prospect of success. On *sainfoin leys* and *chalky downs*, the best course is to commence with turnips, fed off and repeated, so as to put the land in good heart before taking a crop of barley, with seeds to stand two years; for on those very light soils two green crops should always be taken for one of corn, and, after the lapse of a few years, the land should be again laid down with sainfoin; but care should then be taken not to let it become covered with a coarse sward of natural pasture, which may occasion the necessity of repeating the operation.

Cold, clayey land, covered with a coarse sward, may be pared deeper; but the operation will be found useless, if it be not thoroughly drained and laid dry. It is then very commonly sown with oats; for turnips, even if the land be sufficiently light to admit of their growth, are, on such soils, found to be uncertain as a first crop, and the oats are generally very productive. The more judicious farmers, however, lime the land immediately after the ashes are spread, and intermix both minutely with the soil, by ploughing it three times, and harrowing it sufficiently between each ploughing. But in this case it is necessary to plough with a very shallow furrow, as, if buried deep, the effect is in a great measure lost. They then sow cole as a first crop, and afterwards farm the land in such rotations as the nature of the ground will permit: but whatever may be the course pursued, the whole of the green crops should be eaten off upon the ground; or if the stock be soiled, the entire of the manure thus made, together with that

arising from the straw of the corn crops, should be invariably applied to the land.

Application.—It is obvious that in all cases the operation of paring and burning must destroy a certain portion of vegetable substance, and it therefore can only be really useful where an excess of this matter exists in the soil in a dormant state; for the accumulation of rank herbage and woody fibre, with which some land is overrun, can only be slowly reduced to a state of mould when left to the process of natural decomposition; nor is it easily brought into a fit state for the immediate purposes of cultivation, even by the application of lime. Burning has also the effect of rendering clayey land more friable in its texture, and consequently not alone better for tillage, but also less retentive of water; for it has been ascertained, that when clay has been burnt, its tendency to absorb moisture from the atmosphere has been reduced in the proportion of 7 to 2*. Thus the process, if judiciously conducted, may change a soil which was tenacious, wet, and cold, into one partaking of the opposite qualities, and therefore better adapted to vegetation. The soils to which it is prejudicial are those consisting principally of sand and flint, consequently, containing little vegetable matter; for it destroys that which is already in too small a proportion to secure the productiveness of the land. But paring alone, without burning, may be safely practised on such soils, when they contain root weeds, and coarse herbage of difficult decomposition; provided the surface be then harrowed, so as to separate it from the earth, and mixed with quick-lime, together with the scourings of the neighbouring ponds and ditches, or clay, if it can be conveniently procured, to form a compost.

The following may be assumed as a summary of the best practice:—1stly. To drain the land perfectly, and to lay it dry, before commencing the operation. 2dly. To regulate the depth of the paring by the nature of the turf, and the thickness of the mat of coarse sward. 3dly. To burn the turf slowly, but completely, so as to reduce the whole to ashes; yet carefully to guard against allowing the fire to take such hold of the ground under the heaps, as to harden it into pits. 4thly. To spread the ashes upon a shallow ploughing, and as fresh as possible—even hot; as they operate more powerfully in a caustic state than afterwards. 5thly. To mix lime in a

* Sir H. Davy, Elem. of Agric. Chem., 4to. p. 21.

moderate proportion with the ashes, if the land be clayey; as in this species of soil, the deficiency of calcareous matter renders it essential to the purposes of vegetation, and the two manures assist each other. 6thly. To sow the seeds as promptly as may be convenient after the ashes have been spread and ploughed in. 7thly. To commence the cultivation (if the time of the year and other circumstances will permit) with turnips or cole; but if oats or barley be taken as a first crop, to follow it with two successive green crops; and never to sow wheat until the land be brought into a fine tilth, and perfectly clean. 8thly. To apply the whole of the manure produced by the crops to the ground, and to manage it, generally, in the usual course of regularly-cultivated arable land.

If these rules be strictly adhered to, there can be no doubt that paring and burning will be found advantageous on all soils of the kind we have described as adapted for the operation; but, although neither coinciding in the odium which has been cast upon it by some writers, nor in the praises with which it has been loaded by others, and only viewing it as a means of clearing ground which is encumbered with dormant matter, and thus stimulating the inert powers of vegetation, we by no means recommend it to repetition; for, if the land be properly managed, it can never afterwards become so foul as to require the surface to be pared.

CHAPTER IX.

MINERAL MANURES CONTINUED.—BURNT CLAY.

The burning of clay, for manure, is an invention which has been attributed to the Earl of Halifax, and is supposed not to have been adopted in England until about the year 1730; but it was known in this country at a far more distant period, and has been mentioned in some very old tracts on agriculture, in one of which, published more than a century ago, under the title of 'The Practical Farmer, or the Hertfordshire Husbandman,' the method of preparing and applying it to the land is described in a manner which differs but little from the present practice. In 'The Country Gentleman's Companion,' printed

in London, in the year 1732, there are also two engravings of kilns for burning clay, with several letters from various persons, stating that the plan had succeeded in many places in both England and Scotland; and that, in experiments made in the latter country, it had been found preferable to either lime or dung, but too expensive. In the North of Ireland it has also been carried on time out of mind, and in the vicinity of the bogs, where fuel is accessible, the manure which it affords is cheap and inexhaustible, and the power of cropping is thus extended beyond what could otherwise be practicable. An essay has been written by Mr. Burroughs, describing its good effects in very warm terms: many other treatises have likewise been published upon the subject; and the gold medal of the Society of Arts was, not many years since, awarded to Dr. Cartwright for his experiments.

The practice, however, fell into considerable disuse, until it was revived, in the year 1815, by some letters in the 'Farmer's Magazine,' and, still more recently, by the account given by General Beatson of the process, and its consequences, on his farm in Sussex, in which he describes the efficacy of calcined clay, when compared with either lime, dung, wood-ashes, or peat and dung, as equal, and in some instances superior, to any of those manures. This has been followed by two other publications,—one at York, and the other at Ipswich,—each nearly supporting the same principle by arguments drawn from practical proofs; and it seems to have been, in many cases, sanctioned by the experience of extensive farmers.

Mr. Burroughs, after detailing the difference in the chemical qualities of burned earth, says that 'lime being established as a valuable application to many soils, it would be no easy matter to persuade those who have not tried the former as a substitute, that it possesses more fertilizing properties; but, then, experience, by which all must be governed, has convinced me that burned earth is by far more valuable, on many soils, than lime. I have tried it on *strong clays*, on *light soils*, and on *moory soils*, on all of which it produced good crops of potatoes and turnips, and afterwards corn; and in one instance in particular, where lime had been ineffectually applied, a dressing of burned clay made the land yield most abundantly. Lime only stimulates and pulverizes the soil, whereas burned earth not only possesses those properties, but contains within itself enriching and vegetative qualities.'

He then adds, that 'burned earth may be depended upon as

a manure fit to produce abundant turnip crops, of every description, on a variety of soils; even the Swedes, so difficult to grow on light land, will prove a more luxuriant crop with this manure than with farm-yard dung, and are less liable to be cut off by the fly. It may be supposed by some that any crop sown on this manure would be precarious in dry seasons, not containing, as they may conceive, any enriching quality or properties to preserve moisture: but this is by no means the case, for it will be found that an application of burned earth makes the land on which it is applied more capable of absorbing moisture from the atmosphere; and, by minutely dividing the soil, the roots of plants can search more freely for nourishment. I have often observed that farm-yard dung, unless very well prepared, does not, in excessive dry seasons, supply sufficient moisture to the roots of plants; and that, during such seasons, crops sown on ashes, or burned earth, have uniformly thriven, while those in dunged land have gradually declined.'

General Beatson's farm—which consists of 300 acres, 120 of which are arable—was managed for some years previous to his death under an entirely novel system of culture. The plan on which it had been previously conducted was so unprofitable, that he had determined on abandoning the farm altogether, when his attention was attracted to a small inclosure, where he had four burnt clay experiments, around which was a space unmanured, and beyond it all the rest of the field manured with rotten dung at the rate of forty loads per acre, the whole carefully scarified, harrowed, and drilled, exactly in the same manner. Those clay experiments not only maintained a very striking superiority during the growth of three successive crops—the first being a mixture of tares and oats, and the second and third wheat; but where also perfectly clean, whilst the dunged part was absolutely choked with weeds: they had each respectively at the rate of ten, twenty, thirty, and forty cart-loads of the ashes per acre. This gave rise to his subsequent practice, which, according to his account, he continued with complete success for upwards of six years, during which time the entire of his arable land was manured with the ashes of burnt clay, his farm dung being solely applied to his hop-grounds, and a few acres of potatoes.

Analysis.—The term '*burned earth*' may be understood as implying any species of soil capable of being dried up by excessive heat. Moory and light sandy soils, being deficient in tenacity, cannot, however, be so applied with advantage;

but clay, of all sorts, and strong loams, are well adapted to the purpose. It has, however, been observed by Mr. Burroughs, 'that this mode of preparing earth, as a manure, is upon a principle very different from that of reducing it to ashes; and though the effect produced on the land to which it is applied may be apparently the same, yet the torrified' (dried by fire, or scorched) 'substance, is by far more permanent. The chemical difference in their preparation is this:—In reducing the soil to ashes, much of its fertilizing properties are dissipated, and its vegetable matter destroyed; but, when only torrified, those properties are preserved, and its vegetable matter only reduced to a state more valuable as the food of plants.'

'There are two sorts of burned earth,—1st, that which is obtained from the surface, of which we have already treated; and, 2ndly, that which is dug from the sub-soil.' 'Sub-soil, calculated for this purpose, may be said to be of two kinds, viz., adhesive clay, and calcareous earth: the former seldom possessing any fertilizing properties in its natural state; but the latter is, even in that state, generally a valuable substance. As alteratives to the soil, they may be good applications, if appropriately applied, and may produce fertility accordingly; but by putting them through a process of torrefaction, however naturally deficient in fertilizing properties, they can be converted into valuable manures.'

Mr. Naismith also says, 'that when cohesive earth has undergone this operation, and is afterwards reduced to powder, all its tendency to coherence is lost, and its particles lie compact, without uniting. It seems to have the perfect consistence of a fertile soil; for corn springs quickly, and tillers abundantly on it; and if a little dung-juice be given from time to time, it will grow luxuriantly to maturity. It has also a strong tendency to promote fertility when applied to other soils; and even a very slight torrefaction of the soil has a great effect.

Effects of burnt clay.—From this we should be led to conclude that a very material difference would be found to exist in earth thus merely dried; for there can be no doubt that its properties must depend upon the quantity of vegetative matter which it contains. But it is difficult to draw the line between this process of torrefaction and that which consists in burning the earth to ashes: for if the clay be merely dried, the next rains will reduce it back to its former state, by which the soil cannot be benefited; and if the fire be advanced to a degree

much stronger, it will probably have the effect of consuming the earth to ashes, in the qualities of which no perceptible difference will be found. In the latter state, indeed, we are strongly of opinion that its effects are purely mechanical—acting upon heavy soils merely by correcting their tenacity, and rendering them less stubborn; but this will doubtless contribute greatly to their fertility, though it cannot be considered as a nutritive manure.

The stress which has been laid upon the supposed value of some kinds of burned clay, in consequence of the calcareous matter contained in the subsoil, is probably overrated; for it is seldom found, in soils of that description, in such abundance as to be of much service as a manure to other lands. We learn, indeed, from an experiment of General Beatson, that when even the surface soil has been burned, no difference was found between the effects of that, although containing vegetative matter in the sward, and the ashes of common clay; though the quantity applied was perhaps too small to warrant any positive conclusion. We, therefore, think that the ideas which have been entertained of the effects of this manure, are rather too sanguine; and we are decidedly of opinion that the expectations of those of its advocates who imagine that 'burnt clay will supersede the dung-cart' will be disappointed. It appears, indeed, from a more recent essay by Mr. Burroughs, on the cultivation of white crops, that he has not been so well satisfied of its good effects as to persist in its use instead of farm-yard manure; for although we there find him recommending the use of the latter, he yet makes no allusion to burned clay. In Scotland, also, where the burning of clay was a few years ago very extensively practised, we learn that it has since fallen into considerable disuse. There can, however, be no doubt that clay ashes may be beneficially used; but it does not appear from past experience that they can preclude the use of lime on soils not formerly dressed with it.

We make no apology for the length of these extracts, for the subject is of great importance, and although we entertain doubts of the accuracy of the inferences drawn from the experiments by some writers, yet that should not prevent any farmer who possesses the means, of satisfying himself by similar trials, from ascertaining their effect by actual practice. It is true, that the nature of some soils does not admit of it; in others, the land is in many cases so valuable, that almost every inch of it is in profitable use; and as it requires about 150 square

yards of surface, 6 inches deep, for a single acre, or a pit of proportionate size, if dug from the subsoil, many persons will naturally grudge the sacrifice, though banks and headlands—something, in short, in the shape of waste—may be found on every farm. Every one who has the opportunity should give it a fair trial; and if the result should prove its efficacy, it may then, indeed, be considered 'as opening a new field to the prosperity of agriculture.' The following are the most approved methods of preparation, when pits are dug from the subsoil; but if the earth be taken from the surface, then those directions will be applicable which have been already given in the previous chapter, under the head of 'Paring and Burning.'

Clay-kilns.—There are two modes of burning clay commonly employed, one by kilns partly constructed of masonry, and the other of sods; in both of which the earth is piled upon them, instead of being placed under cover, as in a lime-kiln.

The kiln of the former kind, described by Mr. Burroughs, should be built in a pit excavated out of the ground which is to be burned, and consists of an arch about 4 or 5 feet long, 3 wide, and 2 high, made with brick; the front close like an oven, and the inside fitted to receive a strong fire of coals. On the top of the arch six or eight holes are left, the size of a small brick, to admit the heat passing out, which is to communicate to the earth laid on. When the fire is sufficiently strong, the door of the kiln is to be well stopped, and the earth thrown on in some degree pulverized, about six or eight inches thick, so as to cover the top of the kiln, and every direction round it to which the heat might communicate. In this manner it is to be dressed alternately with culm and earth, which are to be laid on according to the heat of the fire, which is on no account to be allowed to burn too strong.

After the kiln is once lighted, it will burn several hundred bushels of earth without any additional fire inside; and the same kiln will answer for a length of time to renew the process when necessary.

Kilns constructed of masonry, although the most permanent, have, however, been objected to, both because of the outlay in their erection, and the inconvenience often experienced in procuring workmen to build them. There is also this further disadvantage,—that although when once built there is an end of the expense, and with proper care they may be employed for years, yet, if placed at any considerable distance from the land to be manured, the cost of carriage will probably exceed

that of burning. They are, therefore, usually formed in the very field on which the clay is to be laid, and out of which it is dug; in which case they may be made entirely with sods, or mud and straw, in the following manner:—

On a headland or waste piece of ground, off which sods can be procured with sward sufficiently tough to build a wall, erect an oblong or a circular inclosure, about eight or ten feet in diameter, and two feet thick, but not higher than three or four feet. On a level with the surface of the ground, cut flues, opening through the opposite sides of the wall, so that they may all meet in the centre of the kiln; make them also about five or six inches deep and four wide, and let them be covered with sods on the top, so as to keep them free of clay and rubbish, and the mouths well open to the air. Then, in the centre of the kiln, place brushwood, turf, or any combustible, with some blocks of wood to strengthen the fire, and, when all is well kindled, throw on some culm—if you have any—and then clay, and so on, adding clay to the heap as the fire may be found sufficiently strong to take the dressing; always observing to keep the heat of the kiln as even and as moderate as possible,—just of sufficient strength to expel the moisture from the layers of clay as they are laid on. Much care should also be taken not to cover the fire too soon after being lighted, as that might extinguish it totally, and therefore the clods first put on should be of the largest description, that spaces may thus be left for the free admission of the heat. The smoke must be prevented from escaping; but the progress of the fire, as it ascends, may be ascertained by occasionally thrusting a finger here and there through the surface; to which, if it has approached very near, more matter must be added.

The walls, when made of sods, should be beat close with the spade, in order to prevent them from drawing air, by which the burning of the clay would be much retarded; the kiln may then be immediately lighted; but if made with mud and straw, they should be permitted to dry before the fire is kindled. They should not, at first, be built higher than three to four feet, nor the inclosure be wider than ten, because the earth can then be flung easily over every part; the fuel will also be thus more easily placed, and the firing more conveniently managed. As it is not necessary that much neatness should be observed in the construction, a kiln of this size may be erected, under proper directions, by five or six men in the course of a day.

When the inside of the kiln, however, begins to be filled up with clay, then the wall must be raised as high as may allow the earth to be thrown on without much additional labour; and care should be taken, during the burning, to keep the wall fifteen or eighteen inches higher than the top of the clay, in order to prevent the wind from acting on the surface of the fire. As soon as the fire is strongly kindled, the mouths of all the flues, except the one to windward, should be stopped, and even that will only be of use at the commencement of the process; for, if the fire burns with tolerable keenness, the sods of which the flues are composed will soon be reduced to ashes. Some people, therefore, dispense with the use of flues altogether; but the trouble of making them is very slight, and the want of them often occasions difficulty in the management of the fire.

The kiln may be increased to any size, by raising a new wall round the former when that one has been burned through; and in this manner kilns have been made so large as to contain more than 100 loads of ashes: but, as these walls cannot be equally pulverized, they should be broken down, and blended with the contents of the kiln, as that is burning out. No precise period can be fixed for the time which the operation will occupy, as much will necessarily depend upon the quantity of matter, the nature of the fuel, its management, and the state of the weather; most accounts, therefore, affirm, that it can be well accomplished—that is to say, both sufficiently burned, and afterwards cooled, in a few days; some, in a fortnight; others, in a month; but Mr. Burroughs says, that it requires about six weeks, and that it will not then be in good order for the land until after two months longer, for it will take considerable time to reduce it to powder. When the kilns are burnt out, the ashes are still paler than the original clay, and are generally in a powdery state, or are easily rendered so by a slight stroke of the shovel, either when filling the cart, or when they are spreading upon the ground: this, indeed, should never be neglected if there be any appearance of lumps, for if the earth be not completely pulverized, it will have little other effect upon the land than may be expected from bits of brick. The expense of burning clay in the kiln here described is stated to be, in Ireland, from 3*d.* to 4*d.* an Irish load, or about 40*s.* or 50*s.* the Irish acre,—equal to about 32*s.* Imperial measure; but, with the usual inaccuracy observable in all accounts of manure *per load*, we are left to guess at its contents.

The chief art in burning is, *to keep out the air, and keep in the smoke;* which can only be accomplished by having the walls made quite close, and taking care to have the tops always lightly covered with clay. If the smoke should appear coming out in spots here and there, cover those places with sods immediately; for by thus half burning or charring the earth, it is supposed that any vegetable matter which it contains will be preserved, and that the staple of the land will not suffer. In short the kilns must be carefully attended to, both day and night, until the operation is completed. No rule can be laid down for the size of the clods, but those first laid on will burn more readily if dug up and dried a day or two before: if they be properly managed, that, however, is not absolutely necessary, and if once the kiln is fairly set a-going, no further fuel of any kind is required; for the clay, though wet, will continue to burn, unless extinguished by carelessness, as even the changes of the weather, except in very bad seasons, have very little effect upon it. It may, however, be proper to caution those who are not acquainted with the process, from opening any part of the kiln in order to ascertain its progress; for although, from its outward appearance, they may imagine the fire to be extinguished, it yet may be burning fiercely in the interior; and if the air be admitted, the main force of the fire will draw to that hole, where it will blaze out, and thus the work will certainly be retarded, if not entirely stopped. Although the process is very simple, when well understood, yet, like every thing else, it requires some experience, and mistakes are continually made by workmen who, not being already acquainted with the practice, are apt to burn the clay into lumps. It is, indeed, difficult to describe the operation with sufficient accuracy to enable those who have never seen it done to burn properly.

Burning in heaps.—Another common mode of burning earth, is to dig up the surface of banks and headlands, or old borders, and, when dry, to cart it to a heap. The practice then is, to lay a foundation of earth, some inches thick, then haulm, straw, dry weeds, and a few bushes, whins, or any thing of the kind, upon which the pile is raised in the form of a cone, and enclosed with a wall of turf in the manner already described. When fuel is scarce, an experienced burner will light a small heap, and increase it to almost any extent, by pulling down part of the wall, drawing out a portion of the fire, and adding fresh earth. They are not uncommonly car-

ried to 12 yards in diameter, and in that case generally contain about 100 loads of ashes, at 36 bushels to the load.

A nearly similar method is also much practised in Suffolk, where the earth is burned in mounds, and it is called *clod-burning*. The clods are raked together in small heaps of from four to eight bushels, at a rod distance, and burnt by placing them upon a small quantity of haulm, or straw; but this should be done very expeditiously, on the fire being properly kindled, as otherwise it would be exhausted before a sufficient quantity was heated; for which reason it is proper to light them early in the day, that they may be well covered before sunset. This, however, differs from paring and burning, as it is not requisite that any weeds, or roots of weeds, should exist in the soil, for the real earth alone burns or chars sufficiently; and as the smaller the heap, the less is the earth calcined, it is thought by some that the better is the manure. The idea is, however, probably erroneous; for these small heaps are so quickly burned, that what is on fire at noon, may be completed before night: if despatch be an object, that may be attained by employing a greater number of hands, whereas large piles cannot be effectually prepared without more constant attention and delay; but, like the process of kiln-burning, this operation also requires some experience to carry on the work expeditiously, and to burn close.

Although the method of burning in heaps has the merit of simplicity, yet the plan is objectionable, because this method of managing the fire subjects it in many instances, to be either extinguished, or to burn with such increased force as to convert any portion of the earth which consists of clay, into mere brick; besides occupying increased time and labour, and occasioning an additional charge for cartage. It does not produce such good ashes as when the earth is calcined in a close kiln: neither has the same quantity of fuel equal power; for, by the erection of walls, the heat is effectually retained, and will continue for a long period after the fire has been extinguished; whereas, in these round heaps, the air having full power over every part of the surface, the internal heat is sooner checked, and the smothering process—which is considered essential to the value of the manure—cannot be so perfectly accomplished. Besides, as the walls are ultimately converted into ashes, their cost only amounts to the trifling additional charge of the labour of their erection.

Burning with lime, is also a plan which has been adopted

with much apparent advantage by Mr. Curwen, both when applied to the surface soil, and to clay taken from the under stratum. The method is as follows:—

'Mounds of 7 yards in length, by 3½ in breadth, are kindled with 72 bushels of lime; first, a layer of dry sods, or parings, on which a quantity of lime is spread, mixing sods with it,—for he doubts whether clay can be properly converted into ashes without a mixture of surface soil, as it is in that case either calcined, or not sufficiently burned. Then a covering of eight inches thick of sods, on which the other half of the lime is spread, and covered a foot thick; the height of the mound being about a yard.'

'In twenty-four hours it will take fire. The lime should be taken immediately from the kiln; but it is better to allow it to ignite itself, than to effect it by the operation of slaking by water. When the fire is fairly kindled, fresh sods should be applied; and it is recommended to obtain a sufficient body of ashes from the sods before any clay is put upon the mounds. The fire naturally rises to the top; it takes less time, and does more work to draw down the ashes from the top, and not to suffer it to rise above six feet.'

Mr. Curwen also says, 'That the former practice of burning in kilns was more expensive, did much less work, and in many instances calcined the ashes, and rendered them of no value.' On which it may be observed, that, with regard to the expense, the difference in labour in favour of the practice of burning with lime cannot be very material, for it only consists in the charge of raising the walls, with a little more attention to the fire, and will not amount to so much as the cost of the lime.

Application.—The chief point to be observed in the *application of these ashes* is—that they be thoroughly pulverised, or at least brought into a state as nearly resembling powder as may be found practicable; and this cannot be effected unless the heat be so confined as to prevent it from spreading to a flame, for in that case the clay will be assuredly burned to bricks, and to this mistake many failures in experiments have been attributed. The term '*ashes*' may, indeed, in this sense, be deemed somewhat misapplied; but we know not any other that will more clearly convey our meaning, though our readers will doubtless comprehend, that the process is to stop short of that state of hardness which is produced by the brick-kiln. In effecting this, care should be taken not to burn clay that has been much sun-dried, for if put on the kiln in that

state, it will produce lumps, which will not be easily broken, even by a mallet.

The *best time for beginning the operation* is when the weather sets in fair, in spring; but the land should also be well cleaned, and brought into fine tilth, in order to allow of the soil being intimately blended with the ashes. When laid upon arable land, they should therefore be brought, as nearly as possible, into a state of powder, if intended for corn; but when applied to green crops, they may be used somewhat coarser.

Regarding the species of earth to be burned—strong clay is the best for the purpose, for its adhesive properties being destroyed by the process, it will become good manure for land of the same sort, and will be found advantageous to ground of almost any description; but when light soils are burned, (a practice, however, which we have shown to be in general disadvantageous,) the ashes are not calculated to apply to similar land, but should be laid upon strong clays or tenacious loam.

The *quantity of Ashes to be applied to the land* may be varied according to its quality. Viewing its effect as chiefly mechanical, the more adhesive the soil, the greater will be the amount required: for, as strong clays are apt to run together after heavy rains, and to retain the water upon the surface instead of allowing it to penetrate to the pan below, the larger the quantity of matter which may have the effect of rendering them porous, the better; and its application to such ground hardly admits of any limit. In no case will it be found prejudicial; and, from what may be gathered from the foregoing experiments, as well as from the information of other practical men, we think that it should never be laid on any land in a less quantity than 800 bushels per acre.

CHAPTER X.

MINERAL MANURES CONTINUED.—SALT—NITRE.

Salt of various qualities is produced in several countries, and known according to the different sources from which it is obtained—whether from the waters of the sea, from salt-

springs, or from mines. It cannot, therefore, be strictly called a mineral, unless when found in the state of rock-salt; yet, partaking of the nature of that fossil, and not having here to consider its effects in any other light than as a manure, we deem it unnecessary to enter upon any discussion of its peculiar properties when manufactured, and shall, therefore, confine our observations to its effects upon the soil.

It has been represented as operating as a manure upon arable land by its tendency to promote putrefaction, as well as by stimulating the powers of vegetation, through its absorption of moisture from the atmosphere; as being destructive of weeds and insects, and a preventive of rust; as improving the herbage of grass-land, destroying the moss, and rendering fodder palatable which would be otherwise refused by cattle; and as acting as a condiment conducive to the health of all animals. It has been successfully applied to some soils under peculiar circumstances; yet, except in cases where its use has been rather governed by local facilities than by any conviction of its real value, farmers do not appear to have generally availed themselves of its advantages as a manure, though it is gradually creeping into use for live stock. It is, indeed, admitted on all hands to be noxious to the whole tribe of slugs, and worms of that description, though we have yet no proof which can be relied on of its preventing the ravages of the fly on turnips; its effects in correcting the faults of sour pasturage and spoiled fodder seem also to rest upon grounds which can hardly be doubted.* There are also proofs of its power in checking the rust in corn; for although that disease has been generally attributed to the varying changes of the atmosphere, yet it was stated in the evidence of Dr. Paris before the Salt Committee, that it was the practice of many farmers in Cornwall to spread about 30 bushels of salt, the refuse of the pilchard fishery, weighing 56 lbs. each, per statute acre upon their land, a fortnight previous to the sowing of turnips; and they all agreed that they never had any rust on the following crop of wheat where this was adopted, though before they were greatly affected by it. In the course of a very minute inquiry

* Salt destroys vermin by making them void the contents of their bodies; such evacuations being too powerful for them to withstand.—Lord Dundonald on Chemical Agric., p. 138. See an experiment in proof of this, in the Farmer's Magazine, vol. xviii. p. 440, in which it is stated that grubs, full of food, when placed in fresh earth in which some young roots of grass were transplanted after being very slightly pickled with common salt, were in 24 hours reduced to mere skins, and two out of three dead.

into the causes of rust, undertaken some years ago in this country, and afterwards continued at different periods on the Continent, it also appeared, that it was never experienced in the immediate vicinity of the sea, unless when the ground was greatly over-manured; and that when sea-ooze or sand was employed as manure, it was prevented. This, however, does not apply to the practice of *steeping seed-wheat*, which can only have the effect of purifying it, but cannot, it is presumed, prevent the grain from afterwards receiving infection from the air, and which, indeed, applies rather to *smut*, than to *rust* or *mildew*. Its influence in forwarding the putrefaction of manure depends upon the quantity in which it is employed;* and although its property of absorbing moisture from the atmosphere, and retaining it in the ground, constitutes, perhaps, its chief value, when applied to light soils and in dry summers, yet, on heavy land and in wet seasons, its power seems to have little effect: it has therefore fallen into disrepute with many persons who have tried it without due attention to these circumstances. It is, indeed, evident, that the extravagant expectations entertained of it by some, and the disappointment experienced by others, have been occasioned by the contingent nature of its character, which, depending not alone upon the amount in which it is used, but also on the quality of the soil and on the state of the weather, must render it occasionally ineffectual. That it contributes to the health of animals is a fact now universally granted; though its specific virtues, when administered in different quantities to stock of various species, age, and condition, have not yet been sufficiently ascertained, nor have we now to consider of its employment for that purpose. We therefore neither accord in all that has been assumed in its favour, nor yet in its disproval.

Application of Salt.—Nothing decisive has been ascertained regarding either the quantity or season in which salt should be laid upon the land. It appears, however, that its effects are most visible and satisfactory when applied to hot, dry soils, and in very warm summers; but on cold, wet land, and in

* If used in large quantities, it is antiseptic; but if moderately mixed up with composts, it has been found to promote the putrefaction of the vegetable and animal substances which they contain. The quantity has, indeed, been stated as high as a ton to the acre; but this is either foul salt, which has been used in the fisheries, or the refuse of brine which has been manufactured, and which cannot be estimated at more than one-half, or perhaps one-third, of the weight of pure salt.—Sir H. Davy, Elem. of Agric. Chem., 4to p. 295; Cheshire Report, p. 237.

rainy seasons, or under a humid climate, its powers seem to become neutralized, and of little value. We are of opinion that, on arable land, it will be found more advisable to lay it on before sowing, than either with the seeds, or afterwards as a top-dressing. If applied, for instance to a clover ley, either a few weeks before seed-time, or immediately after the first crop is off, it would effectually banish the slug; and it has been justly observed, that, if all stubbles (not laid down with seeds) were to receive a slight dressing of salt before winter, it would not only tend to keep the land free from the slug, but probably also otherwise benefit the soil.

In preparing the land *under the fallow-process*, it has been recommended to spread from 30 to 40 bushels per acre for the purpose of destroying the roots and insects in the soil, and breaking all the tough and adhesive clods which are found to be so troublesome in working the ground. This should be done in autumn, some time before the first ploughing; as the salt being thoroughly incorporated with the soil during the spring and summer following, its strength will be so materially reduced by the time when the seed is sown, that instead of injuring, it has been found to promote vegetation. With regard to the destruction of insects, that object can, however, be attained with half the quantity: and we must again caution our readers against the indiscriminate recommendation given of the use of salt, without distinguishing whether it is *foul* or *pure:* on the application of 40 bushels of the latter, vegetation ceases.

When *applied in composts*, it is said to have been found more effectual than lime. It has been tried in Cheshire on barley and seeds, and greatly exceeded the most sanguine expectations that had been formed of it. A quantity of refuse salt having been also mixed up with earth, and another portion of the same earth with lime, the vegetation of that part of the field upon which the salt was laid was by far the healthiest and the most vigorous. In Ayrshire it has been mixed with 32 bushels of lime-shells, and either spread singly or made up into a compost with 40 cart-loads of peat-moss, and has thus been found peculiarly favourable to the growth of wheat and beans. In those parts of the coasts of Cornwall where the pilchard fisheries occasion considerable quantities of salt to be condemned, it is also much used as a preparation for turnips in composts mixed up with sea-sand, and spoiled fish, dung, and rotten slaty earth, in various proportions, to which from

40 to 60 bushels of lime are commonly added. The quantity of this kind of compost commonly applied to an acre, is usually about a ton of the fish and salt,—more or less as the fish prevails, and in that country it has been long considered as a most valuable and lasting manure, though probably its effects may be at least equally due to the oil and refuse fish, as to the salt with which it is combined. It may also be advantageously mixed with stable-dung alone.

On *meadow ground*, Mr. Hollinshead advises the farmer 'to sow six bushels of salt per acre, immediately after the hay is got in; which will not only assist vegetation, and cover the face of the ground with grass, but will induce the cattle to eat up the eddish.' For *pasture land*, he however recommends the application of foul salt at the rate of 16 bushels per acre; or, which he seems to prefer, to apply it in the same quantity, mixing with every 16 bushels of the salt 20 loads of earth, turning it two or three times, to incorporate it, and laying it on in the autumn.

In *frosty weather*, it has excited the surprise of many persons that, when the land was quite white through heavy hoar-frost, ground which had been top-dressed with salt remained perfectly green, and apparently free from its effects. It is, indeed, known to chemists to be an enemy to congelation; but we have, as yet, no practical knowledge of its effects, in that view, upon vegetation, nor are we aware that its application would tend to preserve crops from the consequences of frost.

The *quantity of pure salt* recommended to be applied to land as manure is from 4 to 16 bushels per acre, beyond which it has been generally found to become injurious to crops when sown with the seed; but, if laid in the autumn upon land intended for a clean summer fallow, from 30 to 40 bushels may be spread, according to the condition and nature of the soil. In the directions for its use given in the recent treatises of Mr. Cuthbert Johnson, from 5 to 20 bushels are assumed as the limits of its application to different crops; and although we think that, in most cases, the latter quantity would be found too large, and that, in all, the rules for its adoption savour too much of theory, yet as, with due discretion, in many instances they may serve as guides for its employment, we here transcribe them with very slight alteration: with this observation, that they only apply to the first year's manuring; though it has been stated by Mr. Hollinshead and others, that

an annual application of a much less quantity will always keep the land in a state of the greatest fertility:—

For wheat and rye, 10 to 20 bushels per acre, put on after the seed has been harrowed in; the earlier the better, but may be done until March.

For barley, oats, peas, and beans, 5 to 16 bushels per acre. For these crops it has however been found beneficial, in the west of England, to lay it on after the seed has been harrowed in; but in counties less humid, it would be more advantageous to spread it in January or February.

For turnips, and most green crops, 5 to 16 bushels per acre, put on about a month before seed-time; or in January or February, as the salt will then meet the insects in their weakest state. Mr. G. Sinclair, however, says—that, for the destruction of slugs, salt should be used in not less quantities than 10 or 15 bushels per acre, applied to the surface of the land.

For potatoes, 10 to 20 bushels per acre in January or February, if no other manure be used; but if a light dressing of dung be intended at the time of planting, then half the salt to be spread after the plants have been covered in.

For hops, 15 to 20 bushels per acre, in November or December.

For grass-land, 10 to 15 bushels per acre in the autumn, and, if possible, not later than November; but may be put on, without injury, until February. If applied to the extent of 40 to 50 bushels, the old turf will be completely destroyed, but has been generally succeeded by a new sward of sweeter herbage.

In Dacre's 'Testimonies,' it is said, that although the fertilizing qualities of salt, when used by itself as a manure, are very great, it yet requires discretion to guard against putting on too much: a few bushels to an acre are sufficient. If any large quantity be put on, it will by its pungency and strength destroy vegetation for a time; but afterwards, when the salt has been well dissolved in the soil, the land becomes very rich. That when mixed with dung and other manure, it is highly efficacious: but the safest way of using it is, to sprinkle it occasionally over the dung in the cattle-yards, that it may amalgamate with it and ferment.

The effects, as ascertained by the result of its use upon the Continent, are described by that eminent agriculturist, Von Thaer, to be nearly similar to those we have stated. When applied in large quantities, vegetation seems completely

stopped; but when the salt has been washed in by the rain, and partly decomposed by the mould, it adds to its force during several following years. On rich land, when spread in small quantities, it produces very sensibly favourable effects, though of short duration; but if laid upon a poor soil, in an equal quantity, it has been found wholly ineffectual.

Nitre, or *saltpetre*, as it is more commonly called, though of more powerful effect than common salt, is yet so rarely employed as manure, and must necessarily be so limited in its use for that purpose by the scantiness of the supply, that we should hardly have adverted to it, except as matter of secondary interest to a few speculative farmers, had not our attention been called to it by some papers which lately appeared in the 'Quarterly Journal of Agriculture.' From these we learn, that it has for some years past been used in parts of Hertfordshire, and appears to be rather on the increase; that good crops have been produced by it, where crops never were good before; that it has been chiefly applied to wheat, barley, oats, and grass in the early part of spring, sown over the crops in the proportion of 1 to 1¼ cwt. per acre; and that the common price is about 25*s.* per cwt.

As to the soil, which is the most benefited by its application, there is, as usual, much disagreement; but it is generally regarded as favourable to chalky land, and the accounts all concur in representing its effects upon grasses in general, but particularly on clover, as being very striking. It is also generally said to succeed best if sown in damp weather; that it should be pounded till it will run through a wheat-sieve, and may be sown by itself, but it is not uncommonly mixed up with ashes. It is, however, of various qualities, which differ exceedingly in strength, and make a proportionate difference in its effects upon the land, by inattention to which errors may be occasioned in its application. From its analysis, as made by Sir H. Davy, it appears that wheat contains more nitre than any other product of a farm, and it was therefore expected to be peculiarly favourable to the growth of that grain:* the fact, however, seems at variance with this theory; for, although it has generally occasioned an increase of straw, the yield of

* It is known by chemists as *nitrate of potass*; and, according to this analysis, consists of one proportion of azote, six of oxygen, and one of potassum. Sir Humphry Davy says, that it may possibly furnish azote to form albumen or glutten, in those plants that contain it.

grain has not been improved, and the crops have, in many instances, been found unusually subject to mildew.

Application.—In answer to some information, requested of Lord Dacre, who has applied it to his land, his Lordship says, that he considers it may be advantageously used as a top-dressing to present crops, in March or April, at the rate of 1½ cwt. per acre; but that it appears to be most profitable to Lent corn and grasses,—both permanent and artificial. Its effect upon meadow land is great; but, inasmuch as it presses upon the stronger grasses, it may, and probably does, smother the dwarf herbage. His Lordship doubts its having strength to bring wheat to full maturity, though its effect upon the straw is immediate and great. No mildew has attended it; but it produces a rank and dark appearance in the stalk.

Mr. Curling, of Offley Holes, says it succeeds equally well on all soils, on any sort of corn, or natural or artificial grasses; that it causes an equal increase of both straw and grain, and is far superior to any other light manure. He has not, however, observed any effect on the succeeding crop; in which he is corroborated by other accounts. Generally, it has been found most beneficial to grass-land; it is destructive to wire-worms,* slugs, and other insects, and it is recommended to be sown after the crop is well up, intimately and carefully mixed with ashes, at the rate of 1¼ cwt. to a small cart-load, for one acre of land.

Regarding the quality, it seems the goodness is measured by the angle at which light is refracted in passing through it; an angle of 5° is called par, and the variations in value are made diminishing or increasing—not the price, but the quantity; for as the quality is better as the angle is less, an allowance in weight is made accordingly. The inferior sort contains common salt. It is tested at Apothecaries' Hall, and the quality marked upon the bags, so that any one who takes the trouble of attending the quarterly sales of the East India Company can at once ascertain its value; but deceptions are constantly practised by the dealers, and as the trade will, perhaps at least at the outset, be less carefully regulated under the new system than formerly, it is not improbable that these frauds will be increased.

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*There is a remarkable instance mentioned by Mr. Crabb, of Temple Dinsley, on whose land a field of barley was much infested with the wire-worm, but on top-dressing it with saltpetre, in the month of May, they all died after the first shower of rain.

CHAPTER XI.

MISCELLANEOUS MANURES (CONTINUED.)—BONES.

Bones, although of comparatively late introduction as manure, have yet occupied so much of farming attention within these few years, that we have no hesitation in placing them at the head of those miscellaneous substances which are usually employed for that purpose. They have indeed been used in some parts of England for a long time, and have been extensively imported from the Continent into the town of Hull, where several machines have been erected either for grinding them into powder, or bruising them into small pieces; which modes of application have been found so advantageous, that they have, within the last twenty years, excited general attention, and are now in almost universal use as the principal manure for raising turnip crops on the calcareous soils in Yorkshire and Lincolnshire. It is upon this description of land that they are the most decidedly valuable, and the testimony of some farmers of experience proves that to mix them with a portion of vegetable or coal ashes is a profitable application for the production of turnips; as, by this method, the vegetation of the seed is quickened, and the young plant, getting rapidly into rough leaf thus escapes the fly.

Long before the great advantage which may be derived from ground or well-crushed bones was generally known, many persons were aware of their fertilizing properties. To render them available, however, the wasteful and injurious process of reducing them into ashes by fire was then commonly resorted to; by which, indeed, a certain degree of benefit was imparted to land upon which sulphate of lime or gypsum will have effect, but could not be so effectual, in point of nourishment, as bone in an uncalcined state, because the oil and other nutritive matter which it contains is thus dissipated. In other instances, they were either reduced by lime, or laid at the bottom of the farm-yard, and decomposed by the effect of urine, and in some cases were partially broken by the hammer. In these modes, however, great quantities were wasted, which is now prevented by the improved method of preparing them by machinery; it is therefore useless to enter further into the details of practice which has become obsolete.

When reduced to powder, the bones are ground, being

divested by the process of boiling, not only of every particle of flesh, but also of a material portion of oil which is also extracted; and it is only in that state that they can be brought to the condition of fine powder. In this state it is only reasonable to suppose that they cannot be so beneficial to the land as when fresh and unboiled; yet we find, by the report of the Doncaster Association "on bone manure,"—to which we shall presently refer,—that they have been found more effectual after having passed through the manufactories. When not ground completely into powder; they are, however, broken in the machines, by cast-iron rollers, formed with deeply indented rims, by which they are first partially bruised, and then falling down upon other sets of rollers, each with the teeth more closely fixed, they are in this manner reduced to various sizes, from one inch to half an inch in thickness, and a considerable quantity of coarse dust is also procured by the process. These bones are usually sold under the respective designations of inch, three-quarters inch, half-inch, or dust; but the greatest demand is for those of the half-inch size, which contain all the dust which has been formed in crushing them. The "dust" is collected in great measure by riddling the inch and three-quarter inch bones.

When the bones are not boiled, each pair of rollers is furnished with a set of malleable iron scrapers attached below, in order to clear the teeth of any animal matter which may adhere to them, and thus the oily substance contained in the bones is saved. As bone mills have been now very generally erected, there are few parts of the country where the manure cannot be procured in a prepared state; but when the bones are only to be had raw, and it is an object with the farmer to reduce them to a small size, they can be easily broken to pieces by his own labourers. [The value of bones being so generally admitted, we cut out a number of experiments which only tended to make assurance doubly sure.]

Effects of Bone-Dust and Bones.—Bone-dust is the fittest state in which to lay it upon grass, for it will not only take more immediate effect upon the crop, but if laid in pieces, it would interrupt the progress of the scythe. It should, however, be recollected, that fine powder can only be obtained from spent bone which has undergone the process of manufacture. It is therefore spread, as a top-dressing, by hand; but it is also very commonly laid in the drills for turnips, for which purpose many ingenious machines have been contrived for

sowing it along with the seed. It is, however, much to be regretted that these implements cannot be constructed with more simplicity, for their cost is so considerable, that unless a man has a very large quantity of land to drill, their purchase would be imprudent, and the hire is generally unreasonably expensive.

Regarding the *quantity of dust*, the powdered bones are dearer than those which are merely broken small, and although said to more forcing to the first crop, on account of their being, when in the state of powder, more intimately blended with the soil, and more directly applied to the seed, yet they are not found so durable as when they are laid on in pieces; but it is also true that, in the former case, they are not laid on so largely, for the amount depends entirely on the size of the bones. They have been applied, in the rough state, to the extent of 100 bushels per acre; but the average quantity, of all sizes, is stated, in the Doncaster Report, to be 39 bushels. When the smaller bones are distinguished from the larger, they, however, seldom appear to exceed 30 bushels per acre, and in many cases do not arrive at 20: perhaps it may be assumed, as the most general practice, that half-inch bones are employed at the rate of from 25 to 30, and dust at 20 bushels per acre; but a distinction should be also drawn between the quantity of those which are applied after being manufactured, and those which are laid on in a raw state.

The *size of the pieces to which the bones should be broken* is also an object of some importance, as the smaller they are the more prompt will be their effect: on which the following observation has been made by one of the correspondents of the Doncaster Association:—"That if he meant to till for early profit, and if he wished to keep his land in good heart, he would use half-inch bones; and, in breaking these, he should prefer some remaining considerably larger:" the reason assigned for which is,—"that by using bones of a large size, with dust in them, there must be sufficient of the small particles of the dust to set the turnip-crop forward, and sufficient of the large particles of the bone left to maintain the land in good condition for the last crop."

Respecting their durability, it has been affirmed, that the effect will not be increased if they be laid on to great amount; for the same produce has been obtained from the comparative application of 50 and 100 bushels; and an experiment has been tried by varying the quantity on different ridges of a

large extent of ground under turnips, at the rate of 28, 40, and larger quantities alternately, without creating any visible difference in the crop. This, however, may be perfectly correct, so far as regards one or two crops, for it has been found that, when used in large quantities, they have rendered the land extraordinarily productive during a great length of time, of which we find the following instances in the Doncaster Report:—

1. On a field, part of which was boned forty years ago, the crops were, on that part, during fifteen or sixteen succeeding years, visibly better than the remainder, although the land was all of the same quality, and the part not boned was manured with farm-yard dung.

2. In another case, about three acres of light sandy land were dressed, in 1814, with 150 bushels of bones per acre; since which time the land is said to have never forgotten it, but is nearly as good again as the other part, farmed precisely in the same way, with the exception of the one application of bones.*

We learn, also, from experiments at Kew, that although they yield a certain supply of nourishment to plants the moment they are capable of receiving it, yet that is done so gradually as to furnish only a regular and moderate supply: reasoning upon which, it is to be presumed, that as a large quantity does not produce the effect of forcing a crop in proportion to the amount supplied, neither can it be so soon exhausted by the gradual consumption of the smaller quantity. This application may therefore be perfectly consistent with good husbandry, if applied to any amount, however large; though, as regards the farmer's purse, the expenditure of the outlay is a different question. The extent of their fertilizing quality is greater upon grass-land, under cattle, than upon arable. Valuers estimate the allowance to a quitting tenant, by supposing the effect of bones upon tillage and meadow-

*About sixty years ago, a farmer is also said to have obtained a forty-year's lease of a tract of poor land, in a high situation near Rochdale, in Lancashire, on which, after fencing and draining it, he erected a bone-mill, and began manuring the ground at the rate of 100 to 130 bushels of bones and dust per acre. The consequence of which was, that in a few years he let off more land than paid the rent of the whole, and retained a large farm in his own hand. The Correspondent of the Quarterly Journal of Agriculture, from whom these details are taken, says, "that one acre would summer a cow of large size, and that some fields were cropped with oats ten or fifteen years in succession; yet that it is surprising to see the herbage which the land still produces, both as to quantity and quality, near one half being white and marl clover.—N. S., vol. iii. p. 715.

ground to be exhausted within four years; but on grass-land depastured it is considered to last during eight.

Experience seems to be in favour of laying the manure in *drills*, especially when applied to turnips, although the superiority of the *broadcast practice* is maintained by some very intelligent farmers, who hold—that the turnip plant receives its support principally from the fibres which it throws out sideways, to a much greater length than people will believe, and derives more nourishment from them than the tap-root; and that the bones being dispersed, the fibres are more likely to meet with them than when they are accumulated round a tap-root; and that method must be the best which occasions the greater quantity of nourishment to be conveyed to the body of the turnip. In drilling the bones, there is also a difficulty found in the after-ploughing, of mixing them with the soil: and although this may be in some measure obviated by cross-ploughing the ridges, yet that portion of the land on which the manure is thus laid receives more than an equal degree of benefit. A third mode is however acted upon by others, who sow them broadcast, and gather them into ridges with a mould-plough.

The *time for laying them upon the land*, when applied to grass, whether natural or artificial, is generally recommended to be early in the spring; but if upon meadow, the growth of which has been fed off, then the moment the cattle are removed. Experience, however, varies upon this point; because it has been found materially to depend upon the season and the state of the land, which, if wet, will be more benefited by delaying the operation until the weather becomes warm and the ground dry.

When applied in the drills of arable land, they are of course deposited along with the seed; but when spread broadcast, then they are not uncommonly either harrowed in immediately previous to the sowing, or with the last ploughing; though, when used in a fresh state without having been subjected to the process of manufacture, they should always be laid in sufficiently long before the sowing, to allow them time to ferment, or they will not take immediate effect upon the rising crop.*

The *soils to which they are best adapted* are those of a light and warm nature; for on wet and cold grounds they

* Doncaster Report, p. 16.

have rarely been found to produce any sensible benefit. Their power of contributing to lighten strong land, by their mechanical action upon the soil, and thus rendering it less adhesive, has indeed been vaunted, and, if laid on to a very large amount, there can be no doubt that the bones, in pieces, would have some such effect; but the smallness of the quantity in which they are usually applied renders their force for that purpose quite insignificant.

On *heavy loams and clays*, the accounts of their operation have been almost invariably unfavourable; and it may be laid down as a necessary qualification in a soil fit for the application of bones, that it should be dry. This, indeed, has been contradicted by experiments stated in the Doncaster Report, upon what is described as a wet sand soil, with an irony-coloured subsoil, upon which two quarters per acre were drilled, and produced an excellent crop, when manure had been previously tried without effect. This, however, having occurred in the years 1826 and 1827, which were unusually dry, may serve to explain the fact, without affecting the principle that bone manure is not generally beneficial to clay lands.

The same Report states, that "*upon very thin sandy land*, the value of bone manure is not to be estimated; it is not only found to benefit the particular crop to which it is applied, but extends through the whole course of crops; and even in the succeeding courses, its effects are visible in the improved quality of the land, and the efficiency of a smaller quantity than would at first have insured a crop. Upon much of the high land about Babworth, which is a light sandy soil, the crops under ordinary farm management were comparatively unproductive; but since the introduction of bones, after having been dressed for several fallows with sixty or seventy bushels per acre, they have not only become productive, but so much improved in quality as to return an equal crop with a much lighter dressing of manure or bones throughout the next course."

"On the *dry limestones* near Doncaster, the same favourable results have been obtained; and no failures, beyond those attributable to peculiarity of season, are noticed."

On the *wolds of Yorkshire and Lincolnshire*, it also appears, by the testimony of several extensive farmers, that "before bones were generally used with turnip-seed, many thousand acres were annually sown for that crop without any

manure whatever, from the impossibility of getting fold-manure for more than one-third or fourth of their fallows. The turnips upon such unmanured land were consequently very indifferent; and the benefit of sheep feeding upon their tops—for of bottoms they seldom had any—was very trifling. Since the use of bones, has however, become general, the turnip crop has been, in many instances, ten-fold, and in few less than four or five-fold its former bulk. All the succeeding crops of grain and seeds have been amazingly increased, and, upon the four or five-shift system, there is no doubt the land will go on progressively improving, requiring a less quantity of bones annually, from its increased fertility and power."

On *light loams*, the returns to the Doncaster Committee give bones a preference to farm-yard dung. And we learn that, upon the calcareous soil of the Yorkshire Wolds, heavy crops of turnips have been raised from 16 bushels per acre of bones, while in the same field, and under similar circumstances, but manured from the farm-yard at the rate of from 8 to 10 tons per acre, the turnips have been of the most inferior description.

On *peat soils*, if previously drained and laid dry, their advantages are reported to be so striking, that from fifteen to twenty bushels of dust per acre, drilled, have been also found to very far surpass the ordinary dressing of stable-dung, and even of lime and pigeons' dung.

On *gravels*, the reports are meagre and contradictory, though perhaps reconcilable in principle, as it has been justly observed, that "a gravelly soil may embrace every variety of texture and quality, from the light dry sand to the water-logged yellow clay—preserving in each the necessary admixture of stones and grit." To wet gravel, their application has been found decidedly unfavourable.

[It is much more economical to treat bones with acid than without. It has been found that burned bones are better than those not burned—and that there is an advantage in using boiled bones rather than fresh. Of the acids, sulphuric is better than muriatic; because it is cheaper, has greater specific gravity and contains less water. In a dry season, however, we should give the preference to the muriatic acid, since the chloride of lime formed, if not rather more fertilizing and soluble than the sulphate of lime, has greater attraction for moisture. The smaller the fragment of bones submitted the better, as they will be more readily acted upon and require a

much less proportion of acid and water. The proportion must be determined by the specific gravity. We take that, ranging from 18.45 to 18.50. Four bushels of bone-dust will weigh about 180 lbs.; often less, rarely more. This contains carbonate of lime, 12½ lbs. About 10 lbs. of sulphuric acid is necessary to convert this to gypsum. The quantity of phosphate of lime, in the four bushels of bone-dust is about 106 lbs. To change this into about half gypsum and half super-phosphate of lime, will require about 33 lbs. of acid. Thus to 180 lbs. of bone-dust not less than 43 lbs. of acid will be required. About 11 lbs. of water should be used. This raises the heat and thus facilitates the solution. The water should be applied first, with a watering pot, so as to completely moisten the bone-dust. The bones becoming partially saturated, the acid, from its great affinity for it, "rushes as it were, into the pores of the bones in search of it," and thus the bones are more readily acted upon. The best vessel for the purpose of mixture is an old sugar hogshead, with its hole stopped up by plaster of Paris. Great care should be taken in handling the acid, as it is a dangerous substance—and carelessness may produce fearful accidents. When no other manure is applied to a turnip field—the above proportions—four bushels of bone-dust should be applied—but the acid had better then be increased to 60 lbs. to the four bushels. It will richly pay, however, to apply it in the following proportions:—twenty bushels of ashes, a small proportion of night-soil and four bushels of bone-dust treated with 60 lbs. of acid and 15 lbs. of water. For turnips, especially Swedes, it is the most valuable and economical top-dressing which can be used. In truth, it is the only manure which can be relied on for Swedish turnips. This matter may be regarded as conclusively settled. A very convenient way of applying this manure, is in a liquid state, by means of a water cart. Or, it may be mixed with the ashes, in the proportion before mentioned and applied with a drill.]

Composts.—The fermentation of bone naturally leads to the consideration of the subject of forming *a compost of bones with earth and other substances*, by a mixture with which they soon become decayed and pulverized—a practice which is stated in the Doncaster Report to have been recommended by several very intelligent farmers, thirteen of whom, solely from the results of their own experience, describe its effects as superior to those of bones used singly. With some of these, it is the practice to mix 50 bushels of bones with 5 loads of burnt clay, or good

earth per acre; by which dressing, the crops between fallow and fallow, excepting clover, appear to have been increased one fifth in value. Others use 40 bushels of bones, broken from two to three inches, in a compost with 5 loads of farm-yard manure, and a sufficient quantity of earth, the effect of which has been felt on the wheat crop at the end of the four-course system. Many also mix up dung, soot, rape-dust, and the ashes from weeds and house fires, with the bones, by which great heat and consequent fermentation is occasioned.

The most general practice, however, is to form the compost entirely of bones and yard muck, mixed, in various proportions, with

From 50 bushels of bones to		4 or 5	of dung.
20	do.	4	do.
12	do.	8	do.

This, if the heap be well covered, will no doubt decompose the bones very rapidly; and one person states, "that he has used as much as 35 bushels of bone-dust, per acre, without manure, in the same field where he laid six loads of fold manure, and ten bushels of bone-dust; but the turnips on the part manured with bone-dust alone were not so good as those on the part manured with the compost and the succeeding crops were still worse in comparison."

As the great amount of bones now actually consumed as manure, besides the quantities applied to other purposes, may reasonably excite an apprehension that the still increasing demand will soon exceed the supply and consequently raise the price, a correspondent of the "Quarterly Journal of Agriculture," has suggested the following economical method of employing them, which he has used for the last two years, and by which he states that he has obtained heavy crops of turnips.

He forms a compost, as the manure for one imperial acre, of 8 bushels of coarse bone-dust, with not less than double that quantity of coal-ashes, which may be generally procured for about 5*s.* per ton. The ashes should be carefully collected in dry weather and placed under cover, in order that they may be kept free from moisture; or, if that be difficult, they may be strewed with a dusting of quicklime: after which they are to be riddled as small as the dust itself, for otherwise, if sown with a drilling-machine, they will not pass easily through the hopper. The bones are then mixed with the ashes; the mass

ferments, and evolves a considerable degree of heat, when they soon become fit for use.

Turnips raised with this compost, he affirms to have always possessed the same characters of a close crop, firm root, and hardiness to resist the rigours of winter, that turnips raised with bone-dust alone evince; in proof of which, he has sold them for 7*l.* per acre to be eaten off by sheep. He, however, supposes that it is the bone-dust alone which secures to the crop whatever nourishment may be imparted to it at the future stages of its growth, in which he is doubtless correct; but in imagining that he has thus discovered a more economical mode of their application in their effect upon succeeding crops, we imagine that his further experience will show him that he has been deceived; for although the fermentation of the bones, occasioned by the application of the ashes, may increase their power upon the actual crop, it will be proportionably diminished in those which follow, and we think that the instances which we have already stated must convince practical men that the durability of their influence upon the soil depends on the quantity in which they are applied.

Application.—Independently of the decided fertilizing properties of bones, when applied to dry and light soils, they have the great advantage of being procurable at a small expense of carriage, which diminishes the labour of teams to a great extent; for one wagon-load of 100 bushels, broken small, will in most cases be found equal to 40 cart-loads of yard manure. They are also capable of being preserved during a long time, when kept dry, without incurring damage, and thus may be stored up during the winter season, when farm business is not pressing; added to which, they leave the land freer from weeds than when it is manured with dung. This and their suitableness to the drill husbandry, renders them peculiarly adapted to the cultivation of turnips—to which, indeed, they have been the most universally applied; and we need not remind our readers, that on the success of that crop generally depends those of the whole succeeding course. The instances are also numerous, upon all soils, of turnips being destroyed by the fly when sown in drills, having had the manure placed directly under them; when turnips sown in the same field, and on the same day, with bone dust, have entirely escaped their ravages. Their value to the holders of light soils, in thus enabling them to procure the certain means of improving the returns from their land, by this increase of their quantity

of nutritive matter, may therefore be considered inappreciable. It has been stated as the comparative result of some experiments, that bone-dust acts in the cultivation of grain, as compared to the best stable manure, in the following proportions: namely,

In respect to the quality of the corn, as	7 to 5.
In respect to the quantity, as	5 to 4.
In respect to the durability of its effects on the soil, as	3 to 2.

We cannot indeed agree altogether in this estimate of its powers, but it requires no further arguments to press its application upon the attention of every farmer, who is in possession of ground to which it is suitable. We shall, therefore, only add the following summary of the rules for its application, as recommended by the members of the Doncaster Agricultural Association, from which it appears—

That on dry sands, limestone, chalk, light loams, and peat, bones are a very highly valuable manure.

That they may be applied to grass with great good effect.

That on arable lands, they may be laid on fallow for turnips, or used for any of the subsequent crops.

That the best method of using them, when broadcast, is previously to mix them up in a compost with earth, dung, or other manures, and let them lie to ferment.

That if used alone, they may be either drilled with the seed, or sown broadcast.

That bones which have undergone the process of fermentation are decidedly superior (in their immediate effects) to those which have not done so.

That the quantity should be about 20 bushels of dust, or 40 bushels of large, increasing the quantity if the land be impoverished: and also, according to our opinion, if the bones have been already manufactured.

That upon clays and heavy loams, it does not yet appear that bones will answer.

On this latter observation, however, a farmer near Nantwich, in Cheshire, remarks, that he occupies a farm in the township of Pickmore, the soil of which is a clay loam, scarcely twelve inches deep, the sub-soil a gray sand, mixed with coarse clay: which the farmers call *rammel*—on a bed of good clay marl. Two years ago, he covered the field with bone-manure; previous to which the grass was so sour, as not to be worth ten shillings per acre; but it is now full of most excellent herbage, consisting of white clover and trefoil; to which he adds, that

"in another of his fields, with a clay soil, a small portion of it was manured, thirty-two years ago, by a former tenant, with bones; and that, although it had been twenty years in tillage, yet that part still shows a superiority over the rest."

CHAPTER XII.

MISCELLANEOUS MANURES CONTINUED.—GREEN CROPS.

Green Manures consist in full crops of succulent plants,—such as buck-wheat, rape, tares, and many others,—which are ploughed into the land, and have been applied in many instances with very singular advantage, more especially on calcareous, gravelly, and sandy soils, the fertility of which has been thus greatly improved. The practice dates as far back as the time of the ancient Romans, and is still continued throughout Italy, even in places where the dung of animals can be procured in abundance. The climate of that country is, however, more favourable than ours to the system, for the corn harvests are so much earlier, that they are off the ground in time for succeeding green crops to arrive at full maturity; and it is there thought that nothing tends more to the improvement of the land than ploughing them down.* It has indeed been held by many intelligent men who support an opposite opinion, that the land which produces these crops will be deprived of their vegetative properties in proportion to their luxuriancy; and, therefore, that, by returning the crop into the same land, its fertility can only be increased in the same degree as it was reduced by their reduction. This theory, however, can only be supported upon the principle that plants are fed more by the soil than by the atmosphere; whereas it

* In Tuscany, the plant which is chiefly sown for this purpose is the white lupin, a leguminous annual plant, well known in our gardens, which grows in sandy and loamy soil, to the height of two or three feet, with a stem of equal strength with the bean, and bearing somewhat similar blossoms and pods; but the produce is so bitter that it is unfit for the nourishment of either man or beast, until prepared by some manufacturing process. It arrives to a considerable size in the month of October, when it is ploughed into the soil; and very extraordinary fertilizing properties are attributed to its effects, which are ascribed to the great quantity of glutten which it is known to contain.

has been shown, by many curious experiments, that the air and water are the chief sources of vegetation; and it is a fact, that poor land, without manure, which by the fortuitous chances of the weather has produced tolerable green crops, has been found more fertile after their production than before.

When ploughed into the land, they however often remain for several months before they decay, for their decomposition goes on slowly beneath the soil, and they are therefore frequently more beneficial to the second than to the first crop. To turn them in effectually, they should be first heavily rolled, and then followed by a trench plough, for the operation cannot be completely performed with a common plough; and, if not entirely buried, their points stick out between the furrows, by which they are partly prevented from fermenting, and a portion of their value as manure is thereby lost.

The *time of the year* when they should be ploughed in, must, of course, depend upon the nature of the crop, which should always be buried before it arrives at perfect maturity, or otherwise it will rob the land of that nutriment with which it is intended to supply it. Most farmers take the first growth of tares and clover, which, if fed off early, is an economical plan; but if mowed, it is only doing the business by halves, for the land is thereby not only deprived of the dung of the cattle, but the operation is then too long delayed, for the work should be done in the heat of the summer, or, at the latest, early in the autumn, while the sun has the power to forward the fermentation. The effect, indeed, will greatly depend upon the season, for the process of fermentation is only slight when checked by the want of free communication with the air; and if the weather be cold, the power of the manure will be in a great measure lost; but if the season be moderately moist, and very warm, the fermentation will be much promoted, and the crop will be converted, by putrefaction, into a mass of nutritive mucilage. Nothing short, however, of an abundant crop will have that immediate effect, as a large mass decomposes much more speedily than a small one; and, if very scanty, the latter perhaps may not putrefy at all, or its decomposition will be so very gradual that the land will be very little perceptibly the better; but if such a quantity be turned under the earth as will excite the force of fermentation, there can be no doubt but that it will then be greatly as well as promptly benefited. Sir Humphry Davy, indeed, says, "that this gradual decomposition affords a supply of vegetable mould for several years;" but

although as a chemist, he may be right, yet every farmer must know that, with such materials to work upon as cannot materially enrich the staple of the soil, his object should be to obtain such immediate effect as will enable him to put the land into a state for growing one good crop, which, by its means of producing manure, will probably lead to others. If the question whether it be most profitable to appropriate green crops as the food of cattle, or as manure, be put aside, and that the sole object is the improvement of the land by the latter process, then there can be little doubt that the crop should be ploughed down as soon as it is in bloom, for the land will thus have its full benefit, besides the partial advantage of a bastard fallow; to which, however, there is this difficulty opposed: that the ground cannot be again ploughed until it receives the seed furrow, and therefore cannot be cleared except by the operation of horse-shoeing, or scarifying, which, if the soil be foul, we need not say will prove ineffectual.

The *crops which are most generally applied to this purpose* are—buck-wheat, winter tares, the second year of clover, and rape; which last, from its oily nature has been found very effective. There is, however, a plant which, although but seldom sown in this country, is very commonly grown throughout Flanders, for the pasturage of cows, and is there sown, like brush-turnips, immediately after a crop of wheat, yet in a couple of months afterwards affords a large quantity of succulent food. Several trials of it have also been made with the happiest results in many parts of Germany, of its effects as a green manure; for it not only possesses the advantage of putrefying with great rapidity when ploughed in, but also that of producing a crop by being merely harrowed across the stubble, and the costs a mere trifle; it is called *spurry*.

Upon arable land which, from any circumstance, is deprived of the benefit of a due application of farm-yard dung, or other putrescent manure, there can be little doubt that green crops of quick growth, abundant foliage, and easy decomposition, may be turned into the land with considerable advantage; but we cannot accord in the opinion that they will be found an effectual mode of improving exhausted soils, for on such land they grow too feebly to produce much effect. The ground, to be benefited by their application, should be capable of bringing them forth, if not luxuriantly, at least with such abundance as to furnish complete shade during their growth, and sufficient vegetative matter to occasion a rapid fermentation when

buried: we therefore conceive that this species of manure is more appropriate for the preservation of good soils in a state of fertility, than to the improvement of those which are impoverished. This probably will in a great measure account for the comparative rarity of the practice on extensive farms containing tracts of poor land, the cultivation of which is chiefly dependent upon the fold; while, on those of a richer description, it may be fairly questioned whether the dung made from a large green crop, when fed off, or soiled, may not be equally beneficial in its effects upon the soil as if ploughed down, besides the superior profit thus gained by its support of the stock.

CHAPTER XIII.

MISCELLANEOUS MANURES CONTINUED.—OIL CAKE—RAPE—AND MALT DUST.

Oil-cake, though a term generally applied to the pressed seed of flax, as well as that of rape, is, however, essentially different, for the linseed-cake is rarely applied to any other purpose than that of feeding cattle, while rape-cake is used solely as manure. When received from the oil-mills, where the seed is crushed, the cakes of rape are commonly abont 4lbs. weight, and contain a small portion of oil, from which their fertilizing quality is chiefly derived; the remainder consisting of husk and bran. Those of linseed are of a richer and more nutritive substance, and consequently bear a much higher price. There is, therefore, not only a material difference in their value, and the uses to which they are applied, but also in their quality; for some mills are constructed with such power, as to leave little else than the husk of the seed, and in some cases foreign oil-cake has been re-crushed in the mills of this country, by which their value is very much decreased. They are in this state very hard, and there is such considerable difficulty in breaking them, that, when not reduced by a regular crushing machine, they must be pounded with heavy iron hammers or mallets; though some farmers attach a stone to their thrashing-mill for the purpose of grinding it to dust.

If laid for some time upon a damp clay floor, from which they attract moisture, this operation will, however, be rendered easier, though it should not be carried too far, or it will injure the manure; and a man can in this manner break about 4 cwt. in the day into pieces small enough to be passed through such a sieve as those used in cleansing oats; but a mill with one horse will crush five tons within the same time. The operation for the crushing of both linseed and rape-cake is the same, and the former has, in many instances, been also employed as manure; but although more effective when thus applied than the latter, we yet strongly doubt the expediency of making such use of any thing which is fit for food. One load of the dung of beasts fed with linseed-cake is thought worth nearly two of any other; and will enrich the land nearly as much as if the cake was laid on in its original state. The cheapest mode of its employment will, consequently, be always found to consist in feeding bullocks or sheep, as the linseed-cake can be both profitably used as food, and will afterwards be nearly as powerful a manure. Our observations, therefore, attach solely to *rape-dust.*

When sown broadcast, it matters little whether the cakes be rendered into dust, or merely pounded into small pieces; but as that mode of spreading them, though more convenient, requires a larger quantity than when laid in drills, besides being less immediately effective to the crop, the practice has now almost universally given way to that of drilling, which is thus performed:—

When laid in drills with the seed, it is generally ground fine by means of a stone revolving on its edge, as in a bark-mill, and in this mode it is usually applied when intended for turnips; but for wheat it is not uncommon to drill it between the rows in March or April, as, when sown along with the seed, it is apt to render the crop winter-proud. In Norfolk, Mr. Coke is said to have improved upon this plan, drilling one half the usual quantity with the seed, and the other half between the rows in the spring, from an idea that the plants are more likely to be then benefited by this additional stimulus. In spreading the dust for turnips, the common drill-barrow might be supposed to answer very well; but a layer of soil should intervene between the seed and the manure, for if applied directly to the seed, it will be injured by the fermentation which always takes place in rape-cake when laid in the land. Some drills are, however so constructed as to cover

the dust slightly with mould before the seed is deposited. For wheat, that precaution is not necessary, for the same danger is not to be apprehended from fermentation.

The *crops to which it is the most generally applied* are turnips and wheat; but, when used for the former, it is precarious in its effects, from requiring moisture either in the soil, or from the weather, to render it operative, for it will remain inactive until aided by the natural coldness of the land or by rain. For the same reason it is seldom used for barley when any other manure can be obtained, because, if sown late in the spring, the weather is then usually dry, and if the season continue hot, the manure will not be of the least advantage to that crop: though, as its powers will not be exhausted, it is probable that it may benefit that which follows; that, however, we need not observe, is not the immediate object of the farmer.

The *quantity usually employed* varies among different farmers, some applying a ton to three acres, others four, and many to six, according to the condition of the land, and the goodness of the cake. At the former rate, it is said to have been found equal to 12 loads of dung per acre, and that with 5 cwt. per acre its effects extend to two crops; but that is more generally limited to the crop to which it is applied, and does not benefit the subsequent ones. Mr. Curwen used 5 cwt. per acre, mixed with two tons of dung, as a manure for turnips, and found the crop admirable. Fifty bushels of dust make a ton; and the last price at Mark-lane was five guineas.

The *soils to which it is the most applicable* are considered to be clays, and other moist lands; but it is generally thought to be occasionally serviceable to any description of soil. It is likewise said to succeed well in wet seasons, but is found injurious in very dry weather.

Malt-dust is the refuse which falls from the malt in the process of drying, and is extensively used as a top-dressing, in those counties where the general production of barley occasions the establishment of large malting concerns. It is also in some places employed in the feeding of milch cows and pigs. It varies, however, very considerably in its effects as manure, both in proportion to the quality of the barley, and to the degree of heat employed in the operation of malting; for when the grain is equally good, the pale malt, which undergoes a regular and uniform heat in the kiln, though considered more lasting in its effects, is not so stimulant as that which is high-

dried. The browner the dust, therefore the more active it is found to be in its immediate application—provided the barley from which it is made be of equal goodness. Farmers are, therefore, not unfrequently deceived in their expectations of its powers, from the want of proper attention to these circumstances, for the quantity to be applied to the land should be regulated accordingly.

It has been used with considerable success upon stiff loams, and even on sandy and chalky loams, and other calcareous hungry soils; but upon cold, stiff land we should recommend the application of the brown dust, as the most likely to be effectual to the crop in the ground. The accounts given of its influence upon the succeeding crops are by no means favourable, though in Walker's report of Hertfordshire, it is said that "these top-dressings not only supply the want of previous manure, but also, when crops are sickly and backward in the spring, occasioned either by bad seed-times, frosts, or other causes, are attended with wonderful success, and enable the crops to vegetate quickly, and cover and protect the soil on which they grow from the droughts of summer." He states, indeed, that the farmers of that country are chiefly indebted to its effects for their never-failing crops: and that, therefore, they continue to enlarge upon the practice, though attended with considerable expense. To which Mr. Malcolm adds, "that he has seen an untoward season so injure the young barleys as to nearly annihilate the crop, which had been previously dusted, but which was afterwards entirely recovered by a repetition of the malt-dust; which shows, that although from some ungenial circumstances the first manuring had not been attended with all the success which might have been expected, yet it clearly proves that we should not be afraid of a second application, which is often attended with more than ordinary success." He, however, advises to be laid on in the following quantities:—

If top-dressed, for wheat, from	36 to 40 bushels.
If drilled with the crop, for barley and turnips	30 to 34 "

according to the strength of the soil. Mr. Young says generally from 40 to 60 bushels; and states that it greatly improves cold grass land: notwithstanding which high authority, we recommend them to weigh the cost against the probable increase of produce, before they apply it. For wheat, it should be laid on some time in March, just before the usual change of the weather, and should be harrowed in with light harrows. For

barley and turnips, it is usual to sow it in with the last harrowing of the seed, and then to finish by rolling. The common price at most malt-kilns is from five to six shillings per quarter.

CHAPTER XIV.

MISCELLANEOUS MANURES CONTINUED.—PEAT MOSS.

Peat-moss, which is universally considered as an inert mass of half-corrupted vegetable matter, has been long applied to land in different ways, and, when burned, has been already treated of in the chapter on Ashes. When reduced to that state, it is of course rendered light by combustion, and consequently so portable as to be easily conveyed to any part of the kingdom; but it is only in the immediate neighbourhood of bogs that it can be used in its natural state, for, even when dried by exposure to the air, its bulk is too great to admit of its being carried to any great distance, unless at such expense as would render its application as manure unprofitable.

It has been extensively used in its natural state in both Scotland and Ireland, in various parts of which there are large bogs, as well as in some parts of this country: it is, however, very sluggish in becoming reduced, and requires two or three years, with repeated turnings and exposure to the atmosphere, to bring it to anything like the condition of vegetative mould; but being of a cold nature, it is found, by a heavy dressing, to cause considerable improvement in hot, gravelly, and sandy soils. When brought to the decayed condition of *bog-mould*, or rich earth, it has also been found highly useful in opening stiff clay land, and has been largely used for that purpose in Ireland; but on mellow friable soils, it is stated to possess too little substance to be of much utility, and it is said that it inclines grass-land to the production of moss. It is likewise impregnated with noxious roots and seeds of aquatic grasses, which when laid on in its raw state, fill the land with those nuisances; and some farmers who have thus applied it, have occasioned such injury to their grass-land, that it has not recovered for several years: though a small quantity of quick-

lime sprinkled sparingly over the surface, after the peat is spread, has been known to correct its bad effects.

During many years it has been the practice of farmers residing in the vicinity of fens, to bed their cattle upon dried peat, as they find that the dung and urine occasion it to ferment and become decomposed. This is so common in Ireland, that every peasant who has a few acres of ground, bottoms his dung-stead with stuff drawn from the bogs, that he may thus preserve the *seep* or *gooding*, as he terms it, of his stable-manure. They also mix the peat with dung in various proportions—sometimes one-third of the latter, at other times one-half; and in the latter case have in most instances found that the mixture has produced an equal crop with a similar quantity of stable-dung. In countries where peat-moss cannot be readily obtained, a proportion of moory soil may be substituted; but it is not advisable that either of these should form the principal part of the compost heap, for neither of them contains fertilizing properties of sufficient power to act in any other way than as alteratives, until effectually decomposed by being judiciously blended with stimulating substances. The difficulty of effecting this decomposition led to frequent disappointment in the application of the manure, and consequently to much difference of opinion regarding its value, until the late Lord Meadowbank happily overcame the objections to its use, by a scientific investigation of its properties, and directions for its preparation in composts with dung, of which the following is a summary.

Composts.—The peat of which the compost is to be partly formed should be thrown out of the pit some weeks, or even months, previously, in order to deprive it of its redundant moisture. By this means it is rendered the lighter and less compact when made up with fresh dung for fermentation; and accordingly, less dung is required for the purpose than if the preparation be made with peat recently dug from the pit. It should be taken to a dry spot, convenient to the field which is to be manured, and placed in a row of the length intended for the midden. When ready to be made up into compost, half the quantity of dung must be carted out, and laid in a parallel row at such a distance as will allow the workmen to throw the rows together by the spade: the compost may thus be laid in the centre, and will form the area of the future heap, which is to be thus formed.

Let the workmen make a layer or bottom of peat about six

inches deep, and extending further than the base of the proposed midden, which is to be thrown up in alternate layers—first, ten inches of dung over the peat, then peat six inches, dung four inches—thus diminishing each layer of dung until the heap rises to a height not exceeding between three and four feet, when the whole should be covered—top, ends, and sides—with the remains of the peat; the whole to be put loosely together, and made quite smooth.

In mild weather, 7 cart-loads of common farm-yard dung, tolerably fresh made, is sufficient for 21 cart-loads of peat-moss; but in cold weather, a larger proportion of dung is desirable. The dung to be used should either have been recently made, or kept fresh by the compression of cattle or carts passing over it; and as some sorts of dung, even when fresh, are much more advanced in decomposition than others, it is necessary to attend to this, for a much less proportion of dung that is less advanced will serve the purpose.

After the compost is made up, it gets into a general heat, sooner or later, according to the weather and the condition of the dung: in summer, in ten days, or sooner; in winter, not perhaps for so many weeks, if the cold is severe. It always, however, has been found to come on at last; and in summer it sometimes rises so high as to be mischievous by becoming fire-fanged. Sticks should therefore be kept thrust into different parts, as by drawing them out occasionally the progress of the fermentation may be ascertained; and if so rapid as to approach to blood-heat, it should be either watered or turned over, and a little moss be added. The heat subsides after a time, and with variety proportioned to the season and the perfection of the compost; but when cooled, it may be allowed to remain untouched till within about three weeks of being wanted: it should be then turned over, upside down, and outside in, and all the lumps broken; after which, it comes into a second heat, but soon cools, and may be taken out for use. In this state the whole appears a black mass, like garden mould, and, it is said, may be used weight for weight, like farm-yard manure, with which it will fully stand a comparison throughout a course of cropping.* Sixteen single-horse cart-loads per acre are, indeed,

* To every 28 cart-loads of compost, when made up, it is also recommended to add one cart-load of ashes; or, if these cannot be had, half the quantity of finely powdered slaked lime may be used; but these additions are not essential to the general success of the compost, though they will tend to quicken the process.

said to have produced comparatively as good a crop as 12 of farm-yard dung.*

By this plan one ton of dung will ferment three tons of peat; and wherever moss is only two or three miles distant from the farm, this mode of raising manure can be confidently recommended as a great acquisition. His Lordship also tried various experiments on the mixture of animal matter—such as refuse fish, whale-blubber, and the scourings of the shambles—with peat, without the addition of any other substance, and found that, in the course of about nine months, a compost formed of one ton of animal substance and 10 or 12 tons of peat, produced a compost of superior power to that composed with dung. He, however, states, that peat prepared with lime alone is not capable of being decomposed when collected in a heap, and has consequently not been found to answer as a good manure; which opinion he supports upon chemical principles, which we need not now discuss, as experience proves that he is mistaken; for not only does peat, when compounded with a small quantity of lime, obviously undergo the putrid fermentation, but it is well known to many farmers that such composts form excellent dressings, particularly for grass-lands. In corroboration of which, there is an experiment recorded by the Manchester Agricultural Society, stating, that a compost of 119 tons of peat-moss and lime having been laid upon five acres of a poor sandy soil, and harrowed in with oats, an equal quantity of the same compost was laid upon five acres of thin, poor clayey soil, and harrowed in with the seed, which was likewise oats. The crop upon the sandy field was uncommonly heavy; that on the clay land, though inferior, was, however, very abundant, considering the state of the soil previously to the application of the compost.† To this it may be added, that lime will operate in composts when used upon land which has been previously exhausted by the application

*Gen. Rep. of Scotland, vol. ii. *n.* p. 550. In Holland's Survey of Cheshire, it is also mentioned, that three tons of compost, made from moss and dung, having been spread on part of a meadow, and three tons of rotten dung upon an equal portion of the same field, it was found that, although the grass on that part which was covered with dung only, came up as soon, and upon the whole grew rather higher than that on the other part, yet the latter was of a darker green, and yielded nearly an eighth more when it came to be cut.

†In Malcolm's Survey of Surrey, it is, however stated, that in one instance, on a small piece of fallow sown with wheat, the application of a compost of peat and lime only was manifestly pernicious.—Vol. ii. p. 198. The proportions of which it is composed are not stated.

of lime and marl, although it may have failed to act when used by itself; but it is only upon the varieties of deep argillaceous soils that it can be used with advantage. It is, indeed, generally supposed that the power of the compost will be increased if animal or vegetable matter be added; but the mixture of quick-lime and dung can never be advisible, for the lime will render some of the most valuable parts of the dung insoluble.

Application.—The practice most usually followed in preparing the compost is to trench and throw the moss up into ridges, at the most convenient time after the autumn sowing, that it may be dried and pulverized by the winter's frost; and towards the latter end of February to turn it over and lay it flat, when it will be found considerably lighter than when it was first dug up. It is then mixed with the dung, and the process of composition already stated is carried through until it is ready to be laid upon the land. When made up in January, such composts are generally in good order for the spring crops; but this may not happen in a long frost. In summer, they are ready in eight or ten weeks; but if there should exist any necessity for hastening the process, that can be effected by a slight addition of ashes, rubbish from old buildings, or of lime slaked with foul water, and applied to the dung while the compost is being made up.

Doubts have arisen respecting the proper season of laying on this manure—some insisting that it should be applied to spring crops—others, that it should be ploughed in for wheat in the autumn; but we believe that its effect upon the land will, in the long run, be found in either case equal.

CHAPTER XV.

MISCELLANEOUS MANURES CONTINUED.—SEA-WARE—KELP—REFUSE FISH—BLUBBER AND TRAIN-OIL.

These manures being chiefly confined to the use of farmers resident in the vicinity of our coasts, necessarily do not engage much of the attention of those who dwell in the interior of the country; but they are of considerable importance wherever

they can be procured with facility, and therefore deserve a place in any general account of the husbandry of the United Kingdom.

Sea-ware, or *tangle*, in many of those districts, forms an article of constant application, and when used with judgment, never fails to add to the fertility of the land. On some parts of the coast immense quantities are thrown up by the tide, when aided by favourable gales of wind; and in those situations where experience teaches its value, it is seized on with great avidity as a sure means of increasing the crops to which it can be applied; while, in other places, either from the ignorance of the farmer, or in some cases from the want of means and hands to assist in securing it, it is either wholly neglected, or applied to other purposes than those of manure. Thus, in the Orkneys, the Western Islands of Scotland, and on the coasts of Ireland, it is almost solely employed in the manufacture of kelp, and is even used in a dried state as fodder for cattle. In the Isle of Thanet, when a large quantity is driven ashore after a gale of wind, the farmers set all hands to work to get as much as possible while the tide serves, lest the current should carry it away; and even if it happen in the night, they work at it till stopped by the flow of the sea. It is carted through sloping passages cut in the cliff, and some farmers will thus procure as much as 200 or 300 loads in one tide, for it sometimes comes in quantities that amount to many thousands, and is perhaps all swept away by the next ebb. Those who live at a distance, therefore, hire small spots of ground on which to lay it, and carry it away at a more convenient opportunity. The principal mode in which it is there used, is by mixing it in layers among the farm-yard dung; and it is of great use in helping to rot the litter carried out of the yard in summer.

Sea-ware, although valuable as a manure, is yet only transient in its effects, which do not last more than the crop; nor can it be applied with any advantage, either to clay soils or in very wet weather. To light land of any description it is, however, well adapted; and it is very beneficially applied to summer fallows. When spread on grass-land, it is also found to improve the herbage, but it should be spread evenly, and rather thinly. On arable, there is no certain rule for the quantity which may be laid on, for it may be employed to almost any moderate amount without injury.

Kelp is made from burnt sea-ware; but since the admission

of foreign barilla, the manufacture has nearly ceased throughout the United Kingdom, and it has become a matter of great importance to a very numerous class of poor and industrious persons, formerly employed in its production, to discover any useful purpose to which it can be applied. It requires about 30 tons of the weed in its wet state to produce one ton of kelp, and it is said to resemble peat-ashes in its effects.

Kelp when intended for use as manure is pounded into a powder, and applied in the same manner as the ashes; but its causticity affects the hands of the workmen, and when spread as a top-dressing, it is therefore prudent to mix it with an equal quantity of fine sand, which both prevents that injury and facilitates its equal distribution. In this way it has been already employed with considerable advantage.

Refuse Fish.—Large shoals of herrings, pilchards, and other sea-fish, periodically frequent many parts of the coasts of Great Britain, which, being salted, leave great quantities of refuse, which are used as manure.* Sprats, and other small fry, are also employed for the same purpose; and in the fens of Lincolnshire and Cambridgeshire, the small fish called sticklebacks abound in such swarms, that they are frequently purchased by farmers at a very trifling cost, and either formed into composts with earth, or laid upon the land without further preparation. One barrel of such offal is mixed in about 4 or 5 cart-loads of earth, sweepings of ditches, or sand; and after being well incorporated, the compost is usually applied at the rate of about 20 cart-loads per acre, more or less, according to the quantity of oil contained in the garbage.

The effect of a compost when thus prepared have been known to last for a considerable time, and when laid as a top-dressing upon grass-land, has produced very large crops; but when applied in that manner in its natural state, it is often prejudicial to the first crops; and not very beneficial to those which follow.† It should, therefore, in every case, be either made into a compost, and completely decomposed; or, if

* In Scotland, it is calculated that 14 barrels of herrings yield one barrel refuse: pilchards something less, but containing rather more oily matter; and there are, besides, large quantities wholly spoiled. To which may be added, the entrails of the cod and ling, which are caught and salted to a vast amount in the north.

† The manure produced in the fishing villages from the oily and fishy substances, though admitted to be favourable to bear (barley) and green crops, yet when much used, is said to render the soil unfit for the production of oats: "Hence that soil is called poisoned."—Sinclair's Statistical Account of Scotland, vol. vii p. 201.

ploughed into the land without that preparation, it should be mixed with a small quantity of quick-lime or strong ashes, for all oily substances are hurtful to vegetation until they are dissolved. We hear, indeed, of a crop of wheat having been rendered so rank in straw by the application of herrings in a raw state, that it was entirely laid before harvest; and sprats are said to produce great effects for one year upon the hop-grounds in the neighbourhood of the Medway; but we have no information regarding the state of the soil, nor the time of the year, when the former were ploughed into the ground, nor whether the latter had not also been laid upon the land together with some alkaline manure.

Oil.—As all writers on the application of train-oil and blubber, as manure, agree in their opinion that it should be made into a compost, with a large portion of earth,* and the experience of practical men in this country has proved its correctness, we do not think it necessary to enlarge on the subject, further than to remark, that in some parts of the continent, oil has been found highly fertilizing when applied to the land in its liquid state, diluted with a sufficient quantity of water, and spread moderately over the surface.

CHAPTER XVI.

MISCELLANEOUS MANURES CONTINUED.—FELLMONGERS' POAKE AND CUTTINGS—TANNERS' BARK—WOOLEN RAGS AND FURRIERS' CLIPPINGS—SUGAR SCUM.

In consequence of the improvements in husbandry, attempts, which in former times were little thought of, were very generally made to increase the natural powers of the soil by the application of every refuse vegetable and animal substance that could be converted into manure. Among these are some of those which form the subject of the present chapter; but being only procurable in the neighborhood of towns, and con-

*Dr. Hunter advises, in his Geological Essays, a compost formed of 12 lbs. of American potash dissolved in four gallons of water, mixed with 20 bushels of dry mold and 14 gallons of train-oil.

sequently not at the disposition of all husbandmen, we shall only touch upon them slightly.

Fellmongers' poake, which is the waste arising from the preparation of skins, is compounded in various proportions of lime, oil, and hair, and is of such a caustic and heating nature, that it is rarely used in any other state than that of a compost with earthy substances, and sometimes, when it is thought expedient to increase the powers of farm manure, also with stable-dung. To form this, whatever materials are intended for the compost should be mixed together in a heap, surrounded with maiden earth, and covered, when it begins to ferment, with soil made fine and sloped so as to throw off the rain. When the fermentation has nearly subsided, it should then be turned over, and if some fresh litter be mixed with it, the midden will again immediately heat; after which, it may be again turned in three weeks or a month, and in about six weeks more, it will be fit for use.

In this state, it is well calculated for cold and tenacious soils, as well as for loams of every description, and when laid on at the rate of 12 to 16 tons per acre, according to the strength of the land, it has been known to produce heavy crops for four or five years successively. It has also been applied, in its unprepared state, as a top-dressing to sour coarse meadow, with very good effect; and after having lain three or four months on the field, and having been frequently moved about with the brush harrow, it has then been raked up, and laid upon the dungheap. There can, however, be little doubt that much of its valuable properties must have been thus exhausted by the atmosphere; which, if it had been made up in the first instance into a compost, would have been preserved.

The *clippings*, are the parings and scrapings of the skins, which, although generally used in the manufacture of glue, have been in many instances used as manure. When ploughed in upon a summer fallow for wheat, these clippings have been found highly serviceable to deep loamy land, and to strong soils which are not too wet, for they not only produce a full clean grain, with a bright strong straw, but the bulk of the crop is also greatly increased. Care should however be taken to cover them well with the soil; for, if left near the surface, the putrid effluvia, which they soon emit, attract the crows in swarms, and great quantities are thus scratched out of the

ground. From 30 to 40 bushels is the quantity usually applied to an acre.

Tanners' Bark.—The refuse of the tanneries consists partly of the same substances as fellmongers' poake; but when the bark is used alone, it is chiefly employed in gardens, as a covering for the beds of pineries, and in that state has been found quite ineffectual as manure. It has, however, in some instances, been made up as a compost with lime, chalk, earth, and dung, and laid upon strong land with considerable advantage. It might, indeed, be supposed that the whole value of the mixture consisted in the latter article; but, according to a long account of a series of experiments made by Mr. Malcolm, and recorded in his Compendium of Modern Husbandry, the bark would appear, by the comparative trials, to have had much good effect in the composition. When mixed with lime, great care is however requisite to prevent it from catching fire during its fermentation, for which purpose it should be so completely covered with earth as wholly to exclude the air. It will, in some cases, particularly if much mixed with earth, take three or four months to ferment; when it should be turned over at least once; which further fermentation and cooling will probably require a couple of months longer before it can be in a fit state to be laid upon the land. As in many cases it is such an incumbrance to the tanners, that they are glad to get it taken off their premises without charge, it may be worth the while of farmers in their neighbourhood to try its effects.

Woollen Rags and Furriers' Clippings.—Rags are sometimes used in considerable quantities upon light chalks and gravelly soils, to which their retention of wet renders them particularly applicable, and they continue to act so long as they remain unrotted in the ground. They require to be cut into pieces, and are sometimes spread upon clover-leys and ploughed in for wheat when sown upon one ploughing. Their chief use is, however, to lay them in hop grounds, for as they act in the nature of a sponge, they preserve the plantations in a constant state of moisture in the dry seasons, when in land which has been manured with dung the hops have failed; but in rainy seasons they, on the contrary, have been known to do injury by creating mould. The usual method of thus applying them is, to open the hills and place the rags round the roots, a little below the surface, and immediately to cover them with mould: a ton of rags being the usual quantity to an

acre. They are also frequently employed as top-dressings for clover-leys, and are sometimes ploughed into the land before winter, when intended for turnips; for, if applied at the time of sowing, they will not work for that crop. If used for other crops, they should be spread before the last ploughing, and laid well into the soil, or otherwise they are apt to be raked out by the harrrows. We have also heard of their being steeped in a reservoir of urine, kept in the farm-yard, and applied to barley and clover with very good effect.

Sugar-Bakers' Scum is the skimmings of the sugar during the operation of refining, in which process it is boiled with a portion of bullock's blood and lime-water. The albumen contained in the blood coagulates on the application of heat, and rises to the top of the pan, carrying with it the impurities contained in the solution which is thus clarified, and the dregs are used as manure. This refuse is of a very caustic nature, and is therefore not well adapted to light soils; nor, indeed, has it been found to answer upon arable land of any description; but it has very considerably enriched meadows of cold retentive clay, and is therefore used to some extent in the vicinity of the great seaports which trade with the West Indies.

The mode of applying it is to break the lumps, and to spread it evenly and thinly, if laid on in its raw state; but a better method is to mix two or three cart-loads of road sand with one of scum, and to apply the mixture, without waiting for its fermentation, at the rate of about 30 loads per acre; a few more or less, according to the state of the land. It may be had at most sugar-bakers at about four to five shillings the cart-load, containing at least a ton.

[*Guano*, owing its fertilizing properties to its uncombined ammonia, is coming much into use. The best system for using it, is to spread and plough it in. About 500 lbs. to the acre is a proper paying proportion. For Indian corn, it is unsurpassed. For turnips, after bruising and powdering it, apply it by hand in the drills. Care must be taken that it does not come in contact with the seed. The guano should be applied, and after the falling of the earth in the drill covers it, the seed are planted. The proportion for turnips, you may apply about 450 lbs. to the acre. It is valuable as a top-dressing to green or growing plants, especially to grass. But bone-dust treated with acid, as before-described, is a preferable manure for turnips, especially Swedes.]

CHAPTER XVII.

MISCELLANEOUS MANURES CONTINUED.—CLAY—SAND—POND, RIVER, AND SEA MUD.

Clay.—Such frequent allusion has been already made to the expediency of mixing together different soils of a marked character, as a means of ameliorating their distinct qualities, that it is unnecessary to repeat that recommendation, whenever it can be carried into effect with moderate expense. This advantage is in no case more fully evinced than by laying clay upon sand lands, whether they be of the red, rich, or more valuable descriptions, or those of an inferior quality which usually contain a portion of moor and white sand. On the former, about 50 tons per acre will effect a vast improvement; but the latter are seldom brought into a fertile state with less than treble that quantity. The most eligible period to apply it is in the autumn or early part of the winter, when the land is in grass, and intended to be broken up for a crop of corn; or otherwise at the same period when intended for fallow. The frost, rain, and drying winds will then cause the lumps of clay, however large, to open, and by repeated slight harrowing, to divide and intimately cover the surface before the land is ploughed,—a circumstance of little trouble if attended to at the proper season, though, if not so reduced before the land is ploughed, large pieces of clay will be found to have been preserved from the atmospheric influence, and consequently unbroken and unprofitable many years afterwards. It is more profitable to repeat the operation after an interval of a few years, rather than to lay on an immense quantity at once, as by this means the clay gets more thoroughly incorporated with the sand; and it will be obvious that the first ploughing ought not to be to the full depth, lest the clay be lost. It is, however, scarcely practicable to lay clay, in its natural state, upon sand, both because of the great labour of digging, and afterwards preparing it with the requisite degree of care for mixture. If not rendered so fine as to be perfectly incorporated with the sand, its tendency to sink through light land gradually brings it to the bottom, and renders it afterwards useless, if not injurious, by forming a retentive subsoil.

Sand is, however, not exposed to the same objections, for

it is dug with less labour, and does not require any further trouble in its preparation. Its application as an alterative for stiff clay land is of the greatest advantage; for its intermixture with the soil—which is effected by various means—has a tendency to lighten the land, and to bring it to that loamy state which is the most favourable to the purposes of vegetation. In this respect its action is the counterpart to that of marl, as applied to light sandy ground; for in both cases it is the interest of the farmer to bring his land into that state which is the most likely to be productive. Marl, by stiffening it, produces this effect in the one instance; and sand, by loosening it, in the other.

Until about half a century ago, this plan was very little known as an improvement to the soil, when a spirited agriculturist in Cheshire began to use considerable quantities; sometimes mixing it with dung, and sometimes laying it raw on his grass-lands. The success which invariably attended these experiments, at length induced several farmers in his neighbourhood to follow his example, and the practice has since been very generally adopted in many of the principal dairy-farms in the middle of the county: deep beds of sand being there frequently met with under the clay, which predominates as the superficial stratum of the soil. The mode of employing it is thus described by a landowner who has employed it extensively with the greatest advantage:—

'When there is a piece of strong clay-land in tillage, and the farmer has an opportunity of covering it over with sand, about twice as thick as in a common set of manure, the soil will be pulverized and opened by this means—will give better crops when in tillage, and when laid down will produce a finer herbage, less liable to be parched in dry, or trod down in wet seasons. It is excellent management in the farmer, before he ties up his cattle for winter, to lay a coat of sand, at least a foot in thickness, where he intends to throw his dung out of the cow-houses. The dung should be repeatedly levelled on the sand, and a second coat of the latter laid on towards the end of February; upon which should be put the remainder of the dung procured before the cattle go to grass. As soon after this time as possible, the compost should be either turned and well mixed where it lies, or filled into the dung-carts, and taken away to some situation near the land on which it is intended to use it. Here it should be laid in a heap of at least two yards in thickness; and after remaining

two or three months in this state, it is in excellent condition for putting on the land.

This, however, only alludes to its employment as a compost; but if laid in its natural state, either as a top-dressing upon meadow of a stiff nature, or slightly ploughed in upon heavy arable land, it will be found to effect a permanent improvement in the soil. It must, in the latter case, however, be laid on in very large quantities; perhaps not less than two to three hundred cart-loads or cubic yards.* This, of course, cannot be accomplished with prudence, unless the sand lies either under the clay, or in the immediate vicinity of the farm; and even in that case, the expense of cartage, if calculated at its cost in money, would appear too serious to admit of much chance of profitable remuneration. Many circumstances are, however, continually occurring on every farm to prevent the constant occupation of teams: on those days they may be invariably employed in the cartage of the sand, without any charge except that of day-labourers to dig; and if it cannot be immediately spread upon the land, it may be laid up on the headlands of the field to which it is intended to be applied.

Mud.—The *mud from ponds*, when they are cleaned out, has always been an object of attention to farmers, so far as regards its collection; but it must be presumed that its different properties, and consequently the most judicious mode of its application to the land, are either but little understood, or neglected: for some cart it directly upon the ground, and plough it in either for turnips, or for corn-crops; others spread it upon old leys; and many lay it out in thin heaps to dry, after which they mix it with lime, chalk or dung. Upon this it has been remarked by an eminent agriculturist, "that in reasoning with the farmers upon the cause or principle by which they are guided in those different proceedings, the reply is generally, 'that it has been their practice to do so—that it has answered very well—and that they know of no better mode of treating it.' From which we are necessarily led to conclude, that upon the same, or nearly the same sort

* It has been laid on a large extent of drained moss, in Dumfriesshire, at the rate of a single-horse cart-load to every square yard of surface, though the land was in such a soft state that the sand could only be carted by horses with wooden clogs or pattens on their hind feet. The expense must, therefore, have been enormous; yet the improvement in the land seems to have reimbursed the proprietor.—See Dr. Singer's Survey, p. 309.

of soil, these different practices cannot be right. It therefore becomes necessary to consider what is the usual composition of the sediment of ponds,—then to point out, as correctly as we are able, the best way of preparing it for use—the soils to which it should be applied—and the crops which ought to succeed such application."(*a*)

Upon this it may be observed, that ponds, being usually placed at the lower part of the fields, receive after every hard rain a part of the soil, as well as of the substances with which they have been manured. If the ponds be large and deep, they may also acquire much decayed vegetable matter, arising from the aquatic plants with which such pools usually abound; and if near to the yards at which cattle are commonly watered, they must likewise receive a portion of their dung: such mud is therefore, particularly applicable to light soils, both as containing nutritive matter, and adding to the staple and consistency of the land. If, on the contrary, the ponds contain springs, the sediment taken from them will be found unfit for vegetation, for it contains more sand than vegetable matter, and it hardens upon exposure to the sun; it may, however, be useful in killing the rushes and coarse weeds upon low sour meadows, but prejudicial if applied to uplands. It is therefore evident that the mud must partake of the nature of the various ingredients of which it is composed; and therefore every farmer should take these circumstances into consideration before he applies it to his ground.

The most common time of mudding ponds is during the summer months, when it is usual to let the slime lie near the edge of the pond until the water is drained from it. A spot is then marked, either upon a headland of the field upon which it is to be laid, or as near to it as possible, of a size to raise a compost with alternate layers of either lime or dung. If dung can be had, the best mode of preparing this manure is to lay a foundation of mud, of about a foot or a foot and a half in depth, of an oblong form, and not more than eight feet in width upon which the freshest yard dung is laid to about double that depth; then a thin layer of mud; after which, alternate layers of mud and dung, until the heap be raised to about five or six feet in height—keeping the sides and ends square, and coating the whole with mud. It should then be left to ferment; after

(*a*) [Pond mud should lay out one winter in low heaps. In the spring make up into compost.]

which it must be again turned, at least twice, at different periods.

If quicklime be used, and there remains any moisture in the pond scourings, it will be sufficiently fallen for turning in a few days,—but if the compost be made with farm-yard dung, it may require to remain for six or eight weeks to ferment and decompose before it is in a proper state for turning. To derive the greatest advantage from composts, it is necessary to mix them thoroughly, which can only be effected by repeated and careful turnings. To form them, in the first instance, with both quicklime and manure is injudicious: the former ought never to be brought into contact with the latter—though manures may be advantageously incorporated with an old compost, in which a little lime has been used.

These composts may be applied at the rate of 16 to 20 cubical yards for strong loams, and upon light loams in a rather smaller proportion. Pond mud is however not unfrequently used, in an unprepared state, upon grass-lands; but the accounts given of its effects are so different, and the experiments are so inaccurately stated, that we might mislead our readers were we to detail them. Were attention paid to the properties of the mud, and to the quality of the soil on which it is to be laid—in the manner already alluded to—there can, however, be little doubt that errors in its application might be avoided. It appears the better mode to apply it in the latter end of autumn, or the early part of winter, and to bush-harrow it well after it has been hardened by the frost.

River mud in creeks, or banks, from which it can be collected, answers the same description, and is also extensively employed in some districts in the operation of warping.

Sea mud or *sleech*, has also been used in some places in very large quantities, and has been found of so very enriching a nature, that it was thought worth while to carry it in barges up the river Mersey, to the estates of the late Duke of Bridgewater, at Worsley, in Lancashire. It abounds at the mouths of many of the friths and rivers which run into the sea; and one gentleman, who has used it for upwards of half a century in Cheshire, asserts that no other manure is equal to it either for corn or grass. It is there, however, always laid upon grass, and ploughed in without any addition in the following spring. If the ensuing March be dry, and there has been much frost in the winter, a heavy pair of harrows will prepare it for the plough; otherwise, it must be chopped with spades. The

land is then generally sown with oats, followed by barley or potatoes, and the third year by wheat. The fourth year the land is laid down either with oats or barley, clover and grasses, and the crops are said to be very great. It is also found that its effects remain longer on the land than marl; and although that which is over-marled is spoiled for grass, yet that never happens to sea mud. In many parts of Scotland it has also been found to answer very well for the improvement of moss; upon which, after it has been well drained, the sleech is laid, to the amount of 100 single-horse cart-loads per acre. To this, however, we must add, that the repetition of it in large quantities fails of its former effects. In Sussex it has been used to the extent of 1200 to 1300 bushels per acre; but on those farms where it has been too frequently used, and which are thus said to have been "over-dosed," it is no longer found to be of any service.(*a*)

CHAPTER XVIII.

MANURES IN GENERAL.—PUTRESCENT, MINERAL, AND MISCELLANEOUS.

It is notorious that a great number of farmers are either ignorant of the most judicious mode of application, or negligent of the means of increase and preservation. The latter remark applies more especially to farm-yard manure, which no one can ride over any part of the country without seeing wasted—dung carted out of the yards and thrown up by the side of some lane without any foundation or further care, until, perhaps, after having become mouldy and fire-fanged, it is at length turned over, while the best part of its juices have been allowed to run into the ditches, or to stagnate around the heaps; thus, neither assisting the proper fermentation of the dung, nor mixing the heap at such regular periods as to ensure its being all of one quality.*

(*a*) [The Albany Cultivator—good authority—says in regard to muck.—"Mix it with unleached ashes, at the rate of from one to three bushels per cart-load. Let it lie in a heap a month, if practicable, before used."]

* On this, however, the following remark has been inserted in the Report

We have already stated our opinion so clearly on the subject of fermentation, in our view of putrescent manures, that it may be thought hardly necessary to add any thing to the discussion of the point in dispute; yet as many farmers have been influenced by the reasoning of chemists, who possess no practical knowledge of agriculture, in favour of the invariable application of long dung—though opposed by experience—and as it is extremely important that the question should be set at rest, we request serious attention to the following extracts from an able article which has appeared in the Quarterly Journal of Agriculture since the publication of what we had written.*

It was promulgated as the opinion of Sir Humphry Davy, in 1809, and it has till lately obtained the confidence of most chemists, that '*As soon as dung begins to decompose, it throws off its volatile parts, which are the most valuable and most efficient. Dung which has fermented, so as to become a mere soft cohesive mass, has generally lost from one-third to one one-half of its most useful constituent elements; and that it may exert its full action upon the plant, and lose none of its nutritive powers, it should evidently be applied much sooner, and long before decomposition has arrived at its ultimate result.*' Experience has nevertheless, acted in direct opposition to this opinion. Manure has been continually applied in 'a soft cohesive mass,' and it has continued to raise large crops; whereas, had it been applied 'long before decomposition had arrived at its ultimate result,' that result would probably have been a loss of crop, manure, and labour.

'It is certainly an erroneous assumption to say the first stage of fermentation in dung must necessarily throw off its most valuable parts. Every dunghill of fresh dung throws off

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of the Committee of the Doncaster Agricultural Association upon bone manure—'The general mode of managing fold manure is erroneous, both as to the expense incurred and loss from evaporation. To prevent both, upon carrying it out to the field, it should be forked up to a considerable height, and the whole covered with the soil nearest to the heap; a long heap, like a potato heap, is therefore best; as it accumulates, taking care always to cover the whole of the day's loading, excepting the end to which the next day's work is to be added. The confinement of the steam, which is always observed upon a fresh-made heap of manure, effectually secures the decomposition of the whole; which will cut out like a jelly, *without the usual process of turning over and over.*'

* No. xxiii. pp. 617 to 624. The discoveries alluded to relate to a substance which chemists call *Humin*, which is said to exist in all soils, and to be formed of carbon and hydrogen. The *Humic acid* is composed of humin and oxygen, and its properties enable it to combine with lime, potass, ammonia. and many substances found in soils and manures, and renders them easy to be dissolved in water, which could not be done in their separate state.

a gaseous exhalation a very short time after it is put together; and the quantity thus thrown off is regulated by the state of the atmosphere. But this exhalation does not consist of the valuable gases; it is a mere evaporation of the water contained in the dung. The same hot haze may be seen flickering over a fallow field in a sunny day in summer. Nobody could with truth assert, that this haze arises from the disengagement of the gases in the dung which had previously been inserted into the soil, when it is clearly nothing more than the evaporation of the moisture in the soil. To say, therefore, the first stage of decomposition in a dunghill throws off "the most valuable and the most efficient" parts of the dung, is just to say the vapour of water is the most valuable part of dung.

'It is true, were the fermentation continued after all the water in the dung was evaporated, a considerable increase of temperature would ensue; and when the texture of the fibrous portions of the manure began to decompose, there would be an evolution of valuable gases. Direct experiment has proved the escape of gases from a heap of dung which has been long fermenting. But what harm accrues to the dung as a manure from the escape of these gases? None whatever. We are told these gases constitute the food of plants, and if they are permitted to be dissipated by decomposition, the quantity of nourishment in the heap of manure will of course be so much diminished; that if the bulk of the dungheap be diminished one-half or one-third by excessive fermentation, the quantity of nourishment to the crops will be diminished in a greater ratio. These cautions have long been whispered in the ears of practical men, but they have listened to the advice with a provoking indifference. Like ducklings when they first take the water, they have continued to disregard every remonstrance of their foster brethren against injurious practices, raising and devouring their food, and enjoying themselves with the greatest complacency in their vocation. It is true, and we must admit it, that some of the gases constitute the food of plants, but it does not follow that plants would receive them as food directly as they are disengaged from a fermenting and heated mass; nay, it is probable they would rather reject the food that would injure them. But as plants are not endowed with locomotive powers, they cannot avoid the food which is directly presented to them; they will therefore be obliged to partake of it even in an injurious state, and in thus taking it they die. Accordingly, we invariably find that

plants suffer from the contact of fermenting dung; and it is this well-known fact, more than from any other circumstance, which deters farmers from applying dung in an unprepared state. It is sometimes applied to the soil, it is true, in an unprepared state, but long before the crop is brought into contact with it, and after it has undergone fermentation in the soil. Though this application of dung is recommended by men of science, it is performed from the very opposite principle which they recommend. They recommend it because the gases arising while the dung is fermenting are absorbed by the soil, and are thence given out for the use of plants; on the other hand, farmers perform it, because the fermentation will have ceased before the crop is inserted into the ground. Which of these is the more rational reason? The practical one, undoubtedly; for it is surely impossible that the slight covering of earth upon the dung can prevent the escape of the elastic gases, however it may retard fermentation.

'Moreover, practice finds that fresh dung is injurious to vegetation, and recent discoveries now inform us that this arises from the acridity of the ammonia, which is always present in unfermented dung. Fermentation drives off the acrid ammonia. Fresh dung is found to injure plants by *burning* them, which is a very appropriate term to describe the action of ammonia. In like manner, stale liquid manure is not so good a top-dressing to grass as fresh, or when it is largely mixed with water; because science now informs us, that ammonia becomes concentrated in stale liquid manure, and is therefore in an injurious state for plants; and that it is necessary, to mix liquid manures largely with water, in order to dilute the ammonia, and allow the proper action of the humic acid, which exists in large quantity in them. Again, it is not an uncommon practice to cover a dunghill with earth in hot weather; and this is now explained, not as it hitherto has been—"that the earth absorbs and prevents the escape of the carbonic acid gas"—but that a violent fermentation in the dung is checked by the earth, partly excluding the atmospheric air and rain water, the oxygen in either of which is indispensable to continue the process, it being this oxygen which forms the carbonic acid gas by uniting with the carbon of the dung. The necessity of checking a *violent* fermentation in a dunghill which contains a large portion of horse-dung, is to prevent it being what is technically called "*fyrefangit*,"—a state in which dung is nearly useless.

'We thus see that science now agrees with that practice 'which has been pursued for years with unexampled success. It is consolatory to practitioners to think that their experience, though unknowingly to them, has guided them to success on really scientific principles. This agreement of experience and science should teach every one that science *and* experience, and not science alone, ought to be made the tests to try the accuracy of opinions; but unfortunately for the credit of sciences, the test of accuracy hitherto, in the application of putrescent manures, has not been submitted to practice.'

We now not only beg to impress upon every farmer the absolute necessity of guarding against the waste of any portion of the farm dung, but also to take care that nothing in the shape of refuse animal or vegetable substance be suffered to be thrown away by his servants. Let a bed of sand, or any earth except clay, be laid in some spot adjacent to the offices, and upon it let every particle of offal collected from the premises be regularly thrown; to which add the sweepings of the roads and lanes about the house, grass, turf, or rubbish dug out of drains and ditches; every thing, in short, which, by decomposition, can be converted into manure, and all of which may be got together with very little trouble. Let the whole of this be every now and then covered with the earth, between two layers of which a small quantity of quicklime may be placed, or sprinkled upon any vegetable substance, such as leaves, tough haulm, fern, or any thing which cannot be easily dissolved, and thus formed into a compost. Care must however be taken that the vegetative powers of the roots and plants be completely destroyed before the compost is spread upon the land, for if unskilfully prepared, they will shoot up in the course of the ensuing season, and overrun the land with weeds. Composts thus formed, whatever may be the ingredients which they contain, will ever be found a most valuable species of manure. The whole substance becomes one uniform mass of nutritive matter, which may be either mixed with the soil, or applied as a top-dressing, and, with proper attention, may be got ready for application at any period of the year. There are numberless receipts scattered throughout the writings of various theorists, in which the quantity and the quality of each ingredient in these various mixtures are as accurately stated as if they were the medical prescriptions of physicians; but these are mere quackeries which do not merit the attention of practical men.

Weeds, also, by the sides of fences, should never be permitted to perfect their seeds, but should be invariably cut while in a state of succulence, and added to the heap; and if those turned up by the process of horse-hoeing were also raked off, instead of being suffered to wither on the land, or to spring up again with the next shower of rain, it is inconceivable what a large quantity of valuable manure might thus be raised by the occasional employment of children, and of labourers, who may otherwise be idling away their time. It would also contribute in a great degree to that neatness which forms a distinguished feature in careful cultivation, and would insure a habit of attention on the part of servants, and a consequent portion of prosperity which can rarely be enjoyed by a slovenly farmer.

Were the *practice of soiling* more generally attended to, it would also very materially aid the increase of the dung-heap, without which no profit can be gained from arable land. But a very small portion of the soil under the plough is, in this country, capable of bearing crops, unless it be recruited by putrescent manure about once in four years, or that it be either suffered to lie for a more than usual length of time under the cultivated grasses and fed off with cattle, or supported by the fold. To obtain the requisite quantity of farmyard manure has, however, baffled the best exertions of many industrious farmers, except in the immediate vicinity of large towns. There, indeed, the object is often obtained through the means of purchased dung, the expense of which has been generally amply repaid by the growth of proportionably increased crops; but any one who is dependent upon the produce of his own farm, without the assistance of extraneous manure, for the support of the fertility of the soil, should endeavour to cultivate those crops which are best calculated to afford a large return of food for the maintenance of cattle. When the land is of such a nature as not to admit the growth of green crops, hay and oil cake should be resorted to for that purpose.

In other cases, *lime*, *chalk*, *marl*, and various other *mineral substances*, have been resorted to as auxiliaries; but the effect of some of these tending more to stimulate vegetation than to enrich the wasted powers of the soil, it has frequently happened that ground which at one time had been greatly benefited by their application, has afterwards been injured when repeated under the erroneous notion that its powers might be restored by the same operation. Land thus forced, has in many

cases been so much impoverished as to render it incapable of producing any thing but a poor pasture, and to require a great length of time to pass away before it can be restored to its original condition. It should, indeed, be observed, that the application of fossil manures requires more judgment and consideration than any other; for vegetable and animal manures contain the fertilizing property within themselves, and however injudiciously applied, cannot fail to impart ultimate benefit to the land, if not to the immediate crop; but the power of fossils consists in their action upon the constitution of the soil, and if this be improperly directed, the greatest mischief may ensue.

None of these has, perhaps, produced more injury in some cases, or greater benefit in others, than lime—of which very striking instances may be found in those parts of the country where it is either very abundant or scarce. In the former it has been not uncommonly laid upon the land without the aid of putrescent manure, until the soil has become worthless; while in the latter, as its scarcity renders it expensive, it has only been moderately used by farmers of judgment and capital, and the effects, after a number of years, are still apparent in the improvement of the soil. While writing this, we have under our eye a farm of 400 acres of strong clay, which has not been limed within the memory of man. The tenant, who is conscious of the advantages which might be derived from the use of lime—as demonstrated in the condition of adjoining land of the same quality—is yet prevented by circumstances from its employment; and thus, not only are his own profits, but the value of the soil to the landlord also, equally reduced.

On the subject of *burnt clay*, we have recently had an opportunity of making some inquiries in the neighbourhood of the late General Beatson's farm, in Sussex; and we have learned, that although several practical farmers in that part of the country adopted his plan, yet very few of them have found it to answer their expectations. One of them, who has followed it extensively, confirms us in the opinion which we have already stated, that much depends upon the mode in which the operation of burning is performed; for if the clay be calcined to the consistence of brick, it yields nothing in the shape of that soft ash which is proper for manure; and if not sufficiently burned, it will return to its original condition. In the former state it may, however, act in some degree as an alterative of the soil; and in the latter, it will at least afford some nutriment to the crop to which it is actually applied. It

therefore does not appear, from past experience, that it can ever be made to supersede the use of lime on land which has not been formerly dressed with the latter; but in such cases, or in parts of the country where lime cannot be procured, it may yet be employed to a certain extent with advantage.

As to *paring and burning*, there can be no doubt that the earth, if combined with fibrous roots and other vegetable matter, will answer the purpose of manure when burned; yet shallow soils are thus frequently more injured by the abstraction of too large a portion of the surface, than improved by the temporary addition of the manure. We have lately seen down-land, which was broken up during the war, and has been now during several years returned to pasture, yet still bears nothing like the sward of a fine sheep-walk on the poorest chalks, and probably will require half a century to bring it back to its former condition. We therefore cannot but again caution all farmers and owners of land against bringing such soils under the plough.*

With regard to *gypsum and salt* we have nothing to add, except to repeat our recommendation of experiments on their effects. Though quite aware of the common sentiment—'that gentlemen may use their superfluous cash for this purpose, but farmers have uses enough for their money in the regular routine of their business, and few are so overburdened with capital as to afford the risk of its diminution by uncertain speculation'—yet we entreat them to reflect, that experiments may be tried with those two articles upon a single acre; that the expense, if unsuccessful, can only occasion the loss of a few shillings; but if they succeed, may be productive of incalculable advantage.

Neither respecting the various *miscellaneous substances* which we have enumerated have we any further observation to make upon their respective properties. The fluid or dissolved parts of animal matter require some preparatory process to fit them for manure, the great object being to blend them with the soil in a proper state of minute division; for when they have been applied in a rank or unreduced state, bad

* A treatise has been just published by Professor Rennie, on Paring and Burning, in which he attributes whatever value it may have to the effects of the fire, considering it 'in the light of an instantaneous fallow.' Were this principle to be relied upon, it would follow that paring and burning might, within a few years afterwards, be advantageously repeated; whereas experience proves that, with whatever benefit the operation may be attended in the first instance, a repetition of it is always found to impoverish the soil.

effects have followed. *Train-oil*, *blubber*, and similar refuse, should therefore be made into composts with a large body of earth.* *Rape* and *malt dust*, requiring no mixture, are very commonly laid upon the land as top-dressings—the difference between which and manure ploughed into the ground, is, that the former are applied chiefly with a view to the sole benefit of the immediate crop, without regard to the further improvement of the soil; though there can be no doubt that if the crop be increased, the soil will also feel their good effects. In this manner *soot* is also almost invariably used; but its fertilizing properties are solely referable to the ammonia contained in it, which is an active stimulant of vegetation. The practice of laying it upon land which has been limed, or of mixing it, as sometimes done, in composts with lime, is therefore injudicious.

It has long been a disputed question, whether all plants extract the same nutritive juices from the soil, and convert them into the kind of sap adapted to their peculiar qualities, or whether each is nourished by a different substance. It would at first appear improbable that plants differing from each other in form, smell, taste, and properties as food, should be produced by the same matter; yet, when we reflect that different plants deprive each other of nourishment, by extending their roots into the same soil in which various kinds are planted, we cannot but conclude that their first nutriment must be of the same nature, though the sap probably acquires different properties in its progress towards perfection. This, however, is one of the secrets of vegetation with which we are unacquainted; but as we also see that some soils are better adapted than others for the growth of particular kinds of grain and vegetables, and that those crops to which they appear the most favourable yet become deteriorated if repeated, even though regularly dressed with one species of manure, it seems evident that there must be some advantage in the change of manures, as well as in the system of cropping tillage land. This will be gained by every farmer who has at his command manures of an unusual kind, and who understands their use, for he may then adopt many plans of cropping which are out of the power of others not similarly situated, and vary his rotations

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*'Tallow and oils received in a crude state by the roots may clog the pores of the plant, repel the aqueous fluid, and obstruct the free communication of the leaves with the atmosphere.'—Davy on Agr. Chemistry.

according to circumstances of the moment, or to his own convenience.

We have already touched upon the properties of alkaline manures, so far as they have been tested by experience: the solution of the effects of acids upon the soil must be still left to future experiments, for those already made by chemists, in many instances, present different results. Whatever may be the food of plants—whether gases, oils, salts, or acids—the farmer, however, need not puzzle himself about their chemical qualities, for he may either satisfy himself from the experience of others, or by small trials of his own, whether the effects of any particular species produce fertility or not. Farm-yard manure has been justly called 'the farmer's magic wand;' and the oftener that wand is waved, the more will it contribute to his prosperity. He sees that wherever it has been judiciously used, it causes abundant crops, and that wherever it has been withheld, sterility seizes upon the soil: his chief efforts should therefore be directed to its increase.

Although the time and manner of applying every description of manures depend so much upon the nature of the soil and season, as well as of the crops to be sown, that no precise rules can be laid down for their employment, yet the following general hints may be found useful.

SUMMARY.

When manures of any kind are to be used as top-dressings for grass, the best season for that purpose is as early as practicable in the month of February, as the vernal showers will then wash them into the soil. If for arable land, at the same time as the sowing of the seed, or immediately after; but if for wheat, when vegetation is about to acquire force in the spring.

If dung be applied to a wheat crop, it should be ploughed in during the course of a summer fallow; if compost, at the last ploughing before the seed furrow; but composts of lime and earth only may be laid upon the land during any period of the year.

The land should be laid dry; and the manure should be equally and speedily spread over every part of it, in proportion to the nature of the soil; but if ploughed in, though it should be well mixed with the ground, it should not be too deeply buried.

The stronger and the colder soils are, the more manure they require; and, as such land is generally applied to the production of crops which do not speedily attain their full growth, the application of dung which has not been completely decomposed by the putrefactive process may be there admitted; for although the progress of vegetation may not be so rapidly forwarded, yet the manure will at length decay, and afford a more gradual degree of nutriment to the present, and greater support to the land for the production of future crops. On adhesive land, long manure from the farm-yard also acting mechanically, by keeping the soil open, is not so binding as short dung; but on dry, sandy, hot soils, the dung should, on the contrary, be perfectly decomposed, or rotten; and manure of any description should, on such land, be only laid on in moderate quantities at one time. One general observation may be made regarding all dissertations on manure, which is—that as there will be different gradations both of soils and the substance of which manures are composed, we can never speak but in general terms of their application.

The following table will explain how many heaps of manure—each containing an equal quantity of any given amount—are required to dress any field, per acre, at certain regular distances: so that, by calculating the solid contents of the manure in cubical yards, each containing 27 bushels, and dividing it by the number of heaps, the exact quantity to be laid on in each heap may be correctly ascertained:—

No. of heaps, at	5	yards distance	193 per acre,
"	5½	"	160 "
"	6	"	134 "
"	6½	"	114 "
"	7	"	98 "
"	7½	"	86 "
"	8	"	75 "

APPENDIX

In mixing compost, peat or charcoal should be used. They are both powerful absorbents, taking up large quantities of ammoniacal gas, and thus preventing the evil effects of too high a fermentation.

Charcoal has been used at the rate of fifty bushels an acre, and has produced an enormous crop. It can be advantageously used at the rate of one hundred bushels to the acre, and should be well pulverized.

The use of charcoal is, firstly, to supply carbon to plants, in the carbonic acid absorbed from the atmosphere; and secondly, to condense ammoniacal gas in its pores—which gas is easily appropriated by plants to their use, when the ground is moist.

The value of decayed leaves and leaf soil to be found in our woods is immense. It is a capital nutriment for wheat in combination with other matters. How much of it is used?

The following compost is recommended by the American Farmer for an acre of wheat. Take forty bushels of leaf mould (from the woods,) five bushels of ashes, leached or unleached, five bushels of bone dust, one bushel of plaster. Incorporate the whole by shovelling over, and then moisten the heap thoroughly by thirty gallons of human urine. Then shovel it over again. Practically, we know nothing of its value in proportion to its cost. Theoretically, it is worthy, and *should* be valuable.

A general rule in the application of manures is to try the proportions recommended in the book, with such increase or reduction, as your knowledge of your soil dictates. If you are unaware of the chemical constituents of your soil, apply in the proportions recommended. The second season you can increase, if you like. and compare the result.

Coal ashes ploughed into a stiff soil lighten it considerably, and improve it in other ways.

The little runs and creeks running through various farms afford a source of manure, in the mud and decayed vegetable matter which abounds in them. Our farmers neglect this.

The application of manure to the seed produces the most extraordinary effect. Last year we soaked a gill of Indian corn for a few hours in as much ammonia and water as would cover them. We then planted them in half-light soil without manure—planting the same amount of seed, without the preparation, alongside of them. The contrast between the two, in the appearance of the plants was decidedly in favor of the soaked seeds, while the crop was nearly double. We intend to try the experiment, which is of foreign origin, on a larger scale. We do not recommend it as yet. It *may* be of doubtful utility.

Yard-manures are highly valuable for peat-lands.