The natural and agricultural history of peat-moss or turf-bog. To which are annexed corroborative writings, correspondence and observations... / by Andrew Steele.

Sir Robert Shafto Adair.

3 Earl of Cromarty's account of the formation
a peat moss —
Definition of a peat bog

THE

NATURAL AND AGRICULTURAL HISTORY

OF

PEAT-MOSS OR TURF-BOG;

TO WHICH ARE ANNEXED

CORROBORATIVE WRITINGS,
CORRESPONDENCE AND OBSERVATIONS,

ON THE

QUALITIES OF PEAT OR FEN EARTH, AS A SOIL AND MANURE, AND ON THE METHODS USED IN SCOTLAND FOR CONVERTING MOSS SOILS INTO ARABLE AND PASTURE GROUNDS, PLANTATIONS OF TREES, &c.

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TO

THE SOCIETY FOR THE ENCOURAGEMENT
OF ARTS, &c. LONDON;

THE DUBLIN SOCIETY FOR PROMOTING HUSBANDRY,
AND OTHER USEFUL ARTS IN IRELAND;

AND

THE HIGHLAND SOCIETY OF SCOTLAND,

THIS

WORK

IS MOST RESPECTFULLY

DEDICATED

BY THE

AUTHOR.

PREFACE.

THE experimental knowledge necessary for writing a History, Natural and Agricultural, of Peat-Moss, is yet in its infancy. We have no ancient authors on the subject; and no modern continental author that hath written professedly and fully on its improvement, has come to my knowledge. Former writers of this country have, I think, been defective in some particulars, from the want of a sufficient number of facts. And, at any rate, the late experience, and the Reports of the Agricultural Surveys of Great Britain and Ireland, have thrown so much new light on the importance of moss-soil, and its uses as

a manure, as to convince the most obstinate, that these, in general, hitherto useless and neglected wastes, which constitute a great proportion of the surface of Great Britain and Ireland, are worthy of cultivation, and afford room for a New Essay on the means of promoting their culture.

Whether the diligence of my investigation, added to some experience of my own, has been equal to the task of elucidating the nature and qualities of Peat-moss in any degree better than hath been formerly done, so as to open a way for their improvement, I leave others to judge. I can, however, safely affirm, that this publication is made with no other hope than that I may be of some service to mankind.

The Appendix has become in many particulars more copious than even the body of this History; and, in some instances, I have

repeated in it, from better authority than my own, some of the more important facts; because, as I was desirous to give effectual information, so I was solicitous that as little as possible should rest on my unsupported assertion.

WILLOW GROVE, NEAR EDINBURGH,
1st September 1826.

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LETTER JAMES FERGUSON of Crosshills, Esq. addressed to ANDREW STEELE, Esq. Edinburgh, and dated 15th June 1803.

DEAR SIR,

I HAVE had much pleasure and instruction from the perusal of your Manuscript Natural History of Moss-Soils, put into my hands, as Convener of a Committee of the Directors of the Highland Society of Scotland. From what I have before read upon the subject, I cannot doubt that your Work is much a desideratum, and is the best of which the British Farmers are yet possessed relative to this extensive portion of the surface of our Country. I am, &c.

HISTORY

OF

PEAT-MOSS, &c.

THE NATURAL HISTORY OF PEAT-MOSS, ILLUSTRATIVE OF ITS QUALITIES AS AN OBJECT OF AGRICULTURE.

BEFORE entering into any investigation of the methods of culture, it is proper I should explain what I mean by a Peat-moss, sometimes called a Turf-bog, but generally in Scotland denominated a Moss or Flow-moss.

As few men of knowledge who have considered the subject, doubt that a peat-moss is almost entirely a mass of decayed vegetables; therefore, any arguments to prove this seem altogether unneces-

sary. Mosses often occupy and fill up the deep hollows in the earth, and are always moist, and in many cases semifluid, and unpassable by man or beast. Although the medium depth of peat-mosses in Scotland has been found, in some instances, to be no less than forty-five feet, yet, in general, it seldom exceeds twelve or fifteen feet. Beneath some mosses there is frequently a good soil, where trees have once grown: Furrows also of land once ploughed have been discovered, and sometimes traces have been found of the habitations of men. The ground at the bottom of Blair-Drummond or Kincardine great Moss, in Perthshire, extending several miles, is well known to be in many places very good clay soil, which now in some parts bears excellent crops of corn, and possibly bore such before it was covered with moss. Upwards of four hundred acres of it have been cleared by floating off the peat-earth.

In a section of a peat-moss at Deans, in Linlithgowshire, of about ten or twelve feet deep, which had been perpendicularly cut for fuel, I discovered the following strata or layers of vegetable matters, these vegetables being most decayed that were at the bottom, and the rest in proportion according to

the depth of their situation in the moss. I number from the bottom upwards.

1*st*, The rush of different kinds (*Juncus*), also the sedge (*Iris*), mixed with floating fescue-grass (*Festuca fluitans*).

2*d*, Loose branches and pieces of the following kinds of wood; birch, alder, and hazel, with a vast quantity of nuts, which, upon being opened, were found quite empty. This seemed to be floated wood. In other places of the moss there are large trees broken down, some of them having their roots and stumps attached to the solid ground below.

3*d*, Different plants of the moss tribes (*Musci*), called in Scotland Fogs, particularly the *Sphagnum palustre*, *Polytrichum commune*, *Bryum hypnoides*, *Lichen rangiferinus*, &c., which were also more or less mixed with all the strata above this, and were likewise growing on the surface along with tufts of heath and coarse grasses, *Carices*, *Scirpi*, &c.

4*th*, Roots of coarse grasses and aquatic plants (mostly *Eriphorum vaginatum*), like lint or tow.

5*th*, Heaths (*Ericæ*), the floriferous parts of which seemed best preserved, mingled with *Hypna* and roots of coarse grasses and *Musci*.

The plants growing on the surface of this moss were the following: *Sphagnum palustre*, *Polytrichum commune*, *Lycopodium selago*, *Lichen rangiferinus*, with many others of the *Lichen*, *Bryum* and *Mnium* tribes of moss-plants, *Eriophora polystachion* and *vaginatum*, *Tormentilla erecta*, *Scirpus cæspitosus*, *Nardus stricta*, *Ericæ vulgaris*, *Tetralix* and *cinerea*. There were also found growing in deep moss-earth, more dry than other parts of the bog, *Salix pentandra*, *Salix malifolia*, *Betula alba*, *Pinus sylvestris*. I consider that the *Sphagnum palustre*, or green bog-moss, together with the *Bryum hypnoides*, and particularly its variety called the *Trichostomum lanuginosum*, or white woolly bog-moss, are the principal constituent parts of every peat-bog. The sphagnum grows in stagnated water, and begins almost every bog, and the bryum commences its growth when the bog is not so wet, and forms, with its varieties, generally the red peat-bog. The heath, with its accompaniment the *Hypnum cuspidatum*, grows in drier moss-grounds afterwards. The peat generated from the bryum tribe of moss-plants seem to me to continue longest in a soft and spongy state.

Moss-water is antiseptic or preservative. Captain COOK took some of it on board his ship at Terra del Fuego from necessity, and it turned out, he says, the wholesomest water he ever had, and never became corrupted, though he crossed the Line with it. This fact has suggested the making of artificial moss-water in long sea voyages, from infusions of antiseptic vegetables, viz. those containing astringency, or the tanning principle. To try this quality of moss-water, I filled a bottle with it, which I kept in my room uncorked, for seventeen months, without its acquiring any fetid smell or taste. The bottle was filled on the 23d of April 1801, and the water in it was then black and opaque, and its taste insipid. On the 17th of May 1801, this water was quite free from any bad taste or smell. It had deposited first a black, and then a brownish mud, and was much clearer than when first put aside. This water was occasionally examined, and found fresh till 28th February 1802, when it had acquired with transparency, and a bright yellow colour, somewhat of the smell of rotten wood, together with a small degree of a corresponding taste. Quicklime clarifies moss-water almost instantly. This effect may also be produced by other chemical means. But it

is incumbent on me to mention, that a bottle of pure spring-water, put aside at the same time for a comparative trial, was, at the distance of seventeen months, as pure and free of disagreeable taste and smell as it was when first taken out of the cistern. On the 17th of May 1801, being about three weeks after this spring-water was set apart, it had acquired a most fetid taste and smell, which did not wholly depart from it till about 1st December 1801, when it became vapid. The difference is, that peat-water never becomes offensive, or is subject to produce or harbour any living creatures. Water of itself is a pure mineral, without taste or smell. The moss-water holding vegetable matter in solution, is preserved by its antiseptic quality; but spring-water, when at rest, permits the vegetable and animal matters in it to rot and become offensive. I have, however, found on trial, that the water of a certain very deep pump-well never became fetid, after being kept for years. It was, I presume, free of animal and vegetable impregnations.

Sir JOHN PRINGLE found, that an infusion of Virginian snake-root or of camomile flowers, from the antiseptic nature of them, was twelve times more strongly preservative than their weight of common

sea-salt; and no doubt, many of the vegetables found in mosses have a soluble juice nearly as antiseptic as those.

Heath in particular, which grows so abundantly on mosses, as to be considered by some their peculiar production, has been found to contain a great proportion of the tanning principle. In the Transactions of the Dublin Society (vol. i. 1800), there is a statement of THOMAS RANKINE of Ballaghey, in the county of Londonderry, Esq., having produced to that Society cow-hides tanned with heath alone; the juices of which he declared were extracted by fire (most probably by infusion in warm water), and it is said, that the leather so prepared was found to be durable, firm and solid. Also there is in the Transactions of the Royal Society of Berlin, an account of more than sixty moss and aquatic plants fit for tanning. Among these the tormentilla is perhaps the strongest tan, and is used as such in the Highlands of Scotland. Among the Lichens, KIRWAN says, that the *Lichen arboreus* is employed for the common purposes of tanning in Germany. But tanin is unfriendly, even destructive, to the growth of land vegetables. The powder of oak-bark destroys green pasture.

Vegetable substances likewise, as well as animal, are preserved by the tanning principle. Fishermen find, that, by tanning their nets, they are long preserved from decay.

The process of steeping lint can never be well accomplished in water very strongly impregnated with peat. Where the water is only faintly tinctured with the peat, the parenchymatous substance of the lint requires about double the length of time to be decomposed, that it takes in ponds of ordinary water. It is a fact perhaps not easily accounted for, that lint put into a pool of moss-water, where lint had been laid before, is sooner prepared than that which had been first steeped there. Perhaps the lint first steeped had deprived the water of part of its tanin.

The great number of extraneous animal and other substances found in mosses in a wonderful state of preservation, is known to every one: and it is remarkable, that the skins of all the animal bodies that have been discovered in mosses were tanned and tough.

In the Philosophical Transactions of the Royal Society of London, vol. xxii., there is an account of the body of a man found in a peat-moss, with

his skin tanned by the moss-water, and his shape apparently entire, though his flesh and bones were consumed and gone: He was lying at full length, with his head on his arm, as if in a posture of sleep.

In a peat-moss in Lincolnshire, in June 1747, the body of a woman was found six feet deep, her hair and nails unaltered, her skin tanned, soft, strong, and pliable. From the antique sandals on her feet, she appeared to some to have been a Roman lady, or one of their æra in Britain. The body must have lain there many hundred years. One of her hands, and one of her sandals, were sent to the Royal Society by Mr Stovin. Phil. Trans. an. 1747, vol. xlxiv. p. 571.

There is also recorded in the Phil. Trans. in 1734, vol. xxxviii. No. 434., an account by Dr BALGUY to the Royal Society, of the bodies of a man and woman found in a peat-moss in Derbyshire. They had been lost on a peat-moss in a great fall of snow, 14th January 1674, and when found, were buried on the spot by order of the Coroner. The man's name was BARBER; he had been a considerable grazier, but being reduced in his circumstances, was then going off with his servant-maid for Ireland. They lay where they were buried,

in the peat-moss, twenty-eight years and nine months, when some persons opening the ground, found them no way altered, and the flesh soft, as that of persons newly dead. They were after this occasionally exposed to sight in the moss for twenty years, and Dr BOURN, who saw them in 1716, reported that the man was entire; his beard was strong, and about a quarter of an inch long, his skin firm, and of a tanned leather colour. He had on a broad cloth coat, which the Doctor tried to tear a piece off, but could not. The man's grandson having at length procured interment for them in Hope Church, Mr WERMALD, the minister of the parish was present when they were removed, and reports that they had lain about a yard deep in moist moss soil, where no water stood. He saw their stockings drawn off, and the man's legs, which had never been uncovered before, were quite fair; the flesh, when pressed with his finger, pitted a little, and the joints played freely, and without the least stiffness. What was left of their clothes (for the greater part had been cut off and carried away as matters of curiosity) was firm and good: and the woman had on a gown of serge, which seemed not worse than new. Some time after their burial in

the church, their grave was looked into, and it was found they were entirely consumed.

In Slamannan Moss, in Stirlingshire, some years ago, the body of a man sitting on horseback, it is reported, was found apparently entire, with the skins of both man and horse tanned. That he had lain there for centuries, it is alleged, was obvious from the fashion of the armour which he had on, and of his spurs.

About five years ago, a butter-kit was found, filled with butter, in the bottom of Cormaskae Moss, in Perthshire. Mr JAMES MACINTOSH saw the butter, which he described to me as white, tasteless, and very hard, but inflammable. It was evident it had lain in the moss very long, from this, that the kit was made of bark of trees, which has not been the fashion for such articles in the Highlands of Scotland for a century past at least.

The heads of the wild breed of black cattle, well known formerly in this country by the name of the Bugle, have been dug out of several mosses in high preservation. In Ireland, the horns and other remains of a gigantic species of deer, now extinct in the British Isles, have been found at the bottom of peat-bogs, many feet deep, Phil. Trans., vol. xxvii. A nearly perfect and magnificent specimen of this

fossil deer, named by some the Irish Elk, is preserved in the Royal Museum of the University of Edinburgh.

Mr ARTHUR YOUNG, in his Irish Tour, states as follows: "Mr ROWLEY keeps a very considerable domain in his own hands. Adjoining to it is a black turf-bog, of admirable use for firing. I viewed it attentively, and am clear that all such bogs as this, with a fall from them for draining, might very easily be improved into excellent meadow. The surface is covered with heath about a foot high, and under that, eight or nine feet deep, of puffy stuff, which, when burnt, yields no ashes; then the bog-turf, ten feet deep, cuts like butter, and under that a marly limestone gravel. They have found, at fourteen feet deep, evident marks of the plough in the soil at bottom, also remains of cabins, cribs for cattle, moose's horns, oaks, yews, and fir, being good red deal."

All wood, and almost all vegetables of every sort, contain more or less of the tanning principle. By this, as well as by a few other energetic principles, animal and vegetable matters are preserved long beyond their natural period from decay. Oak-bark, used by tanners, possesses in an eminent degree this preserving principle, which seems to operate so

considerably in peat-moss. The barks also of birch, willow, mountain-ash, alder, and other trees beside oak, generally found in mosses, are sometimes used as a substitute for oak in tanning leather: and peat-moss being an accumulation of a variety of vegetable matters, no doubt changed in some degree in their nature, but perhaps preserved by the stagnated water which has imbibed this principle from them, continues to receive, by infusion, fresh supplies of tanning matter from these vegetables themselves, and from others that grow on the surface of the bog, and are continually increasing the heap. I have essayed to make artificial moss-water, and I think I succeeded in making such, as neither chemically, nor in any other respect, could be easily discerned from real moss-water.

Dr PLOTT, in his Natural History of Staffordshire, mentions, that a parcel of coins of Edward IV. were discovered in a peat-moss eighteen feet deep, which, supposing them to have been dropt on the surface in that reign, led him, by the latest date of the coins, to the arithmetical conclusion, that the moss must have risen or grown upwards of an inch every year.

The growth of mosses is occasioned by the con-

tinual accession of fresh vegetables growing over those that have decayed.

By some the growth of peat has been thought to be the operation of ages, but those who are intimately acquainted with botanic researches, know well, that the tribe of cryptogamous plants grow in general with extraordinary rapidity. Most of the moss-plants grow in this climate vigorously during almost the whole period of winter, and also during the summer season, being only checked by the severe droughts in summer, or by the excessive frosts in winter. I have myself observed the *Sphagnum* grow four feet in a year, springing from the bottom, and covering the surface of stagnated water of that depth. The *Hypnum fluitans*, which also grows in water, and floats on its surface, has been known to grow two or three feet in length in a season, and to form a stratum of peat in twenty years. Mr LIGHTFOOT, in his Flora Scotica, says, that the *Polytrichum commune* grows sometimes annually a yard in length, which, with the other musci that flourish in bogs or marshes, he adds, by continual increase and decay, soon fill up, and convert them into peat-bogs, which afterwards become fertile pastures, or the source of inexhaustible fuel to the polar regions.

That celebrated naturalist LINNÆUS, in his *Amœnitates Academicæ*, observes, "that on the margins of pools grow these moss plants, viz. *Sphagnum palustre*, *Mnium triquetrum*, *Bryum paludosum*, *æstivum*, and *squarrosum*, *Hypnum aduncum*, *Scorpioides*, *riparium cuspidatum*, &c.; and principally by the growth of the *Sphagnum palustre* and *Mnium cuspidatum*, the whole pool is, by degrees, converted into a peat-moss, which, at length, by nature or art, becomes a most fruitful meadow." Now, it may be farther remarked, that, although the musci do often very quickly fill up wet valleys in this climate, and convert them into peat-bogs, yet it must be obvious that a wood, decaying all at once, from the stagnation of water, or other causes, may, with the assistance of the musci, and the gramineous and other plants that are natives of wet soils, form a considerable depth of peat in a very few years. The roots of the *Eriophorum vaginatum* also, mixed with *Scirpus cæspitosus*, *Schœnus albus*, *Carex pulicans*, and *limosa*, form very quickly entire strata of peat. By replacing the surface turf of a moss cut for fuel, I am informed a peat-moss near Cupar-Angus grew again, so as to admit of being cut for fuel twice in fifty years.

I have also observed the *Conferva bullosa*, and others of the algæ tribe, cover the surface of deep stagnated water an inch or two in thickness, in appearance like a green scum, in the course of a very few weeks in summer; while shallow pools, in the same time, having the addition of musci growing from the bottom, are entirely filled up with vegetable matter; and the colour of the water is then dark, and the taste of it somewhat styptic; and, on trial, I have found that the water in which *Confervæ* grow, becomes black when iron is put into it, thereby denoting the presence, probably, of tan and gallic acid, which, in such a situation, might preserve vegetables from rottenness. Also the *Ranunculus fluviatilis* assists to cover, very rapidly, the whole surface of large stagnant lakes, and to convert them into peat-mosses. Boats have indeed been frequently found buried deep beneath the turf in extensive mosses.

A very curious instance of the growth of an extensive moss, viz. Cree, in the south of Scotland, was reported in 1785, as follows:—About nineteen years before, a gentleman, who lives near one side of it, could, from a certain window of his house, observe the door of a cottage which was built on the

opposite side of the moss; whereas then, from the same place, he could scarcely see the top of its chimney.

Trees found in mosses are not properly to be considered as extraneous substances, but as constituent, and, in many places, no doubt, primitive component parts of the moss. It is curious to remark, that the Scotch firs, in particular, found in mosses (trees of which species, *Pinus sylvestris*, being sometimes discovered there, upwards of 100 feet long), have lost their transverse adhesion, while the longitudinal fibres are so tough as to be capable of being made into ropes. I am informed that these ropes are so common in the Highlands of Scotland, and in Ireland, as to be even usually sold. Pieces also of such fir trees were, within these thirty or forty years, made use of universally as the common candles of the Athole Highlanders, and are still used in that part of the county of Forfar situated among the Grampian mountains, and other places of the Highlands of Scotland.

The barks of the birch and alder, being that part of them that contains most of the tanning principle, are generally found very entire in mosses, whilst their wood, nevertheless, is frequently seen much

decomposed. But the wood of the oak is commonly black, and in a state of great solidity and strength.

On draining Hatfield level, in Yorkshire, upwards of a century ago, oaks were found in excellent preservation, which then sold in general at L. 10 or L. 15 a-tree. One large oak was found there, 120 feet in length, 12 feet in diameter at one end, and six at the other, and ten in the middle, for which L. 20 were offered. These trees were hard and black as ebony. Oaks possess in themselves the tanning principle, in a higher degree than most other vegetables; and therefore it is not much to be wondered at that they should be thus surprisingly preserved in mosses. Nor is it difficult to account for oaks being always of a black colour, when so preserved, if we reflect that iron is to be found in almost every substance in nature, and which, when liquefied and mixed with either the tanning matter or the gallic acid of the oak, forms ink. Moss water is also blackish, which probably arises from a similar cause, or partly from that cause, and partly from a tinge of the carbon or coal of the decayed vegetables. And here it may be proper to observe, that water, or some liquid sub-

stance, must always be the menstruum or agent which performs the operation. Without stagnated water, no moss, I apprehend, could be formed originally; and, without water, the moss would soon cease to exist.

It has indeed been alleged, by some speculators, that water alone is of itself sufficient to account for the preservation of the vegetables in peat-moss, in the manner they presently appear. But, granting water had that power, it does not seem reasonable to allege that it is capable of preserving animal and other substances in the situation that has been just now stated.

As the removal of the means of the origin and increase of any natural production is apparently the effectual way of destroying it; so the original cause of vegetables, in a half decayed state, being accumulated in mosses, appears a subject worthy of careful investigation: For the great question concerning mosses to an agriculturist is, How may this huge mass of half decayed vegetables be reduced, at the least expence, to a state of complete decay? How may it be made what other masses of vegetables can easily be rendered, a dunghil for poor lands, or where it lies, of itself, an inexhaustible fertile soil?

Though no moss can originally have been formed without a stagnation of water, yet too much fluid seems as unfavourable to the formation of peat as too little. No moss, as is evident from all that has been seen, can exist without a constant but small supply of water, and a stagnation, or very slow drainage, of the superfluous moisture. It also appears, that the tendency to putrefaction occasioned by a warm climate is what no vegetables in any situation can resist. Hence there are no peat-mosses, or very few, in the regions within the tropics. Were there no sufficiency of stagnant fluid to keep the wood and vegetable bodies of which the moss is composed, always moist; were these materials exposed to the vicissitudes of being wet and dry, cold and hot, and to the free access of the air, instead of forming into mosses, and accumulating, they would, like all other sublunary things, even not excepting the hardest siliceous stones and granite rocks, fall into decay. Were even the action of a constant stream of water applied to them, that fluid, of itself, would probably decompose them, by first exhausting all their soluble juices, after which the fibres themselves would be rotted; or their substance would be reduced to mud.

But even mosses are valuable as fuel in countries where there are no trees nor pit-coal near at hand. PLINY informs us, that the people of Bremen (Cauchi), in his day, for want of wood used peat, which he calls *Lutum*, for dressing their victuals; and TORFÆUS tells us that the Danes, during their sovereignty of Shetland, introduced turf as a fuel there. "The people of Holland (says ANTHONY VON WOLTER), may thank GOD that they have so many peat-mosses, which are worth mines of gold to them."

My theory of the formation of true peat is simply this, That peat-bogs must have been, in general, originally stagnant pools of water, which, in most cases, if left undisturbed, will be gradually filled up with vegetable matter. Many deep mosses float on the surface of water. The smallest stagnation or even detention of water may be the origin of moss. Moisture and cold I assume to be always essential to the formation of peat, wherever it is generated. Also that sort of peat called *Bent-moss* is so formed on the declivities of bleak mountains. Moss plants (musci), the production of cold and moist situations, are generally, if not always, the principal constituent parts of peat. Fallen wood I conceive

to be favourable, but not absolutely requisite for the acervation of the peaty substance in bogs, because I have seen mosses in which no trees could be discerned. Some peat-bogs, indeed, are situated in an elevation and climate where no trees could grow.

The generality of mosses, situated on extensive plains in this country, have very probably taken their origin from overthrown woods, and from the consequent stagnation of water arising from the trees overspreading the ground, and stopping the passages of the water along the surface of the soil.

It is observed of many such mosses, that the trees found in them have an uniform direction to the north-east, probably because the strongest winds on this island blow from the south-west.

One striking instance of this sort is given in Mr MAXWELL'S Statistical Account of the parish of Kilbarchan in Renfrewshire. He there describes a moss, consisting of 500 acres, from seven to nine feet deep, the bed of which is a white clay, where formerly a forest has stood. The oak is found perfectly fresh, but the other kinds of wood are rotten. The stumps, in general, are standing in their original position; and the trees are broken over at the height of three feet, and are lying from south-west to north-east; so, wherever one sees a stump, a tree

is sure to be seen to the north-east. Mr MAXWELL adds, the Romans produced many mosses, by cutting down the woods, to which our ancestors fled for shelter. Other mosses have doubtless been produced from woods, that have decayed by the stagnation of water, or otherwise, or that, having been burnt, were afterwards overthrown by the wind. He alleges, moreover, that the moss described by him is not very ancient; and in which opinion he supports himself, by the places around the moss being still denominated by the Saxon name of *Wood*. He might have added, that a great proportion of the mosses and mossy farms in the Lowlands of Scotland retain the name of woods, though there does not now exist a growing tree in their vicinity.

There is an account of the formation of a peat-moss recorded in the Phil. Trans. vol. xxvii. It is given by the Earl of Cromarty, and deserves to be here repeated in his own words:

"In 1651 (says he) I went by a very high hill in the parish of Lochbroom, which rose in a constant steepness from the sea: only about half a mile up, there is a plain of about a half mile round, and from thence the hill rises as before for more than a mile in ascent. This little plain was at that time all

covered over with a firm standing wood, which was so very old that not only the trees had no green leaves, but the bark was totally thrown off, which the old country men told me was the universal manner in which fir woods did terminate, and that, in twenty or thirty years after, the trees would ordinarily cast themselves up by the root, and that they would lie in heaps till the people would cut them and carry them away. They likewise shewed me that the outside of those standing trees, for the space of an inch inward, was dead white timber, but what was within that was good solid timber, even to the very pith, and as full of rosin as it could stand in the wood. About fifteen years after, I came the same way, and saw not so much as a tree, or appearance of the root of any; but, in the place thereof, the whole bounds where the wood had stood was all over a plain green ground, covered with a plain green moss. I asked the country people who were with me what became of the wood, and who carried it away. They told me that nobody was at the pains to carry it away, but that, it being all overturned from the root by the wind, the trees did lie so thick and swarving over one another, that the green moss, there called fog, had overgrown the

whole timber, which they said was occasioned by the moisture that came down from the high hills which were above it, and stagnated on the plain. They said none could pass over, because the scurf of the fog would not support them. I would needs try it; and, accordingly, I fell into the arm-pits, but was immediately pulled out by them. Before the year 1699, that whole piece of ground was turned into a common moss, where the country people are digging turf and peat. The peats were still soft and spongy, but are always growing better and better, and I am informed it now yields good peat."

That peat-moss is sometimes found buried under a great depth of earth, does not seem to be contrary to the doctrine that it was all at first formed on the surface of the ground. Such revolutions of the globe as placed sea-shells, and masses of limestone composed of them, on the elevation of mountains, are not requisite to account for this. A running stream, or copious spring of water, may either undermine a moss, and carry it off several miles, similar to the case of Solway-Moss in 1771, or these, and many other causes, may deposit mud and sand upon it, and thus bury it many feet deep. Besides, moss or peat may, by decomposition from the ordinary causes

above referred to, be frequently resolved into rich mould, the vegetables growing and decaying on which will increase and meliorate the mass.

If water, then, is necessary for the formation of a peat-moss, whether it follows as a matter of course, or not, that, without it, the materials of which a moss is composed, must fall into a state of decay; this at least is obvious, that little or no fresh accumulation can take place, when one of the constituent causes is removed. Hence an important deduction arises, that a moss, if drained, will probably in time be covered with a more productive soil, whether the body of the moss becomes so or not: For it is a well known fact in the history of the earth, that there is no other level unprolific ground besides an increasing or living peat-moss, but what acquires a soil fit for plants to grow upon, that are useful for cattle, except alone the burning sands of the intertropical regions of the earth: — the one rendered useless principally from too much water; the other from too little of that element. It is surprising how soon a deserted channel of a river, or even an unused causeway, or pavement, obtains a soil, and verdure, and suitable plants.

Some persons have taken notice of a noctilucous

quality in some peat-bogs; which quality of shining in the dark is common to it, with moist decayed wood in a certain period of its decomposition. Sir HANS SLOANE says, on microscopic observation, he found this quality is derived from small, half-transparent, whitish, live worms; probably of the glow-worm kind. It has been commonly ascribed to slow combustion, such as phosphorus exhibits. Others speak of what they call Bog-tallow, as a curious natural production of mosses: but this last phenomenon is explained to be mossified rosin, and it is said to be found only in mosses that abound with fallen fir-trees.

The mineral oils called naphtha and petroleum, with other bitumens, are also found in most mosses. These shew the same chemical principles as vegetable matters, and are supposed to originate from the slow decomposition of plants; and the oily substance obtained from peat by distillation is of the same nature and appearance. They are found floating on waters exuding from crevices, or forming strata of the earth. Common pit-coal is reckoned by some among these bituminous substances.

As to naphtha, so very commonly seen oozing out of mosses, I found it generated in artificial moss-water; and KEMPFER, in his "Amœnitates

Exoticæ," mentions, that this thin, light coloured oil is collected in such great quantities in several places in Persia, that it is there much used for giving light in lamps furnished with wicks. There are many pools of water, where the vapour of naphtha floating on their surface will take fire at the approach of a lighted candle. FOURCROY describes a noted fountain of this kind, at Chittagong, in the East Indies, which bursts out into flame of its own accord; and he takes notice, that the credulous inhabitants of the country have consecrated the spot to a favourite deity, and appointed a set of priests to watch over the waters of the fountain. He also supposes, that petroleum, which is an oil somewhat thicker in consistence than naphtha, and of a dark-brown colour, enters into the composition of wild-fire. Nor does it seem improbable that the noctilucous appearance of some peat-earths may frequently mislead travellers in the dark. Almost all the mineral substances found in other soils have been found in some peat-mosses. In those that abound with sulphur and iron especially, spontaneous fires sometimes occur that burn for months together.

It does not indispensably fall under the present subject (and the narrative would be rendered by it too diffuse) to consider all the different materials,

trees and plants, of which mosses are sometimes composed. Neither does the chemical analysis of peat-moss, which has been repeatedly detailed in many printed treatises, and does not differ materially from that of other decayed vegetable substances, necessarily require discussion here, except in as far as it may be supposed to throw some light on the means to be adopted for converting it into valuable vegetable earth, or into manure for other grounds.

But, unfortunately, chemistry does not throw so much light on the matter as might have been expected, from this inquisitive science. It has hitherto given little or no new information to serve improvers of mosses as a soil, who must be guided by experiments and practice; for it is not given to man to know the first principles either in chemistry or agriculture. From the results of a variety of minute chemical trials of the nature of peat-moss, they appear exceedingly indecisive, and contradictory in many points; probably, in some cases, arising from variations in the modes of analysis pursued by the inquirers, through which the combinations of the subject are destroyed or altered, and new and different substances formed; but perhaps, in most cases, arising from accidental mineral substances imbibed by the moss; unless it can be presumed that differ-

ent mosses have in their growth acquired different chemical qualities.

Lord DUNDONALD alleges, that peat contains oxalic and phosphoric acids; and the Reverend Mr HEADRICK says, some peat contains a little of the sulphuric acid, neutralized in some cases with lime, and so forming gypsum. Other chemists assert, that they found in peat the suberic, and various other acids, and alkalies, in small quantities, and also tanin and gallic acid.

Indeed, although others have ascertained that some peat hath somewhat of acidity, yet, generally, it must contain very little; for I could never discover any free acid in peat-earth. Neither a decoction of it, nor the most concentrated moss-water of different mosses, had any effect, on my trial of them, in changing any vegetable blue colours to red. But if the presence of an acid were necessary for the existence of a peat-bog (as some think), it would seem surprising that there should be very frequently found in mosses strata of lime and marls, substances that would soon neutralize any unsaturated acid in that moist or semifluid body:—which fact may perhaps tend to puzzle those agriculturists who imagine lime, or such calcareous manure, essential for neutralizing the acids, and converting peat-soils of every

kind into arable grounds. Moss-water, though rather insipid in taste, has a slight degree of astringency, and I found that the moss-water which I examined, though it had no free acid, held a little of tanin in solution.

Mr JAMESON, Professor of Natural History in the University of Edinburgh, on the chemical principles of peat, observes, that "Peat is a vegetable substance, which has undergone in part, and is still undergoing, changes; and many facts lead me to conclude, that common peat is the vegetable matter deprived of a considerable part of its hydrogen."

Nothing, I think, has been made out from chemistry which shows that peat is much dissimilar from vegetable substances in a particular progress of decomposition or alteration, somewhat different from ordinary decay: and as the cellular substance of most vegetables found in peat-mosses is most decayed, its upper strata may be fitly likened to a mass of lint or tow, that has been long steeped in water.

Dr HOME, in his Principles of Agriculture, says, "Some peat, burnt in the open fire, gave me about the two-and-thirtieth part of alkaline salt" (potash): and he concludes, "Hence we see that peat affords

the same principles as other vegetables do, and therefore must be classed among them."

But Mr HEADRICK, in his Essay on this subject, printed in the Communications to the Board of Agriculture in 1800, says, that, by trial, he found *no* potash in the ashes of the peat-earth which he had scrutinized.

I must here remark, that I examined the ashes of some peat, formed obviously of heath and musci, cut out several feet beneath the surface of a bog, and I found there was potash in them, though extremely small in quantity. It is, however, certain that other peat-earths contain much of that substance. But whether potash is an important part of peat-ashes, when used as a manure, does not appear from chemistry; for we must probably remain for ever ignorant of what is the food of plants: but it shall be shown afterwards, that, practically, most peat-ashes, and especially the ashes of peat situate very deep in some bogs, which theoretically should contain least alkaline salts, are found to be a most excellent manure, and very quick in its operation. Hence the use of paring and burning the surface of a peat-bog as one of the incipient agricultural improvements of it: by this means, any acid

quality that may be in the soil is perhaps neutralized.

I regret that chemistry has done so little for agriculture; and Dr CULLEN, in his "Materia Medica," remarks also, "That chemical analyses hardly throw any light upon the medicinal virtues of the substances treated in that manner."

In general, from the analyses of peat, by a vast number of different chemists, it appears that its component parts, like those of all vegetables, are reducible by heat to airs or gases, and a trifling quantity of the primitive earths, alumina, silica, lime, &c.; and it seems, in some circumstances of its general nature, to be not unlike coal. Indeed, firm peat is very easily charred by smothered combustion, even in an ordinary chimney-grate, as is generally done in Holland, where its charcoal is commonly used in winter for burning in small pots, for the purpose of keeping the feet warm. We are informed by Mr HEADRICK, that some of the Scotch Highlanders convert large quantities of black peat into charcoal, which the smiths use in their forges: and he thinks this species of fuel is better adapted for the reduction of metal, and the making of bar-iron, than even charcoal of wood. The "Stutgard

Physico-economical Essays, 1763," state also, that turf-charcoal burns more clearly, and gives a more equal and constant heat, than wood-charcoal, and that the heat by it can be raised to the greatest possible pitch of fervency; and bar-iron is sometimes made by means of peat-fuel, in certain districts in Germany and in France.

From what has been stated, it is apprehended that no doubt will remain of the vegetable nature and origin of peat-moss. Its being retained in a state of preservation by the want of heat and air, which, along with water, are necessary to the decomposition of vegetables, or by the tanning principle, or by any other principle inherent in itself, and common to the nature of wood and vegetables, together with the operation of moisture attended with cold, does not naturally suggest that it should be so altered as to resist the effect of the putrefactive process, when these causes cease to operate.

We see that all animals and vegetables are formed to live here only till they have time to perform certain natural functions, and to continue their species. From the insect that lives but for a day, and the plant that flowers but for a few hours, to the elephant that lives 400 years, and the oak that

flourishes 600; all must have their chemical affinities, by which they are held in life, dissolved, that they may be so changed into other substances, as to afford food for succeeding generations.

It has been common, through most parts of Scotland, to mix peat-earth with stable-dung, and that, when separated from the general mass, it is thereby fermented and putrefied, is obvious from this, that the peat-turf thus loses its fibrous adhesion, is easily crumbled into dust, and, as I have found from trial, loses a great part of its principle of inflammability.

Peat designed for a compost with dung, should neither be too wet nor too dry, as either of these qualities is unfavourable to the putrefactive process. It should therefore be dug, and deposited in a heap, on dry ground, for some months before it is needed. The common method of making the compost, is to throw alternately a stratum or layer of about six or eight inches thick of this peat-earth, between a layer of about the same thickness, or more, of fresh stable-dung, taking care not to compress this dunghil much, and covering the whole thinly over with peat-earth. Otherwise, the peat-turf, well chopped, and to the extent of a third, or a half, of

the heap, and carefully mixed with fresh dung of any sort, makes an excellent compost. I have examined dunghils of this sort, and found the peat-turf in them well rotted.

It is proper to be observed, that the fomenting heat of such compost-dunghils should, perhaps, never be allowed to exceed 55° of Fahrenheit's thermometer, because, otherwise, the mass is apt to be too much dried and wasted. This heat is sufficient for rotting every organized matter; and when a dunghil exceeds it, it should be turned over.

Peat-turf, also, when mixed into a compost with hot lime, called sometimes lime-shells, seems to fall into nearly the same state as when fermented with stable-dung; and composts of both these sorts are used by farmers as excellent manures to their cultivated fields. More, however, on the subject of compost-dunghils containing a proportion of peat-turf, will be found in the Appendix.

Peat-earth alone, and particularly that which lies near the bottom of a peat-bog, and which is more easily pulverized than what is nearer the surface, is sometimes made use of successfully as a manure for opening strong clays,—for rendering sandy and gravelly grounds more retentive of moisture,—or for

deepening any thin soils that are not of a mossy nature.

In the late Agricultural Survey of the county of Perth, by Dr ROBERTSON, he observes, that peat-moss, which has been hitherto little tried as a manure, has a better effect than most people are aware of. The tenants in the vicinity of Auchtertyre, he adds, cart it off to a considerable distance, to be spread upon their leys; and one of them showed him some dry, rising ground, which had been laid over with peat-earth, where the grass was as thick and verdant, in the month of November, as in any of the adjacent fields which had been dressed with marl. He farther observes, that, upon light land, where there is a great proportion of sand or gravel, the moss retains the rains and the dews, which that kind of soil could not naturally do; and by this supply of moisture, the peat-earth preserves such a porous soil from the effects of severe drought; and, even after the peat-earth is ploughed into such soil, it not only acts as a sponge, but forms an addition to the staple of the land, not to be disregarded.

The late Mr KING of Drums, in the county of Renfrew, laid out, in two successive seasons, about L. 500 in carting moss-earth from a bottom, and

spreading it upon dry uplands; which, from this addition, ever since that operation, and particularly in this year (1803), have been greatly improved in the earliness and richness of the pasture. The fact is well known to the whole neighbourhood.

It is also worthy of remark, that others of the Agricultural Reports for Scotland, England, and Ireland, recommend peat-earth as a manure; and particularly Mr DUBOURDIEU, in his Survey of the county of Down, notes it as an excellent manure for gravelly soils, and also for counteracting the too dense nature of clay-grounds.

Indeed, from actual experiment and observation, I have satisfied myself, that the most of peat-earths, when freed from their superfluous moisture, and properly pulverized, are of themselves able to produce, and bring to perfection, almost every kind of plant. But more hereafter shall be remarked on this subject.

Having thus far inquired what peat-moss is, let us next consider what methods have been taken, and ought to be taken, for improving peat-bog soils: and viewing the immense deserts, and the many hundreds of thousands of acres of this sort, that re-

main a blot upon the beauty, and a derision to the agriculture of the British Isles, Who will say that the inquiry is not of importance? Before proceeding farther, however, I must define more particularly what I here mean by a Peat-bog. It is not such a soil as is mixed with earth of any kind, or where the earth can be turned up along with the peat-surface by the plough. Neither is it an effete moss, or what has been once a moss, but now bears good crops of grass. A true peat-bog, or flow-moss, in its natural state (the means of improvement of which it is the principal object of this Essay to detail), is a tract of ground generally almost level, often many miles in circumference, consisting of a soft, light, fibrous substance, of several feet deep, so inflammable as to be a common fuel; easily cut with the spade; and when so cut, and exposed to the air, changing, in a few minutes, from a dusky yellow to a blackish colour. The surface of a peat-bog is brown or dark in its appearance; even in the midst of summer, always wet and spongy, commonly covered with heath, coarse grass, and musci, in detached and elevated patches; the intermediate and wetter places bearing no vegetable production, but (except in a drought in summer, or when frozen)

being a soft, black or brown, moist mud, unfit to support the weight of a man.

The only animals found on these grounds are a few grouse, lizards, and serpents.

The most obvious defects of a moss-soil in its unimproved state, in an agricultural point of view, are, that it is too soft and spongy. It imbibes too much water, that it does not transmit it to the earth below, yet it remains always too wet; except when exsiccated by the droughts of summer, it is frequently so parched near the surface as not to supply moisture or nourishment of any sort fit to support cultivated vegetables.

That a peat-soil thus defined, or even when in a more wet situation, it is found almost entirely covered with plants of the moss or musci tribe, is capable of being converted into excellent arable and pasture land, is well known from the actual result of experience in many cases: but the cheapest and easiest means of this conversion form a most important subject of investigation.

> Turn to the Arts, the useful pleasing arts
> Of Cultivation; and those fields improve
> Your erring fathers have so long despised.
> Leave not to ignorance and low-bred hinds
> That noblest science, which in ancient time
> The minds of sages and of kings employed.
>
> DODSLEY.

ON THE DRAINING OF MOSSES.

DRAINAGE is the first object of importance to be attended to, before any thing can be done towards reclaiming a peat-moss. This alone will gradually alter the nature of any wet soil, and make it produce different plants, more pleasant and more nutritive to cattle than those that heretofore occupied its surface. There are very few mosses where sufficient declivity cannot be had for draining them. If not, and if there is no hope of accomplishing their drainage by perforating through a retentive to a pervious substratum, as recommended by Mr ELKINGTON, and very ably described by Mr JOHNSTONE,—or as has been practised in Germany, for draining peat-mosses, and other wet grounds, long ago,—it will be obvious they can never be improved into arable fields. They are, however, not without their use, as they are not only serviceable for manuring other lands, but also valuable as fuel.

And here it may be remarked, by-the-bye, with regard to the care of such mosses as are intended to be preserved for fuel, that the above mentioned

EARL of CROMARTY, in his account of peat-mosses, observed, that if the pits dug for fuel are not cut down to the solid ground at the bottom, and if stagnated water remain in them, the moss will quickly grow up again. And he advised his tenants not to dig to the bottom, that they might reserve a perpetual supply of fuel from their most commodious mosses; and he says his method was followed with success. He adds, that Sir ROBERT ADAIR told him, that even though cut to the bare ground, yet if the turf cut off from the surface were preserved, and replaced over the ground, the moss would grow again. Indeed, a careful observer will perceive, that any pits that contain moss-water, though three or four feet deep, are very quickly filled up with the musci. Nor does any cause of alarm arise to the improver of the surface of mosses on account of want of that necessary fuel, peat, for it appears by experience, that the decomposition of a deep moss is so slow, that those which have been covered with excellent grass for centuries, may be dug up, and used for the purposes of fuel or manure. This, I think, is proved by several of the late Agricultural Surveys, and particularly that for Berkshire; as well as by RAMAZZINI's account of Modena, where

moss-earth is described as inflammable, after having been covered with fruitful soil for ages. My own experience, also, has satisfied me, that peat-soil, very long cultivated, has continued inflammable. ANTHONY VON WOLTER, in his Essay on Turf, read in the Bavarian Academy of Sciences, in 1763, observes, that M. NANTILLY, in 1728, found on his own estate at Offenbach, near Frankfort-on-the-Maine, turf, *fit for fuel*, in a bog that had been covered with grass past all memory.

I have observed with attention a variety of methods followed with success for draining mosses. They have been generally adapted to the situation and circumstances of the ground: and good sense and care, with the aid of scientific men, or the assistance of the publications of enlightened writers on the general subject of draining, seem to me more necessary for obtaining the object of drainage than any particular directions. Indeed, it is justly remarked by Mr JOHNSTONE, in his account of Mr ELKINGTON'S method of draining bogs, that "it is hardly possible to explain it by words or writing, owing to the great variety of bogs, and the great diversities of countries in which they are situated."

Hollow or covered drains, however, of any sort,

are not, in my humble opinion, adapted for the soft substance of peat-moss, and in my own practice I have seldom used them. Nevertheless, if, in any case such drains are deemed proper, I would recommend as the best, those that are filled with brushwood and heath, as taken notice of in the Agricultural Report of Ayrshire, by Colonel FULLARTON: for wood is almost perennial in moss-grounds.

In the Survey of Lancashire, by Mr HOLT, he gives an account of different sorts of covered drains made by Mr WILKINSON and others, in their extensive moss improvements in that country. One sort is described as follows: "A piece of peat, the usual size and dimensions of common turf, has been made use of, after piercing the turf with a kind of punch when wet, by which a hole is left of about three inches square, a little arched at the top, and which are placed, after being hardened in the air, side by side." For this the Agricultural Society of Manchester rewarded the inventor with a premium. Common bricks also, with thin slates at the bottom of the drains, he says, have likewise been used. He adds, "The fens or moss-lands thus drained, have acquired solidity, and become fertile meadow and corn-lands; and in consequence of the drain-

age, have sunk sometimes four feet and a half lower; and Waston Moss, and Mr WILKINSON'S, are become very rich meadow and pasture land."

The generality of mosses in Scotland are drained by wide open ditches. And it is of importance to remark, that the workmen employed in digging moss-ditches should use wooden implements, on account of their lightness. If iron spades are used, they should be of a slender construction, and kept very sharp. I employed at one time a man, from the west of England, to make such ditches, and, with wooden implements, he did as much work in the same time as three men with ordinary utensils.

Captain JOHN SMITH of Swindridgemuir, Ayrshire, who, it is to be observed, dug up his moss-ground with the spade, gives the following directions for draining a peat-bog:

"The first thing to be done is, to mark off and cut proper main or master drains, in order to carry off the superfluous water, taking care to preserve the greatest possible level, which, in every case that has yet occurred, has been easily obtained, and which drains can be, and are, so constructed as to divide the field into inclosures of from six to ten Scots acres, each being one-fifth more than the Eng-

lish statute acre. If the moss hangs or declines, the inclosures may be of any dimensions whatever. In digging the drains, the workmen stand upon small boards, to prevent themselves from sinking, and move them forward as the work advances.

" The dimensions of these drains, when first made, are eight feet wide, by four and a half feet deep, declining to two and a half feet at bottom, and cost at the rate of 1s. per fall, of eighteen and a half feet running measure. The ridges are then to be marked off regularly, six or seven yards broad, formed with the spade in manner following :

" In the centre of each ridge, a space of about twenty inches is allowed to remain untouched, on each side of which a furrow is opened and turned upon the untouched space, so as completely to cover it, like what is called the feering of a gathered ridge. Thus begun, the work is continued by cutting with the spade, in width about twelve inches, and turning it over, to appearance, as if done with a plough, until you come to the division-furrow, which should be two feet wide, cut down and thrown upon the sides of the ridges.

" The depth of the division-furrow is to be regulated by circumstances, according as the moss is

wet or dry, but so as to answer the purpose of, as it were, bleeding the moss, and conducting the water to the main drains.

"It may be observed, that the success of the after crops depends very much upon a proper formation of the ridges. They must not be made too high in the middle, for there they will be too dry, like a peat upon which the lime cannot act, and near the furrows they will be too wet, which is equally prejudicial; they should therefore be constructed with a gentle declivity to the furrows, so as the rain which falls may rather filtrate through the ridge to the furrows, than run quickly off the surface.

"The operation of digging and forming the ridges has generally been done by contract, and where the surface is tolerably even or equal, it costs L. 1 : 13:4 per Scotch acre, or 2½d. per fall; but where it is in great holes, and wheel-barrows used, it costs from L. 2 to L. 2, 2s. per acre. At these rates, an ordinary workman will earn 1s. 6d., and an able and experienced workman from 2s. to 2s. 6d. per day."

ALEXANDER MARJORIBANKS of Marjoribanks, Esq. in Linlithgowshire, seems to have followed Captain SMITH's directions as to the mode of drain-

ing his extensive mosses. My observations on examining them are, that, in the circumstances of these bogs, the main drains are too shallow, and that, at any rate, they are not effectually drained, as the ditches are full of stagnated water. It occurs to me, that, if the main drains, which, if possible, should have a good declivity, and retain no stagnated water, are made deeper and more numerous, they would answer the purpose better.

Mr PITLOH, at Deans, in Linlithgowshire, seems to follow a method similar to this. His main drains in Deans-Moss, are five feet deep, and seven feet wide at the top, declining to about four inches in depth at the bottom, or the width of an ordinary ditching spade; for no extraordinary implements for digging or ditching in a moss are common in Scotland; and so far they are behind the improvers in Lancashire, who have light timber spades, and other utensils, made for the purpose of cutting the peat, and throwing it aside. Mr PITLOH pays his workmen for making these ditches, 5s. per Scotch chain of seventy-four feet in length.

In none of the mosses in Fife, particularly described afterwards, which have been drained very successfully, are there any such drains as those called

Division Furrows by Captain SMITH; but different methods have been used for draining them, according as the circumstances of the ground required.

PETER GREENHILL, Esq. of Cordon, in Perthshire, drained a small moss, by digging a pit near it, deeper than the moss soil, into a stratum of sand, and connecting the pit with the bottom of the moss by a small cut, which entirely carried off the water in the moss; and, having put earth on the whole peat surface, several inches in thickness, it now bears excellent crops.

I could not presume to give any special directions for draining mosses. A few general remarks, chiefly on the nature of the ditches to be made in them, is all that can be expected from me on this head.

As complete and effectual drainage of every drop of stagnant water in a bog, as far as possible, appears to me essential, where it can be accomplished; so I think the main drains, if the moss is not very deep, and there is a sufficient level, should be dug to the bottom of the moss soil, and even a few inches into the harder ground beneath it. Otherwise the ditches should be, where the situation will admit, four or five feet deep, or at least as deep as the level will permit; and, as all wet peat ditches shrink much in

width, this should be great in proportion to the depth. Perhaps not less than seven or eight feet wide at the least.

In small mosses of the extent of a few acres, that have no water pouring into them from surrounding hills, a single deep ditch cut across them, with a sufficient level for carrying off the water, has, in some instances, been found effectual drainage for the whole ground. Such small mosses are frequently kept moist by a spring of water, which should be carefully conducted into the drain.

In larger mosses, besides cutting deep ditches, so as to form the whole into fields of from six to ten acres, it is also necessary to intercept the surface water that falls upon them from the higher grounds, by cutting ditches round the outskirts of the mosses, at least in such places where it is obvious that the water descends: also to cut small drains in such places as are necessary in the moss grounds, in order to lead the surface, or other water, into the main drains. These small drains may be larger or smaller according to the nature of the ground, and quantity of water to be conducted. When the moss ground becomes consolidated, or is ridged and fur-

rowed by the plough, these small drains may become unnecessary.

Mr ARTHUR YOUNG, in his Irish Tour, says, that Mr LESLY, of Leslyhill, recommends to cut the main drains eight feet wide and five feet deep, which must be made wherever the fall is; if only one fall, one drain will do. Then, at six perches asunder (or about 100 feet), cut cross drains four feet wide and three deep. This draining (says he), will make the moss in a year dry enough for cars.

It may here be observed, that flooding or irrigating peat-mosses has been strongly recommended by some, and particularly by a Mr TURNER, who writes on that subject; and I have myself tried irrigation successfully on a small detached peat-bog, and also on peat grounds situated on declivities. My opinion is, that water running over the surface of a bog, probably carries off the tanin, and other antiseptic or poisonous juices engendered in such soils; and that draining does the same, though very slowly, in the generality of peat-bogs, because they do not readily permit the transmission of water, but hold it as a sponge.

One general remark may likewise be made on the effect of draining bogs. By this means, the astrin-

gent aquatic vegetables growing on their surface, and supplying them with fresh tanin, being partly destroyed, the antiseptic nature of the bog, at least near the surface of it, is thus gradually overcome.

It has been remarked, that, in this climate, one can hardly overdo in draining wet lands. The more drains of various kinds the better. To underdo in drainage is a common error. Bogs, by natural or artificial drainage, become in time valuable meadows.

ON THE LEVELLING, PARING, AND BURNING OF MOSSES.

AFTER a peat-moss hath been effectually drained, although it will, of its own accord, in most cases, in time produce good grass for cattle, yet it is expedient, in order to obtain, more quickly, the best grasses or other crops, to do something more; and I observe that the practice most generally followed has been to pare off the rough unsolid substance on the surface of the moss-bog, to dry and burn it, and to level the ground.

Some mosses have been pitted for fuel; and the generality of those that are in a state of nature have a very unequal surface, with broad water-channels, and rising into hillocks of a soft and fungous texture. Those pits and channels may be filled up with a portion of what is pared off the hillocks. The remainder of the substance of these hillocks, and in general all the loose soft surface of the bog, should be burnt. Some inches deep also of the firmer peat surface should be pared off and burnt.

In the Agricultural Report for Suffolk, the following remark is made on this subject. "It is

scarcely possible to bring boggy, moory, peat soils from a state of nature into cultivation without the assistance of fire, which never fails, but because the men employed do not pare deep enough."

1802. THOMAS KINNEAR, Esq. of Kinloch, in the county of Fife, began to improve a very deep peat-moss on his estate, about fourteen years ago. It was then covered with heath, and did not yield the value of sixpence per acre. He has now let part of it for upwards of L. 2 per acre.

After draining this moss, Mr KINNEAR cut off, with a common spade, all the heights and rising tufts of the soil, and also a great deal of the coarse moss, full of recent fibrous roots; and what remained of the turfs, after filling up holes, and levelling inequalities, were collected together, and piled up in heaps to dry, and thereafter burnt, and the ashes spread on the surface, so as to cover it nearly half an inch in thickness.

The ashes, as soon as produced, were spread and mixed with the peat soil, to prevent their becoming the sport of the winds, or being exhausted in detached spots, by rains.

From the effectual drainage which this peat-bog received, it sunk and consolidated so as to be able to

bear a plough and horses in the course of the second year after it was drained. This gentleman attributes a great deal to the ashes thus obtained from the soil itself, for procuring him excellent crops of grass and corn, ever since his moss was in culture. An account of his rotation of crops is given under his own hand, in the Appendix hereto.

The expence of levelling, and paring, and burning must of course depend on the circumstances of the surface of a peat-bog. I find it estimated at different prices, accordingly, from fifteen to fifty shillings per acre.

Sometimes the nature of the surface admits the work to be done with a common plough, and sometimes with a paring-plough and horses, and sometimes, in particular circumstances, it is performed with the breast-plough or paring-spade. This last mode is thus accurately described in the Agricultural Report of the North Riding of Yorkshire. "It is performed with a paring-spade, which a man thrusts forward with his loins, and which cuts the sods about one foot in breadth and three feet in length." If the weather is so unsettled, after paring, that the sods do not dry when lying on the ground, women and children are employed to set

them on edge, to expedite their drying, after which they are put into heaps about the size of a bushel, and burnt.

This simple and cheap mode of converting peat-moss soils into arable and pasture lands, by paring and burning, hath been tried in various parts of Scotland with success.

Mr RUTHERFORD, in his letter to Sir JOHN SINCLAIR, in the Appendix to the Survey of the Northern Counties, says, " The greatest improvement after draining boggy land, is burning the surface, which operates a total alteration on the soil."

In the Agricultural Report of Clydesdale, Mr NAISMITH recommends draining mosses, and then paring and burning their surface, and top-dressing it with lime, sand, gravel, and clay, which he says has been followed with success in the Middle Ward of Clydesdale, which alone has 42,000 acres of moss ground. Mr NAISMITH also lays down the following as his corollaries in regard to the improvement of moss.

1*st*, That though peat be incorruptible in its native state; when its original texture is deranged by smothered combustion, or by the intervention of foreign substances among its interstices, the carbon

it contains becomes soluble in water, and furnishes abundant food to growing plants.

2*d*, The primitive earths, which are ingredients in other soils, are also necessary in peat, not only for the purpose of subduing its resistance to solution, but for affording the solidity requisite to permanent fertility.

3*d*, That lime, differing widely in its qualities from the other earths occurring on the surface, is not capable of rendering pure peat soluble in water unless it be accompanied with these earths; but combined with them, increases the fertility of peat, by facilitating its decomposition. It also forms a soil favourable to the grasses.

4*th*, That cohesive earth, which has suffered torrefaction, such as brick-dust, is a most powerful solvent of peat.

It would be tedious to go over every account of the success of reclaiming mosses found in the late agricultural surveys of Great Britain and Ireland, and statistical accounts of Scotland. But those accounts that I have found stated with precision and accuracy, are put in the Appendix, together with such others as I have derived knowledge of from personal information.

Permit me, however, farther to remark, that, both in England and Ireland, the same ideas as those here stated are entertained respecting the improvement of mosses by the best informed cultivators.

In the Statistical Survey of Kilkenny, in 1802, by WILLIAM TIGHE, Esq. there is a valuable communication of the experience of Mr ST GEORGE on this subject, in which he advises farmers simply to drain well their peat-bogs, assuring them that they will soon thereafter serve for pasture; and to have patience, after draining, till they are consolidated, before they attempt any farther improvement, ever recollecting to keep a free passage for the water to go off. Thereafter, he adds, bogs may be ploughed and burnt, and sown with grass seeds, by which good meadow grass will be produced for fattening sheep; after which, as a farther improvement, they may be gravelled on the surface.

The Agricultural Report of Pembrokeshire, by Mr HASSAL, contains likewise the following notice: "Mr CAMPBELL of Stackpole Court, has made such an improvement on the bog of Castlemartin-corse, of several hundred acres, as must convince every observer what ground of this sort is capable of. It is now drained, inclosed, and divided by ditches,

most of which are planted with thriving trees. It has been improved by paring and burning. "No agricultural improvement," Mr HASSAL adds, "that he has been a witness to, in the course of extensive and long experience, has succeeded better than this undertaking, the subject of which promises, in a few years, to become some of the most valuable lands in the county."

Mr JAMES KINNEAR, farmer at Lordscairnie, in Fife, has improved forty-seven acres of deep peat-bog, which I viewed. He first drained it well; and in a year after, it was firm enough in most places to bear a plough with horses. He burnt the furrow-slices, and had immediately a good crop of turnips on it. I saw, the subsequent year, that is, two years after the bog was drained, an excellent crop of oats growing on it. He told me it was formerly covered with heath, and it had received no other manure than ashes. The remains of a birch-wood were mixed with the surface soil of this bog.

The Communications to the Board of Agriculture, published in 1802, contain also some observations on paring and burning peat-soil, by men of great knowledge in agriculture.

Mr CLOSE, in his Essay, mentions an improve-

ment on a peat-soil, by Sir HENRY PEYTON, where great crops were produced, by paring and burning. He adds, "No soils can pay better for paring and burning than these, as the operation of paring costs very little, and it is a very efficacious dressing on the spot, and the same soil, continuing for some yards below the surface, it is an inexhaustible fund of vegetable food."

In another Essay to that Board, the Reverend ARTHUR YOUNG observes, that paring and burning, with a proper course of crops, are safe on any soil, and essentially necessary to some. Peat, it is said, is the richest soil in the world, and, therefore, burning the most universally practised on it. "Whatever variety of sentiments there may be on this method for other soils, here there can be none. The universal practice, from the flat fens of Cambridgeshire, to the swelling bogs of Ireland; on the mountainous moors of the north of England, and on the rough sedgy bottoms in almost every part of the kingdom, where fresh lands are broken up by men of real practice and observation, is to begin by paring and burning. Registered experiments of doing it by fallowing, are to be met with in various works: The Board's Report of the North Riding

of Yorkshire, and of Somersetshire, detail some: Others are to be found in Mr YOUNG's Tour, and the result is, either loss, or a profit so very inferior, that the question ought to be considered as settled and done with; let it sleep for ever; except for the wrong-headed individuals who will, upon every question, arise, in every age, to contradict the common sense of mankind."

JAMES GORDON, Esq. of Culvennan, one of the Directors of the Highland Society of Scotland, who has improved 100 acres of moss in Galloway, by paring and burning, writes thus to the Secretary of that Society, 28th June 1803:

"Mr GORDON has perused Mr STEELE's History of Peat-moss, and can recommend it as a most useful work, and richly worthy of the patronage of the Highland Society, and he can, from experience in improving, about ten years ago, 100 acres of peat-moss in Mr KINNEAR's mode, assert, that Mr STEELE's information agrees, in a considerable degree, with his own observation."

ON THE DIGGING OF MOSSES WITH THE SPADE.

THIS expensive mode of culture frequently bestowed on mosses, does not appear in all cases necessary, after the operation of draining and levelling has been correctly performed. If a moss is sufficiently drained and levelled, Mr T. KINNEAR found, that, by allowing it to subside and dry for two years, it then became in summer able to bear a plough, and also harrows, and the consequent tread of horses, even where the surface was not covered with gravel, or any other firm substance; and it will be perceived, from a variety of similar facts, that his moss is not different in that respect from others.

Captain SMITH observes, that his mosses were consolidated so as to bear ploughs and carts often after the second, and always after the third year after draining; and I would humbly presume to think, it were better, in most cases, to wait a sufficient time for the consolidation of a moss, than to be at the expence of digging it by manual labour, in the manner followed by that gentleman.

Yet BOYD ALEXANDER, Esq. M. P., whose moss improvements in Renfrewshire I visited in 1803, and which are carried on after Captain SMITH's method, by digging them with the spade, and manuring them with dung and lime, assured me, that, by this method of improvement, he was very quickly indemnified by the crops for all his expences incurred.

ON LIME AND DUNG AS MANURES OF PEAT-SOILS.

MANY mosses in various places have been made valuable for corn-crops after draining, by the application of dung alone.

Mr AITON, in his Treatise on Moss-earth, mentions a peat-moss, twenty feet deep in some parts, situated near Strathaven, in Lanarkshire, and extending to near 200 acres, that was entirely improved by dung after drainage. He says, "The only manure ever applied to Strathaven Moss was dung, at the rate of five or six tons per acre every second or third year." He adds, "In many instances, more than sixteen bolls of corn of the best quality have been taken from one acre of this moss, and the crops of oats cut from some parts of it in 1799 and 1800, brought, at the common prices of these years, L. 30 Sterling per acre. Industry has raised the rental of it from 2s. 6d. to L. 400."

Lime, however, is accounted by some as an absolutely necessary manure for converting moss lands into arable grounds. The necessity of it for improv-

ing peat-soils of every sort, seems to have been conceived by some, and the doctrine hath been productive of a very extensive practice. Lime may indeed be necessary as a corrective in many peat-soils; but, in my opinion, though lime is a most valuable manure for almost all moorish firm soils, it is not generally the most useful and cheap manure for peat-bogs, till they have acquired a firm soil and surface fit for producing grass.

Captain SMITH, above mentioned, who, with his tenants and others, had, previously to 1802, improved to the extent of about 150 acres of moss-ground, so as to bear good crops of cultivated plants, instead of heath, with which it was formerly covered; after draining his bog in the manner already taken notice of, digs the surface over with the spade, and top-dresses it with lime, in quantity 64 bolls Linlithgow measure; or 320 Winchester bushels of burnt lime-stones, called by some lime-shells. In this situation he allows the bog to remain fallow for one season. Next spring, he plants potatoes on it, with a manure of twenty single horse-cart loads of dung; that is, I presume, about ten or twelve tons of dung per acre. In this way he obtains a produce of from forty to fifty bolls, containing each

five Winchester bushels of potatoes, on every acre. The second year's crop is oats, and the produce is about ten bolls per acre. He continues to take a third and a fourth crop of oats successively; but the fourth crop of oats, in general, or sometimes the fifth or sixth repeated crop of that grain, is sown along with rye-grass seeds. These grass-seeds, with the natural grasses, which are then become prevalent in the soil, produce an abundant crop of hay, not inferior to any hay-crop upon the best lands; and it afterwards affords pasture-grass, which would let at 25s. per acre.

A great number of other gentlemen in Scotland follow the same plan of improvement of their peat-bogs.

ARCHIBALD SPIERS, Esq. of Elderslie, Renfrewshire, hath improved about 100 acres of moss upon his estate of Fulwood, and about 100 acres of moss and moor upon his estate of Elderslie, by manuring these grounds with eighty bolls of lime-shells (burnt lime-stones), and from twenty to thirty tons of dung per acre. That gentleman observes, that, without the dung, the lime does not answer his expectations.

It will naturally occur, that, with such a quantity of manure, almost any kind of dry lands might be

rendered productive: besides, as lime cannot be had every where at a reasonable expence, it is, if an absolute *sine qua non*, a complete bar to the improvement of moss-soils in many cases.

It does not seem requisite here that I should enter into a disquisition upon the manner in which lime acts in improving lands. For, though it is a well known fact that it does improve the generality of grounds, yet, whether it meliorates the soil by neutralizing its acids, and dissolving its inert vegetable matters,—whether it acts by tumefaction, or consolidation of the ground,—whether it is a food, or supplies food, for vegetables, or is a stimulant or corrective power to the earth, or how it operates, it has not been in the power of chemistry to unfold; or, at least, chemists have not been able to agree on the subject. We must trust to experience as our only sure guide.

Thomas Kinnear, Esq. Fifeshire, who, as has been already stated, has improved a moss, and converted into excellent arable fields what was formerly a barren heath-bearing deep peat-bog, assured me, that he tried both lime and shell-marl in improving his moss, but found no beneficial effects from either. He tried the lime and marl in the most particular

manner, having manured alternate ridges with them, and he found no difference in the crops of corn and grass on what ground was so manured, from that which was left without such manure. He, indeed, adds, that he thinks, that, if lime were applied several years after the drainage, when the moss is consolidated and well pulverized, it may probably have a considerable effect, especially in rendering the straw of corn-crops more firm, and thereby preventing the lodging of such crops.

That lime has at least much less effect than has been attributed to it in meliorating peat-bog soil, in its original moist heathy state, I must be persuaded from the following facts: *First*, From my own trials and practice; and, *secondly*, I have observed, year after year, on the mosses of Mr MARJORIBANKS and Mr PITLOH, in Linlithgowshire, when in the progress of improvement, that those plots that were dunged, and not limed, brought forward much better crops than those that were limed and not dunged. Those moss fields of Mr MARJORIBANKS that were limed with about sixty bolls of unslaked lime or lime-shells per acre, but not dunged, he hath found hardly worth the sowing and reaping; and being abandoned, and not kept dry, they are now, after

a few years, again grown over with rank heath, without even a mixture of grass. In short, as to lime alone, as a manure, I conceive, but I am afraid of speaking too strongly on the subject, that it had no great effect in meliorating peat-soil as an incipient preparation.

To endeavour to bring this matter to the test of experiment, I, on the 30th of April and 13th of May 1801, sowed oats in different pots, one filled with fresh moist peat turf from Deans Moss, cut out four feet beneath the surface; another filled with dried peat turf from a different moss, teased down; another with dried peat earth and a mixture of one-twentieth part of powdered lime; another with moist peat of the same turf as that first mentioned, and with lime, to the extent of one-half of the quantity of the turf; and, lastly, another pot filled with garden soil. I repeated these experiments again in 1802, and found, to my surprise, that pure unmixed peat earth, pulverized, and deprived of what I call its antiseptic juice, brought the oats to as great perfection, for two successive years, as the richest garden mould: but, in those pots containing a mixture of lime, the oats were evidently not so vigorous. These experiments are more fully detailed in the Appendix.

Sir CHARLES COOTE, who writes the Statistical Survey of the county of Cavan, in Ireland, seems to have a firm opinion in favour of lime; and he particularly recommends limestone gravel as very valuable for reclaiming bogs. He thinks the application of lime reduces the acid of the bog, which will not yield to putrefaction, and consolidates the mass of matter so as to prepare it for the purposes of tillage; yet he acknowledges that the peat-bogs of Cavan require no lime to make them verdant. His words are:—"Here the bogs, when drained and burnt only, yield a verdure of a very kind and fine nature, superior to any I have before seen, which had not been limed. When the surface is burnt, it yields shamrock and clover naturally, and the sweetest herbage."

There is a communication by Mr RICHARD SIMPSON to Mr TUKE, in the Report of the North Riding of Yorkshire, giving an account of the improvement of 145 acres of black moory soil, from two to six inches thick, covered with heath and a few tufts of bent grass, partly by paring and burning, and partly by liming, without burning, on which he makes the following remarks:—"It was evident that the nature of the mossy herbage, intermixed

with patches of ling, indicated paring and burning as the best husbandry. So indeed I thought, and so I acted in general; but, being a young farmer, and having frequently heard it asserted that to burn soil was to destroy it, I ploughed out and limed ten acres of the best herbage, and the most free from ling, without paring and burning. I may add, I had sufficient cause to repent it, for I have not had one middling crop from it." He adds, that he does not expect better till he pares and burns its surface.

On the other side, hear the opinions of W. Roscoe, Esq., on his improvement of Chat-moss in Lancashire: "The usual mode of improving moss lands in Lancashire, is by what is called paring and burning." "A course of burning in a few years produces a great quantity of inert and insoluble matter, which deteriorates instead of improving the soil." "It appeared to me, therefore, that the real improvement of moss land could only be effected by the introduction of calcareous substances, of which lime and marl are the principal. I have used both in considerable quantities. I have a tract of sixty acres on Trafford Moss, which has been entirely reclaimed by lime, and which has been in cultivation many years, and borne crops of potatoes,

clover, oats, and wheat, equal to any of the adjacent lands." Mr ROSCOE's statement of his improvements of moss-soils to a very great extent, is to be found in the Appendix.

Upon considering general principles, I am inclined to think that quicklime should have some effect as an alterative on all peat-moss soils. I have already stated, that it clarifies black moss or moor-water, which shews plainly that quicklime possesses a strong power of decomposition of even the wettest peat-earth, probably by counteracting its tanning, astringent, or antiseptic qualities: and it is unquestionable that it improves all dry moor grounds. Upon this subject, I have the following communication from the Reverend Mr HEADRICK: "Whether tanin be an acid or not, is of little consequence; but that tanin abounds in moss-soils, appeared to me from the following experiment: I took a quantity of wet moss from the bottom of a drain lately cut, and mixed it with powdered lime recently slaked, working them together with the hand, and with sticks in a large earthen basin. After the moss and lime had remained some days, and were occasionally stirred, the juice was squeezed through a clean cloth into a filter of paper, placed

in a glass funnel. The juice passed through this filter in a perfectly limpid and transparent state. Into this limpid juice, thus extracted from the moss, in combination with lime, a solution of sulphate of iron was poured, and immediately a black inky precipitate ensued. It did not occur to me to try this experiment with powdered chalk or carbonate of lime: But it appeared that the quicklime had extracted from the wet moss a considerable portion of tanin, which occasioned the inky precipitate when it came in contact with sulphate of iron. Perhaps this may in part account for the action of lime in destroying the astringency of moss."

ON PEAT-ASHES.

THE Dictionnaire Economique, 1725, remarks, that turf and peat ashes are very rich manures. Experience of farmers, I may here add, renders this an incontestible axiom. It signifies little, therefore, to the practical agriculturist, that some chemists of late have announced, that peat-ashes contain no alkaline salt, though most fresh vegetables give, by burning, a portion of this salt or potash, which they allege is the nutriment of plants. The principles of fertility we are ever mistaking. Let us be guided by facts. In the Gentleman's Magazine, June 1766, there is the following account of peat-ashes:—Properly burnt, it is observed, they afford an excellent manure for both corn and grass land; but the most valuable are those obtained from the lowest stratum of the peat, where the fibres and roots are most decayed. This will yield a large quantity of very strong ashes of a colour (from iron), when recently burnt, resembling vermilion, and of a very saline and pungent taste. Great care and caution should be used in burning these ashes. The

method is similar to that of making charcoal. After the peat is collected in large heaps, and covered so as not to flame out, it must be suffered to consume slowly till the whole substance is reduced to ashes. Thus burnt, they are found excellent in sweetening sour meadow land, destroying rushes and such weeds, and producing great quantities of rich grass.

In a treatise published at Edinburgh in 1724, by the Society for improving in the knowledge of Agriculture, peat-ashes are praised as a manure, and the following method of burning is recommended: "After you have tirred the ground by a flaughter spade or breast-plough, or to save men's labour, with a plough and horses, cutting the ground with the coulter of a plough without the sock; and then cross cutting it with both coulter and sock, and when the turfs of moss are sufficiently dry, let them be gathered in small heaps; and if need requires for the better executing of this, you may have some dried whins, broom or other fuel to be mixed in the heaps for the readier firing them: but carefully observe in burning, never to allow the heap to go to a flame, but as you perceive it to break out, to cause cover it with new turf; for the slower you burn it,

and the more you stifle the flame, you shall have the more ashes, and consequently the more salts. After being burnt, let the ashes (if you mean to use them on the same field) be spread in a calm day, after rain, as equally as possible, and let the places where the heaps stood be pared clean."

Turf-ashes are also reported to be a manure known in the North Riding of Yorkshire. The Reporter takes notice, that they make an excellent hand manure for every kind of crop, particularly turnips, but that they are not used to the extent they deserve.

Among the late Transactions of the Agricultural Society of Amsterdam, is an Essay recommending peat-ashes as containing valuable salts for enriching the ground, and, therefore, as an incomparable manure for lands: which Essay gained a prize of a gold medal from the Society. Both in Holland and in Germany, peat-ashes are very much used, with a mixture of earth, for flowers, as well as for meadows and fields.

The following remarks on this subject are made by Mr FORBES, in his Treatise on the improvement of waste lands. "Peat" (he observes) "about Norbury, in Berkshire, was sold (1778) at from

L. 50 to L. 100 and upwards per acre, and the price was then advancing. The ashes as a manure were found excellent. They make good top-dressings, particularly for clover, sainfoin, and grass lands; from eight to ten bushels being sown with the hand on an acre. The price is from 6d. to 1s. per bushel." He further remarks, " that peat-ground is valuable when used in this way, to the owner of the soil, and to the purchaser of the peat of it, as well as to the country at large, which is benefited by the ashes as a manure. And, moreover, the ground is returned to the proprietor, as he thinks, in a better state than it was before, as the bottom is generally a good soil, where large trees have grown."

In the Agricultural Survey of Berkshire, by Mr PEARCE, he informs the Board of Agriculture, that he was told by a gentleman that has concerns in the peat country there, that he, in the former year, had sold the peat on one acre of land for L. 300, where the purchaser was limited to cut no deeper than six feet, and to clear off the whole in the course of a year; and also, as the peat-bog was covered in this case with a green turf, the purchaser was likewise taken bound to replace the sward, after he had cut out the peat beneath.

In Bedfordshire, nearly the same prices are given for peat to be converted into ashes, which are carried from thence to a great distance, for agricultural purposes.

Mr PEARCE, it may be added, farther remarks, that peat, besides serving the purposes of fuel, is used with great success, in ashes, for dressing young crops of all kinds. It is, he says, an excellent improver of grass-lands, particularly clover and sainfoin, which show to an inch where the peat-ashes have been bestowed on them. Moreover, he observes, that, as peat-ashes may be procured at a moderate expence, it is unpardonable in any cultivator to omit using a dressing at once so beneficial and so cheap. But a more explicit account of the manner of preparing and laying peat-ashes as a manure on fields, and of the crops to which they are best adapted, will be found in the Appendix hereto.

Nor is it unworthy of notice, that Mr T. KINNEAR, before mentioned, made trial of the effect of peat-ashes, some years ago, by applying them to a dozen of turnips, selected to be manured in this manner from others, in a large field of a light gravelly soil. He tried to ascertain upon a wager to what bulk he could raise any of that dozen of turnips, and he

made choice of the ashes of peat cut out somewhat beneath the surface of a bog, for assisting their growth. So large did they become by this manure, that one of them weighed no less than thirty-six pounds English weight.

It is stated to me by Mr KINNEAR, that the above account of peat-ashes, cited from the Gentleman's Magazine, corresponds with his practical knowledge of their utility for these fourteen years past. He thinks the ashes of the inferior strata of a moss, where the peat is most consolidated, and where, perhaps, some mud had been deposited, and the peat materials also most decomposed, are not only more copious, but better than those of a surface covered with heath or musci. But if the moss has acquired a sward of coarse grass, the ashes of the surface are then a still more valuable manure.

The surface of a peat-bog may acquire a sward of grass in different ways. If it ever happens to be overflowed with water, a sediment of mud will be deposited on it, which will in general prevent the further growth of the moss, and also enrich the soil: and it likewise appears to me, that the overflowing of water of a considerable depth on a moss, will decompose and consolidate its soil, even although it

has not been previously drained, and thereby it will be rendered disposed to produce grasses in place of heaths, when the overflowing ceases. A moss will also have a tendency to acquire a sward bearing grasses a few years after it hath been drained. The surface of it must become enriched by the decay of the vegetables of which it hath been composed.

Captain CHEAPE of Rossie, in Fifeshire, hath some extensive and very deep peat-bogs, part of which has been covered with a sward of grass, perhaps from a sediment of mud. After drainage and paring, and burning the surface of the soils, the strength, height, and excessive luxuriance of the crops raised on them, are such as to be beyond credibility. To describe them here, therefore, shall not be attempted, although I had ocular demonstration of their uncommon fertility.

The ashes of swarded peat-bogs are also made use of by Captain CHEAPE, for improving poor lands, and he says they have a most powerful effect.

For paring his mosses, Captain CHEAPE makes use of the ordinary turf or flaughter spade. He cuts off but a thin slice; and the work of paring and burning costs him no less than about 52s. per acre.

The Reverend Mr MARK, in the Statistical Ac-

count of his parish of Carnwath, Lanarkshire, takes notice of the powerful effect of peat-ashes as a manure, and mentions that there it is a common practice to burn the surface of deep mosses as a manure for successive crops of barley and oats, till an approach is thus made to the firm ground at the bottom of the bog, which is, in general, good soil. He adds, in favourable seasons very rich crops are thus produced, and some hundred acres have been converted, in this manner, from moss to arable land.

The Reverend Dr ROBERT RENNIE thus states the substance of a letter to him from ALEXANDER MACLEAN, Esq. of Mark, in Galloway:—"I never reclaimed an acre of waste land, whether moss or moor, but what has paid me cent. per cent. Some has paid more than 500 per cent. after every expence. From recent experience, I would prefer paring and burning to every other method of reclaiming barren land, where there is a depth of soil, and where that soil will produce ashes. I have contracted this year for fifty acres, which are to be pared and burnt, at the rate of 36s. per Scotch acre."

ON THE EARTHING OF MOSSES.

ALL different sorts of earths have been used successfully in improving and consolidating moss ground. These are generally laid on the surface an inch or two thick, and sometimes much less. It is natural to suppose, that the three principal requisites of all fertile soils, viz. aluminous, siliceous, and calcareous earths, must be an useful addition to all sorts of mossy grounds, and experience shews this to be the case.

Mr JOHN HAMILTON for JOHN SYME, Esq. Kinross-shire, has improved a piece of moss, which I viewed on the 25th of August 1801, being the first year it had ever borne a crop. It had then one of the strongest crops of oats on it I ever saw. This moss, as indeed appears obvious from what of it still remains unimproved, was irregular and rough in the surface, covered with tufts of heath, without grass, and also full of large holes where peats for fuel had been dug. Mr HAMILTON, having drained the moss, filled up the largest holes, and levelled the inequalities of the surface with the spade. He then covered over the moss an inch thick, partly with

loamy earth and partly with sand. These manures were laid on with carts, a road having been made of earth for them. All this was done in summer 1800. In spring 1801, Mr HAMILTON found that, by having covered the surface of the moss with earth and sand, it having been well drained and allowed to subside for a twelvemonth, it was able to bear a plough; and he gave the surface an exceeding slight furrow with a light plough; and, having sowed it, it produced the luxuriant crop above mentioned. This crop was sown down with rye-grass and clover-seeds; and, in summer 1802, the moss bore an excellent crop of hay. The Right Honourable WILLIAM ADAM of Blair-Adam, Kinross-shire, has also improved a piece of moss, which, in 1801, was bearing good crops, partly of oats and partly of rye-grass and clover. It was drained by a single deep drain, both sides of which were gradually sloped off.

But the finest crop of grass I ever saw on a moss, was raised by the ingenuity of Captain CHEAPE of Rossie, Fifeshire. The moss having been formerly drained, levelled, and ploughed, and the surface peat burnt, was covered over, an inch or two in thickness, with barren sand, good for nothing else, in the month of May; and, in June or July following, sown down

with clover and rye-grass seeds, which were harrowed and rolled into the ground. The crop of hay that was reaped next summer was so great that it was reported to contain considerably above 300 stones per acre; and the surface is now fine pasture for sheep.

Mr PITLOH, above mentioned, has also successfully improved part of Deans Moss, by covering the surface of it, which had acquired a sward of coarse grass, after drainage and levelling inequalities, without tillage, with composts containing earth and lime, in many places not a quarter of an inch thick.

Mr HERBERT of Mucruss (says Mr YOUNG in his Irish Tour), has improved a bog merely by draining, and then spreading mould upon it, without tilling or burning, which brings it into a meadow as soon as possible, as there is never any necessity of tillage in order to bring turf-bogs to grass.

NIEL MALCOLM, Esq. of Poltaloch, Argyleshire, hath also most successfully improved 500 acres of moss, by drainage, and covering the surface with sea-sand.

The Report in the Appendix, on Mr GRÆME'S moss improvements, in Stirlingshire, bears: "The earthing is certainly the principal article of the moss husbandry, as it thickens and changes the soil."

Sir HUMPHRY DAVY, that eminent chemist, whose work on the Elements of Agricultural Chemistry I have perused with care, remarks, in relation to this subject, that an excess of vegetable matter, as peat, should be remedied by earthy materials, including lime, and by burning. Ashes, he adds, in case of burning, afford also earthy ingredients fitted to improve the texture of the peat-soil. The labour of improving the texture or constitution of a soil is repaid by great permanent advantage. Capital laid out in this way secures for ever the productiveness, and consequently the value, of the land. Peat-earth itself, of a certain consistence, and having no poisonous impregnations, is, he says, an excellent manure for other soils. He particularly recommends it for dry sandy soils; and is of opinion "that soft black peat soils, when drained, are often made productive by the mere application of sand or clay as a top-dressing.—But when peats are acid, and contain ferruginous salt, calcareous matter is absolutely necessary."

There is a great extent of peat-moss ground improved in the neighbourhood of Paisley, which I inspected in 1803; and I found growing on them excellent crops of oats, wheat, potatoes, and grass. Some of these grounds had been improved in the

Ayrshire mode, with lime and dung; but I was also informed a great part had been brought into culture by administering earth of different kinds, and even clay or sand alone: but my own moss ground I have not been able to make productive any where by the application of mere sand alone.

ON ROADS THROUGH MOSSES.

THESE are very easily made fit for bearing carts, or any machines, or implements of husbandry, after the moss is fully drained, by laying them a few inches thick with gravel, or even with earth. High roads through deep peat-bogs are said to be, when once well made, easily kept in repair, to which the elasticity of the bog contributes. " I have often heard of roads being made over quaking bogs (says Mr YOUNG in his Irish Tour), and here, in several places, every step the horse set moved a full yard of the ground in perfect heaves." In another part of that Tour, Mr YOUNG observes, that " the high road to Tullamore leads through the Bog of Allen, which is very extensive, and would make here a noble tract of meadow. The way the road was made over it was simply to cut a drain on each side, and then lay on gravel, which, as fast as it was laid on and spread, bore the cars. Along the edges is fine white clover."

Many public roads through deep peat-mosses are now made in Scotland. There is a high road of this sort through a deep bog, two or three miles south of

Kinross, where I have observed a coach, in passing, shake the bog for many yards around.

PONTOPPIDAN, in his History of Norway, says, that, near Læssœ, in the diocese of Christiansand, there is a timber causeway a mile in length, over a bog of so soft and wet a nature, that if a horse, or even a lighter animal, happens to make the least wrong step, he sinks, beyond recovery, into a mud that forms but a weak vault over an immense abyss.

Bridges over the large drains in mosses are generally formed of a few trees laid across them. Over the trees are put branches, and these are covered with turf, which should be two or three feet in thickness.

Mr PITLOH has formed some bridges over his deepest ditches, by leaving a sufficient breadth for a foot road of the solid peat, having merely cut an arched passage for the water through the peat ground, as a continuance of the ditch. Such bridges seem to stand very well, where no weighty materials pass over them. I have made some such bridges that have lasted many years.

ON PLANTATIONS OF TREES ON MOSSES.

We have complete evidence, from ocular demonstration, that woods have, in many instances, grown on peat-mosses naturally, after the surface had, in any manner, acquired dryness and solidity.

Captain Cheape made several avenues through Rossie Moss, in Fifeshire, recently after he had drained and improved it, which have thriving young trees, of many different kinds, on each side of the paths. There is a deep ditch on each side of the avenues, which serves both as a drain and a fence. I presume the generality of trees planted on mosses, have perished for want of sufficient draining and consolidation of the surface of the bogs. Captain Cheape recommends, as the best trees to be planted on mosses, birch, Scotch fir, oak, and alder, with a few of spruce. His larches have grown pretty large; but he says they are apt to be destroyed, in such situations, by frost in spring.

At Whim, in Peeblesshire, the seat of Sir James Montgomery, Bart. there are particularly as fine spruce firs, perhaps fifty years old, growing on a deep moss soil, as I ever saw. There are likewise many

other good trees growing there; and I was informed the moss is so very deep that their roots could not possibly touch the solid ground.

In a deep moss near Kinross House, that cannot be drained, owing to its vicinity to Loch Leven, which sometimes overflows it, the following ingenious device for planting wood on it, it being very near and within view of the house, was fallen on by Sir WILLIAM BRUCE, a century ago. He raised platforms or banks, about three feet broad, by digging deep trenches in the moss, and planting them with rows of different trees. These banks are pure peat earth to this day, overgrown, in general, with heath. What was the original height of them above the level of the moss water, cannot now be ascertained; but one large beech tree, which is of the girth of five feet six inches, and I judge about fifty feet high, is still, at the ground, two feet above the level of the black moss water in the ditch below. There are Scotch firs growing here larger than the beech tree above mentioned, and some firs, though not the best of them, have been lately cut down, and sold at from L. 2 to L. 4 each. The other trees growing there are principally birch and alder; but the Scotch firs are the best trees. Num-

bers of these firs that have been decayed for many years, when cut down, were found to have white wood on the outside, but within had excellent red wood full of rosin.

Captain CHEAPE informs me, that his grandfather planted trees on a deep moss, in a manner similar to that of Sir WILLIAM BRUCE, by raising banks for them. Of these Captain CHEAPE cut down many fine oaks and Scotch firs.

JAMES STEDMAN, Esq. of Whinfield, in Kinross-shire, shewed me a little wood, containing, besides other trees, particularly good birches and Scotch firs, planted by him about twenty years ago, in deep moss soil. They had grown well wherever the moss was not too wet. His father had also, forty years ago, planted a white or hawthorn-hedge in the moss, which, being on a bank, had thriven well, and was a fence to his plantation. However, in general, the white thorn *(Cratægus oxyacantha)*, certainly does not thrive in peat soil. Mr KINNEAR has planted a white thorn hedge on his moss, fourteen years ago, and it is a tolerable fence. I have also seen a barberry hedge, many years old, thriving well on a moss.

Trees of the kinds above mentioned, and perhaps

several others, such as mountain-ash, poplars, &c. may thrive very well on mosses, if they are sufficiently drained, and their fibrous structure destroyed by the spade, the plough, or by manure, or in any other way; for some mosses are, at the surface, as tough as leather. Mr MARJORIBANKS, who has planted different trees on his mosses, thinks that spruces thrive best.

Mr ARTHUR YOUNG, in his Irish Tour, mentions a Mr FRENCH, who, he observes, had planted several large clumps of trees on his reclaimed bogs, and had found that almost every kind of tree throve well in them. He remarks, that he thought the spruce seemed to get up the quickest, but all of them appeared perfectly healthy. Sir JOHN SINCLAIR, in his Account of Mr WILKINSON'S moss at Castlehead, in Lancashire, remarks, that birch, alder, plane, black poplar, and mountain-ash, thrive well there.

Trees are sometimes planted among the ancient surface heath, without turning the soil, as at Blair-Adam, in Kinross-shire, where I have seen several sorts of trees were thriving on deep mossy places sufficiently drained, planted in the way of lazy beds. Also the same has been done at Walkinshaw, in

Renfrewshire, where I saw Scotch firs, birches, and larches, seemingly thriving: but this need not be attempted in moss grounds that have been recently so wet as to be covered with sphagnum, bryum, or mnium moss plants; for such grounds hold rain water as a dish; or are so porous and woolly that no tree can grow in them, even if they were not subject to be dried up in summer.

The great ruin to planting, in whatever ground, is the want of effectual draining at first, or afterwards neglecting to keep the drains in repair; but, in mossy grounds, the due attention to drains is of more importance obviously than any other.

From what has been stated, and the examples given, I think I have sufficiently proved to such as are not inclined to be unusually tenacious of a contrary opinion, that plantations of trees may be made in peat-bog soils; which being the principal object in view in this section, I think I need add no more on that subject.

ON FENCES IN MOSSES.

Mossy ground is easily fenced by the drains, which serve sufficiently as fences for black cattle. Captain Cheape hath had long and great experience relative to very extensive moss grounds. I therefore often mention his practice. That gentleman hath his inclosures of a size from ten to thirty acres, with belts of planting round some of them. The ditches are on the side of the field, gently sloped off to the bottom; and the earth, being thrown out to one side, tends to raise the platforms where the trees are planted. Some of these platforms or banks contain only a hedge of Scotch firs, each plant being placed at two feet distance from that next it. Others of the platforms are 74 feet broad, with many thriving trees, and a path in the middle, as already noticed.

ON THE MODE OF CROPPING PEAT-MOSS SOILS.

FROM the concurring testimony of every one acquainted with moss improvements, a peat-bog, when brought into a proper tilth, bears the most luxuriant crops of almost every kind of cultivated plant. This I have seen eminently exemplified in the mossy fens of the east coast of England, where more superabundant crops of beans, hemp, cole, &c. are exhibited than I ever have witnessed any where else, or on any other soil.

In Scotland, the first crop has been, in general, potatoes. " Boggy or swampy places, if properly drained, dug, and dressed, will make great returns; and indeed no soil will produce a larger quantity of good, sound, healthy potatoes than black moss or peat, when mixed with earth or mould."—*Scots Farmer*, vol. i. 1773, p. 339.

Captain SMITH, above mentioned, recommends, that the first crop on a reclaimed bog should be potatoes, and thinks that five or six consecutive crops of oats may be taken, without administering any

other manure than what was bestowed the first year, and without danger of the soil being exhausted.

Mr KINNEAR, as well as some other improvers of mosses, in the county of Fife, although they likewise acknowledge that moss soil seems inexhaustible, when once put into proper tilth, yet they do not crop in the manner practised by Captain SMITH, but, in general, follow the same rotations of green and white crops known and approved of for other arable fields; and they find green crops of clover and rye-grass, with rib-grass, turnips, and cabbages, to be commonly excellent, more easily raised, and more luxuriant, than in most other soils. Manure of dung is also given by them to reclaimed mosses as to other fields; but the crops are in general faulty, from the softness and luxuriance of the straw which the green crops tend to correct. Potatoes, however, Mr KINNEAR thinks an improper crop for mosses situated in a hollow such as his, their stems being apt to be cut off by premature hoar-frosts.

In an essay given in to the Board of Agriculture by Mr GREENALL of Lancashire, he recommends the sowing of reclaimed peat soils first with turnips, and next with barley, along with grass-seeds for making them meadow lands.

Mr MARJORIBANKS, already noticed, has had a tolerable crop of soft meadow-grass (*Holcus lanatus*) on one of his moss-fields; and this grass seems to be congenial to all drained mosses. It is remarked by Dr SMITH, in his Survey of Argyleshire, that mossy ground is best adapted for the raising of grass, and that the kind of grass that he thinks suits it best, is the meadow soft grass, which grows close and quickly, keeps the ground well, and is equally fit for pasture or feeding.

In the Essay by GEORGE MAXWELL, Esq. to the Board of Agriculture, regarding the conversion of grass lands into tillage, he observes, that all fen or peat land has a great tendency towards grass, and he recommends such lands to be well drained, pared, and burnt, and the ashes spread as soon as possible after the burning; and he remarks, that, if well drained, they are not only adapted for good pasture, but afford a drier lair for sheep than almost any other land whatever. Moss-ground makes good pasture, because it is deep enough to allow the roots of grasses to run down out of the reach of the summer drought.

Mr FRENCH is mentioned in the Irish Tour, as depasturing his reclaimed bogs with sheep during

winter, as they have a perpetual spring of grass all that season, and are of a nature so contrary to that of rotting sheep, that such bogs will recover those that are threatened with that distemper.

Captain CHEAPE is of opinion, that no soil is so well adapted as moss for perpetual and luxuriant pasturage, of which he has had experience for these many years. He wishes his soils of that sort (and he has many hundred acres of moss) to be burnt on the surface and top-dressed with earth, and then laid down with clover and grasses, without any white crop. Some of his fields of improved moss (lying in the midst of Fife, and not many hundred feet above the level of the sea, and formerly, no doubt, the forest of Falkland, the hunting place of the ancient Kings of Scotland, as is obvious from its situation, and the great trees found in it every where) he now considers as so valuable, that he would not let them even for an extraordinary high rent.

In the Irish Tour, Mr ARTHUR YOUNG, after enumerating a vast variety of methods practised in that country of peat-bogs, for reclaiming such grounds, many of them in a style of incredible extravagance and profusion, and after in theory re-

commending the very modes of improvement now so successfully practised by Mr KINNEAR and Captain CHEAPE, observes: "Whatever the means used, certain it is, that no meadows are equal to those gained by improving a bog: they are of a value which scarce any other lands rise to. In Ireland, I should suppose, it would not fall short of 40s., and rise in many cases to L. 3 per acre."

CONCLUSION.

FROM the examples that have been stated, and those that are given in the Appendix, every person is at liberty to form his own opinion as to what measures and manures are indispensable requisites for rendering a peat-bog a fruitful soil. All are agreed that drainage is the first and most essentially necessary step. By undertaking, therefore, to drain a moss, or indeed any wet soil, with a view to improve it, no one can go wrong. To advise to drain wet lands, of whatever nature, misleads none.

But, it has been the favourite hypothesis of some, that peat ground can not only possibly be rendered too dry, but even is in danger of being transformed into as obdurate a substance as a piece of peat, dried and prepared for fuel. Such gentlemen advise us to beware of draining too deeply, lest, peradventure, we may see our peat-bogs become sapless and unproductive. Repentance may come, when to cure the evil is too late. Peat, they rightly observe, when once dried, can never be brought back to a

plastic state, neither can the exsiccated turf be easily pulverized.

I acknowledge, that it is the nature of peat-soil, in its original state, to hold water as a cup does, and that after its texture near the surface is mechanically broken by the plough or spade, though it will imbibe a great deal of water, it too easily parts with it, unless it is well manured with dung, or mixed with earth; so that crops of corn are frequently lost on such soils in dry weather.

There is, however, no great danger of peat-soils in general in this climate becoming too dry. Indeed, mossy soil, if unbroken, is the most retentive of moisture of any whatever. Hence it is in common use by gardeners for preserving living plants, in transporting them from one place to another. No instance has occurred to me of draining having in any case made such soils too obdurate; but many instances are now brought forward to show, that peat-soil cannot be too much drained and compressed, in order, if possible, to deprive it of its superfluous and noxious juice.

Under a similar impression, Mr KINNEAR of Kinloch, who has great experience regarding moss-ground, hesitated not, alongst with a conterminous proprietor, of some small detached peat-mosses, not

exceeding twenty-five acres in extent, to pay upwards of L. 100 to the owner of the adjoining lower ground, for the liberty of a level for draining these mosses completely. They also expended a still greater sum for making a large and deep drain for this purpose, and have no reason to regret the expence, as by this means these useless pieces of ground have been converted into rich and valuable fields for grass and corn. And, moreover, in this case, a single deep ditch had the power effectually to filtrate or bleed the whole of these mosses without the assistance of any other drain; a year, or sometimes two, having been allowed for the moss-soil to be filtrated and compressed, before any other steps were taken to improve and crop it.

By digging deep also, this gentleman fell upon a bed of excellent shell-marl, many feet beneath the surface of his moss. And although he hath not found on trial, that either marl or lime is to be depended on for increasing the fertility of his peat-ground, yet, by this manure, he hath enriched his other lands, and likewise obtained a considerable profit by the sale of it.

It hath been proved by many examples, that a moss thoroughly drained, sinks down, and is conso-

lidated. The consolidation is the test of the complete drainage of any moss soil. When effectually drained of its stagnated water, and antiseptic juices of various sorts, and consolidated, the bog admits of the tread of horses, and of the weight of ploughs and harrows, employed to triturate and manure the soil, and to reduce it to a proper tilth for being a matrix to cultivated seeds and plants.

If water, falling on, or running over the surface of a drained bog, carries off its deleterious parts, it is obvious that such bog will be sooner reclaimed by also breaking its fibrous texture.

Neither from the examples given does peat-bog soil of every kind seem to stand absolutely in need of any extraneous manure whatever. The being deprived, by deep and effectual drainage, of its antiseptic moisture that preserved this vegetable mass from the ordinary effects of putrescency, leaves it, as has been seen in many cases, to suffer a gradual decay, through means of which, in a period of years, it becomes, of itself, an inexhaustibly fertile field of grass. Perhaps every swamp, of every sort, may become in time valuable merely by drainage, except in some cases of a very wet climate, or a very retentive subsoil, or other circumstances.

To reduce the surface of a drained peat-bog into ashes, for the purpose of improving the lower stratum of it, has indeed been much commended: and, seeing the experience of others proves its utility, I presume to give my opinion in its favour, though it is attended with considerable expence.

The ashes act, perhaps, in different capacities in improving a peat soil.

1*mo*, The peat, on the surface of a moss being soft and spongy, and less consolidated, in general, than the rest of the moss, the burning of it answers the same purpose as carrying away that portion of the soil that can, with difficulty, be reduced to a suitable tilth for bearing good crops.

The nearer an improver of moss-soil gets to the bottom of the bog, I apprehend the richer he will find the stratum of peat, the more mixed with earth, the more decomposed, and the more consolidated. I am indeed of opinion, that peat, formed of the musci near the surface, and especially of that tough and unmanageable moss plant the *Polytrichum commune*, is ill adapted either for agricultural purposes or for fuel.

I know that, in some places, farmers are restricted from paring and burning moss, under the appre-

hension that it wastes the soil; but, as such an idea can never, with any degree of judgment, be applied to a deep peat-bog, such as we have been considering, the question as to the propriety of paring and burning, in general, does not necessarily occur to be discussed here: For, of a peat-bog, the soil is always the lower the better, to a great depth, and there is much of light aquatic productions on its surface necessary to be destroyed.

2dly, Ashes may improve a peat-soil as a food for plants, as well as a stimulus to the soil, or by filling up the pores and interstices of it, and thereby rendering it less open. The porosity and looseness of such soil is one of its greatest defects; and, accordingly, heavy rollers have ever been also recommended for it in all cases where peat ground can bear the tread of horses to drag them along its surface.

Nor is it improbable, as they have so powerful an effect on drained peat ground, that ashes may act as a corrective or alterative of the soil, especially in cases of acidity in it, and they may possibly also help the putrefactive process in reducing the peat to earth.

Earth, sand, gravel, and clay, and composts or

mixtures of these with lime, are also applied, as a manure, to peat-soil, and for improving its texture, and consolidating it; and, doubtless, where they can be obtained without incurring too great an expence, they are, for that purpose, invaluable. They are used either as a top-dressing to the unbroken surface of peat-ground designed for pasture, or they are mixed with the peat-soil by the spade or plough, where corn or other crops are intended.

Quicklime, and probably carbonate of lime, and calcareous substances of every sort, may also produce advantageous effects on all peat soils, especially on those that have acquired a grassy surface. But that they are by no means an indispensable requisite for improving deep peat-bogs, I trust I have proved from example.

Now, as the accomplishment of an improvement at the least possible expence is the most important object, so it has been my desire, in these remarks, to establish, by proof, that peat-bogs may be converted into fruitful soils, in many different ways, without much expence, and without the aid of lime: and indeed without the assistance of any calcareous or putrescent manures whatever.

I have only to add, that, if the principles, infor-

mation, and directions contained in these observations, are found to be applicable and useful for the improvement of the soils here treated of, in the generality of cases, it would not, I hope, be accounted reasonable to condemn them as useless, because, perhaps by some readers, it may be thought they do not correspond with the circumstances, and point out the best possible mode of improvement of some particular piece of moss ground; and it would not be just to pronounce sentence against a general rule because it may have some exceptions. I trust I have no reason to fear that the exceptions in this case may be more numerous than the applications of the rule itself. But I am rather in pain lest, in attempting to exhibit every thing to view relating to the subject, I may have said too much. Yet I hope those most indulgent to my errors may be pleased to admit, as an apology for my prolixity, that the matters treated of in this Essay, concern a vast portion of the lands of Great Britain, and a still greater proportion of those of Ireland, that remain in the gloomy state of uncultivated and fruitless peat-bogs. The subject is also not generally known even to many of those that are most interested in their improvement.

APPENDIX.

APPENDIX.

Account of the Mosses on the Estate of Dunnichen, in the County of Forfar. Drawn up by the Author, in presence of the Proprietor, GEORGE DEMPSTER, Esq. M. P.

DUNNICHEN, 29*th October* 1802.

THE changes that have occurred, and the revolutions that have taken place during ages, and are still in their progress in the filling up of the valleys of the earth, cannot perhaps be more beautifully displayed to the philosophic eye, than by examining Resteneth Peat-moss, the property of GEORGE DEMPSTER, Esq., in the parish of Forfar.

Situated 200 feet above the level of the sea, in a hollow from which the water of a copious spring hath had no clear and sufficient issue, this moss,

consisting of about seventy acres, must have been once a lake. Indeed this is sufficiently obvious, not only from its lying at the west end of, and being somewhat connected with, a very considerable lake, called Resteneth Loch, almost a mile in length, but more especially from a bed of shell-marl found beneath the peat, and immediately above the solid ground. This bed of marl (and of which there was also a great quantity found in Resteneth Loch) is in some places fifteen feet in thickness, gently diminishing towards the margin of the moss. Its average thickness is about five feet, but the stratum is very irregular. On dissolving a portion of this marl in the muriatic acid, I found it a very pure calcareous matter, containing only about a tenth part of its weight of peaty and other substances. The shells composing the marl, many of which are quite entire, are mostly of the cochlea kind, *Helix putris*, Linn.

The great value of this bed of marl ought to be a powerful inducement to every one that possesses any moss grounds, especially such small bogs as are situated not above 500 feet above the level of the sea, to search them carefully, and particularly in

their deepest recesses, for this important article of manure.

Mr DEMPSTER hath sold, from the bottom of this moss, marl to the extent of upwards of L. 1000 Sterling per annum, ever since it was drained, which is about twelve years ago, and the quantity that remains is yet very great.

The immensity of time that I apprehend it would take to form so vast a collection of so long lived and minute animals, is beyond conception, if we might be permitted to judge from natural causes and effects.

This valley, when it ceased to be a lake, from causes now to us incomprehensible, seems to have acquired a surface fit for the production of trees: for all the under stratum of the moss next to the marl is composed of roots, stems, branches of alder, birch, hazel (with the nuts externally entire), and some oaks of considerable size.

From a wood it must have been transformed into a moss, which was about six feet thick above the marl, and, at the time of its drainage, was all covered over with heath.

Occasioned by its drainage, twelve years ago, the heath has been entirely obliterated, the moss, even

on the surface, formed into a fine tilth, and covered with grass, coarse indeed in general, but where it hath been gravelled for a road, it is not unworthy of remark, that it is swarded with the finest pasture grasses and clovers.

This moss has been drained by one deep cut through the middle of it, and through a sand-bank of the depth of thirty feet, that obstructed the issue of the water. The drainage, however, having been intended for the purpose of obtaining the marl, no improvement of the surface of this ground has yet taken place; but from every appearance, when it is set about, the crops will be uncommonly luxuriant, from the decomposed nature of the moss, caused by its being so long in a drained state. Mr DEMPSTER hath inclosed, levelled, and dug over with the spade, about six acres of it, which he means to sow down with grass-seeds next spring, without any corn crop.

There are observable some holes of stagnated water made in the moss, now almost filled up again by *Sphagnum palustre*, a plain example of the quick reproduction of peat matter. It is also to be remarked, that the peats at the bottom of this moss next the marl, are very firm and excellent fuel:

and Mr DEMPSTER observes, that such firm peat, and particularly what is found on some of the Highland grounds is very little inferior to coal. He burns such peat commonly himself, and has sold many hundred pounds worth to his neighbours from this moss.

Dunnichen Moss in the parish of Dunnichen, now under culture, is situated near four hundred feet above the level of the sea, in a small valley, kept wet, like that of Resteneth, by a copious spring of water.

It consisted of fifty-nine acres, mostly of peat-soil, deepening to fifteen feet towards the middle. The drainage of it, which was accomplished forty years ago, at the expence of L. 50, was originally intended for the purpose of procuring peat for fuel, of which the country stood in great need. Beneath the peat was found, on cutting a deep level through it, a stratum of sand six feet thick, and immediately under the sand, a bed of marl, mixed, however, considerably with sand.

On the subject of marl as connected with moss, it may not be improper to observe, that though the common practice of searching for the discovery of marl, is by the boring-irons used for trying for coal,

and other hard mineral substances, yet Mr DEMPSTER very judiciously advises rather to make use of a long wooden pole for this purpose, with an iron auger fixed to its end. This makes the operations of boring for marl both cheap and easy. A pole of twenty-five feet, he thinks, will, in general, be of sufficient length. If the moss is found to be deeper than this, it is easy to join another pole to the first, or to obtain a new one of a greater length.

When Dunnichen Moss was drained, it must have been covered with heath. The remnant of the floriferous parts of the heath are yet found every where on its surface. It had afterwards, however, from being long drained, acquired a sward of coarse grass. Beneath there is found birch and alder wood, and large oak-roots, fixed in the sand, with the remains of musci, rushes, sedges and flags. Before the improvement of the surface was first conceived, it had been cut every where into deep pits for fuel. The levelling and digging of the surface of that part of it now improved, therefore, became the first necessary operation. It was all dug over with the spade, and division-furrows, at thirty feet distance, made down to the sand, for carrying the water into the main drain. These operations, by reason of its

inequality of surface, cost L. 4 per acre, amounting to about L. 69, for digging and levelling near sixteen acres in summer 1800. In spring 1801, it was sown with early oats, except a quarter of an acre planted with yams. The yams had a manure of dung administered to them; and though their haulms were cut off, after they had sprung up by a frost that did not affect the potatoes in the higher grounds, yet they grew up again, and a crop was produced, more weighty by double than on any of Mr DEMPSTER's best fields. The oats, which received no manure whatever, were too rank, and therefore lodged. The produce was sixty bolls Linlithgow measure, estimated at 15s. per boll, amounting to, - - - - - L. 45 0 0

The yams amounted at 12 bolls of 20 stones Dutch weight per boll, at 5s. - - - - - 3 0 0

L. 48 0 0

Deduct expence of the seed and the labour of harrowing, - - - 14 0 0

Gain on the first year's produce, L. 34 0 0

For the second year's cropping, the moss supported a plough and horses, even on the places that had been hollowed by pits. It was sown with early oats, except one acre sown with flax. The whole was laid down also with grass-seeds, though the produce of this crop of oats has not yet been ascertained, it is presumed it will be more than last year. It shall, however, be here put down the same as it was ascertained to be last crop, viz.

60 bolls at 15s. - - -	L. 45	0	0
Lint, - - - - -	15	8	6
	L. 60	8	6
Deduct the expence of seed and labour, - - - - -	25	8	0
Gain on second year's produce, -	L. 35	0	6
Add again on the first year's produce, - - - - -	34	0	0
	L. 69	0	6

From this statement, it will be obvious, that a yearly rent of above L. 30, is, by the improvement of sixteen acres of this otherwise useless piece of

ground, added to the produce of the estate in future, the two first years' crops being sufficient to repay the expence incurred in improving it.

It is to be remarked, that the last crop of oats was so strong as to destroy the sown grass. This may be avoided, by laying down the ground in future with grass-seeds, in April or May, without a corn-crop. Some patches also of the moss that had been hollowed for fuel, and levelled with coarse peat-earth, seem to have had but a thin crop. This might have been avoided, probably, if turf-ashes had been mixed with the soil on the surface, or a little sand or earth put on it. Nothing seems necessary further for rendering a peat-bog that has been so long drained as this, a better or more productive soil. The crop of grass on it at present is most luxuriant; indeed, it is so beyond belief: but it is mostly fine natural grass, the sown grasses having been destroyed by the over luxuriance of the crop. Mr DEMPSTER remains doubtful, whether, from its appearance of producing so great quantities of good grass, he will let it remain for pasture, or admit it into a due rotation of crops, as part of his farm.

Mr DEMPSTER remarks, that the cultivation

of the mosses of Scotland cannot fail to contribute greatly to the fertility and richness of the kingdom, and seems to be one of the safest speculations in which a proprietor or tenant can employ his money, more especially since experience has proved, that the mere act of draining mosses is the principal expence attending their improvement; for while lime or other calcareous manures were understood to be necessary, its distance from many mosses, as well as the expence, might naturally deter prudent people from the undertaking.

As to the growth of trees on drained mosses, Mr DEMPSTER observes, that, on the dry parts of the Moss of Resteneth, the Scotch firs, the seeds of which had been blown from some neighbouring plantations of that wood, took root, and grew very kindly; though they have since been destroyed by the pasturing of cattle on the moss, after obtaining the height of two or three feet.

Account of the Improvement of the small Peat-Moss of Innerleth, in the Parish of Collessie, in Fifeshire. By ANGUS MACLEOD, Farmer there, in a Letter to the Author.

INNERLETH, *October* 26. 1802.

SIR,

THE moss I improved here consisted of about one acre. I drained it by one single deep ditch running through the middle of it, in 1801. The moss substance had much wood in it, was deep, and of a very bad kind, covered with some patches of heather, but mostly of yellow fog, and of so light and spongy a nature, near the surface, that it was with the greatest difficulty I could get any of it burnt. Being full of holes, where peats had been dug for fuel, I was obliged to level and dig it all over with the spade. In spring last I sowed it with early oats. Where the surface had been burnt, and the most of it was so, and also near the margins, where the peat had been mixed with a little sand, the crop has turned out very fine, and is well ripened; but it was not good where it had received

no burning nor any sand. No other manure was applied.

At this time my moss bears a light plough drawn by a single horse, which goes out of the furrow upon the stubble as far as possible; and I mean, next spring, to sow this ground again with early oats.

On the whole, this peat-moss was not formerly to me of the value of one penny, and I account it now of the value of 20s. per acre of yearly rent, and I expect it will continue for several years to increase in value.

Letter from the Author to THOMAS KINNEAR, *Esq. of Kinloch, Fifeshire.*

6th October 1802.

DEAR SIR,

I HAVE, along with this letter, sent you for perusal, a paper written by me relative to the improvement of peat-moss, in which your operations on moss are particularly mentioned. I request the favour of you to say whether the facts that regard you are correctly stated. I am also desirous to obtain from your experience an account of what you

judge the best rotation of crops for improved moss soils. I am, &c.

Answer to the foregoing Letter.

KINLOCH, *20th October* 1802.

DEAR SIR,

I received yours, with your paper on peat-moss improvements, which I think correctly states those that have been carried on here.

You wish to know the rotations of crops I would recommend for moss-soils.

My opinion is, that, after the operations of draining, levelling, smoothing, and burning the surface of the moss, if it is desired to lay it down with pasture grass, which, surely, for all high situated mosses, I would most approve, it should be sown with rye-grass, white-clover and rib-grass, in the month of June, without any previous crop of any kind. It would be desirable to have this crop of grass eaten by sheep in the autumn thereafter. But if the moss is very soft, lest the roots of the grasses should be injured by cattle, I think it must be cut with the scythe. Otherwise, it appears to me, the

luxuriance of the crop would probably rot the grass. Sheep have not been found subject to any particular disease, by being kept only a few months at a time on moss ground.

If crops of grain are desired, I shall mention a rotation which I have practised with success: but I must first observe, that I have found wheat not to be a good crop for a moss soil, because, however great the crop has turned out in quantity, it has always been found inferior in the quality, of the grain. Neither do I think pease a good crop for such soils, because such crop there runs too much to straw, and does not ripen.

I think, then, the rotation may be as follows:

1. Barley, after burning and levelling as above.
2. Oats.
3. Drilled turnips or cabbages, sown with a compost of earth and dung.
4. Barley or oats with grass-seeds.

I beg leave, however, to remark, that the last mentioned rotation of barley has sometimes turned out so luxuriant as to destroy the crop of grass sown with it. In this case, after repeated ploughings, I have laid down the field anew with grass-

seeds alone, in the month of June following, for pasturage.

As to barley, the quality of what has been produced on moss has been found equal to that on any soil. I have had ten bolls per acre on moss, each boll weighing seventeen and eighteen stones Dutch. The kind of barley I recommend is Thanet, because being strong in the straw, it is not apt to lodge. I sow it the third or fourth week of April.

Oats thrive equally well as barley on moss. The potato and red oats are those kinds, I think, that answer best, for the same reason that I prefer Thanet barley, and because I find they ripen better than any other species of oats I have tried on such soil, and produce grain of equal good quality as on other soils. The red oats I have found here to be earlier than the potato-oats, by at least fourteen days, but the latter being stronger in the straw, stand better. In the newly cultivated mosses, I would recommend that the pasture grass should be broken up after a few years, or when it is found coarse grasses spring up, which rotations of corn crops, and cultivation, will in time prevent. I am, &c.

Letter from the Author to JOHN CHEAPE, *of Rossie, Esq., Fifeshire.*

21*st October* 1802.

SIR,

I HEREWITH send you the perusal of my paper on Peat-moss, and beg to know in return the best mode of cropping and manuring such soils, according to your practice.

Answer.

I THINK the test of all improvements of unproductive soils, is to shew them bearing good pasture, at least three years old, without any symptom of their returning to their original state. Now, to attain this upon deep moss, where there is not above three or four feet of level (having no experience where a greater level is to be got), I would recommend the following method:

First drain and level the field, sloping all the ditches on one side. Burn about an inch of the

surface, and then put on sand, gravel, earth or clay, an inch or two thick. Take a crop or two (according to the richness of the field), in order intimately to mix the soils, and expose them to the weather. The second or third year sow grass-seeds without a corn crop, as early in the season as the ground can be got ready, and pasture, at least the first year, with sheep or other light stock. After two years, I think it should be top-dressed with lime, and never ploughed again, but top-dressed with compost, if it requires it. The rushes, if any appear, to be kept down with the scythe.

If there is mud-earth upon the top of the moss, the ashes will be much more powerful, and the field will of course require less extraneous matter drove upon it, according to the thickness of said mud-earth. Rolling with a heavy roller is of great use.

Remarks on the Improvement of Moss or Peat Land. By Dr CAMPBELL of Lancaster. (Communicated to the Board of Agriculture, and published 1802.)

A PART of the farm, consisting of about seven acres, is moss-land, producing peat and turf for

fuel. After it is cut down for this purpose to a certain depth and drained, it becomes capable of bearing good crops (of turnips and oats particularly), but for this it is always pared and burnt to such a depth as the discretion of the cultivator directs him. The prejudice I had taken against this practice, from reading Lord DUNDONALD'S Treatise respecting it, was so great, that I was determined to reject it almost totally, and to try what could be produced without it. The result, however, has been, that where the parts were burnt, an immediate fertile crop was the consequence, and that not only for the first year, but the ground has exhibited an improved state in all the successive crops, beyond comparison better than where this process was not employed. The greater part of the field not having been pared and burnt, is at present in so wild and unproductive a state, that I intend to extend the operation to the whole of it in the ensuing spring. Whatever objection there may be to the paring and burning land, where there is only a small portion of vegetable matter contained in its composition, there can be none to converting from three to six inches of the surface of a moss into ashes, when there will be many feet remaining of

this same substance. Paring and burning not only affords a cheap manure (for the completion of the whole process will be undertaken for fifteen shillings per acre), but the mechanical texture of the land is changed. From being an open spongy light substance, in which no valuable vegetable can get root, it is converted into a more compact substance; to which, if marl or clay be added, from an useless barren soil, a most fertile one is produced.

What follows on this subject, is for the purpose of shewing what should be avoided, not imitated. The pointing out practices that will prove unsuccessful, may prevent others from committing the like mistakes. *Felix quem faciunt aliena pericula cautum.*

A moss field, in 1796, had been drained perfectly, so that the greater part was quite dry and spongy. It produced some herbage, and was pastured until October. I then carted a considerable quantity of hard soil from the adjacent lands, upon the spongy part of the land, to render the soil more compact.

In 1797, April 8th, the field having been covered with soil from the hard land, and a certain portion of it pared and burnt, it was ploughed, and sown

with an early kind of oats, at about the rate of five Winchester bushels to a statute acre.

June 14th. The crop, in general, totally failing, except where dung had been dropped by the cattle, or where it had been pared and burnt: there the grain is luxuriant in the extreme. Cut in the beginning of September; but it was hardly worth reaping, except where it had been pared and burnt; there the grain was tall and strong, and the heads full and heavy.

1798. The field was ploughed and manured in this manner: a compost of stiff clay was mixed with fresh lime, in layers, and then turned over twice; allowed to lie all the winter; then mixed with a good proportion of stable dung. The land was then ploughed in furrows, at about two feet distance, in the bottom of which this compost was laid. On some parts, turnips were sown, in the drill method; on another, potatoes were set.

The crop of turnips produced was uncommonly luxuriant in the tops, and where the dung was plentiful in the roots also. But it was almost totally destroyed by the severe frost which came on about Christmas, and is a proof that there is no depen-

dence on any turnip crops for spring food except the *Ruta baga*, or Swedish.

The potatoes were a moderate crop; and, from the various manures employed, I now find that peat mould and lime cannot be put in comparison with dung. The quantity of produce has been uniformly correspondent to the dung employed. Some carrots were also sown on a part that was well dunged: the crop very good. The nature of this land being open, and without stones, allows the roots of the carrot to strike deep and freely. They were eaten with great avidity by horses and cows; so that I strongly recommend a more general culture of this root. I observed that some which were left in the ground stood the severe cold of the winter 1799. This field was ploughed once (it being in so fine a tilth as to require no more), and sown with barley, together with white clover, twelve pounds to the acre; rib-grass, two pounds; rye-grass, one bushel and a quarter; then rolled well to compact the surface of the earth, which is now mixed with soil, clay, lime, and dung.

September. The crop came up very thin as to barley; the stalks short, the heads small and light, except where the paring and burning had been

practised; here the crop was good. On the parts where the carrots grew, which had been well dunged, the barley was so luxuriant that it was laid by the wet weather, and mostly spoilt. The crop of grass is, however, luxuriant, even where the barley failed. This is a consoling prospect, as it was my object to get it into pasture land.

1800. It had been intended to pasture this field; but it being at a distance, and other circumstances, obliged it to be mown for hay. Contrary to expectations, it proved very thin indeed, the rye-grass, which at first appeared so luxuriant, became thin and dwindling; the white clover almost entirely died away, except where the cattle had dropped dung here and there, and the land still retaining that light spongy texture which is not suited to the maintenance of any good grass. On the other hand, the parts that were pared and burnt appear covered over with a close sward, especially of rib-grass, which, it would seem, is particularly well adapted to this kind of soil.

The conclusion which I am induced to draw from a survey of the whole proceedings is, That, in consequence of the mistake in the outset, of omitting to pare the sward of tough loose spongy roots, and

burn them, agreeable to the usage of the country, I have lost three good crops, which would have paid for the fee-simple of the land: and that all the extra expence I have been at is, if not totally thrown away, at least of little utility. I have therefore to begin *de novo*, and intend this year to pare and burn for a crop of turnips, and also to raise seed potatoes, those which are produced on moss land, with a little dung, being, as we have seen, not liable to be affected with the curl. This preparation will, I am informed, be also sufficient to carry a good crop of oats, with which grass-seeds will be sown for a pasture field the year following.

Letter from the Author to Mr PITLOH, *Deans, Linlithgowshire.*

7th October 1802.

DEAR SIR,

I BEG you will have the goodness, at any leisure hour, to give me your sentiments on the best method of draining peat-mosses. There is none more capable than you to give a judicious opinion on this subject. Captain SMITH, who has improved

above 100 acres in Ayrshire, advises to dig a main drain four feet and a half in depth, to encompass each field of moss soil, of from six to ten acres; and likewise to cast division-furrows, of a foot or two deep, at the distance of each six or seven yards, to conduct the surface-water into the main drains. Be pleased to say how far you approve of this method. I am, &c.

Answer by Mr Pitloh.

11*th November* 1802.

If it is meant to drain a moss completely of its water, I have no doubt that, to cut a ditch or ditches through it, even deeper than the moss, and from six to twelve inches into the ground below, (where there is sufficient level), is the effectual way to drain it; as I have found that a great quantity of water oozes out between the moss and the solid ground. Very frequently there is a bed of sand or gravel situated immediately below the moss, which, if cut into, must have an effect to drain off a great deal of the water of the moss.

If the moss to be drained is levelled, it does not appear that the division-furrows used by Captain SMITH are necessary, as ordinary plough-furrows will do the business. Deep drains, perhaps, according to circumstances (for all draining must depend on the circumstances of the particular case in view), may be necessary to surround each four or five acres, besides the main drains above mentioned.

But it is proper to add, that my experience on the improvement of mosses, which is but of a few years, does not warrant me to say, whether a moss to be improved should be completely drained of its moisture, or whether, as some allege, it should not be fully drained, lest it become too dry.

Mr VANCOUVER's *Account of the Drainage of a Peat-Bog or Fen in Ireland, and of a Swamp in America.* From his Appendix to his Agricultural Report of Cambridgeshire.

MY first step towards the improvement of a large tract of bog, in the King's County, in Ireland, was to form and recover an outfall drain, twelve feet wide, and about a quarter of a mile long at the foot

of the bog, which was designed to be drained. The bottom of this drain was formed of a compact, retentive clay, above which, in many places, there was a depth of twelve and fifteen feet of turf-moor; under which, and on the resting place of the bog, there were distinctly to be seen ridges and furrows, the indisputable remains of an ancient cultivation. On other places, on the bed of the bog, were found considerable quantities of oak, yew, and pine, all of which appeared to have been more or less exposed to the action of fire. An oak measured fifty-five feet in length, and twenty-two inches through at the but-end. Such of the yew as was not cut, or wind-shaken, was cut into planks, and made into beautiful furniture; and for the remainder, as well as for the oak and pine, I found a ready demand for building and for farming use. Upon the clay, at the bottom of the outfall-drains, we found the dash and lid of a hand-churn, and a large crane-necked brass-spur, with a rowel a full inch in diameter.

The outfall-drain being completed, and proper sluices erected, to give command of the water, the next step was to cut foot-drains, or drains one foot and one spit deep, at right angles to and parallel with the outfall-drain, thereby dividing the whole

surface of the bog into squares of four plantation-acres each. The following year these drains were deepened and enlarged to three feet wide, and two and a half feet deep. The result was, that, within two years from the time the outfall-drain was begun, the whole mass of bog, from actual and accurate observations, subsided and shrunk downwards four feet in perpendicular height; and from being in a state in which, with much difficulty, I could step from one hassock to another, without slipping off and sinking up to my middle, it became so far consolidated and compact, that the store-cattle, in the spring following, roamed over and browsed upon it with ease and perfect security.

When, in former ages, the country of Ireland was divided into principalities, colonized from different nations, and subdivided again into various tribes, a constant and cruel warfare appears to have been waged amongst them. At that time the whole country was covered with wood; and as advantages were obtained by one chieftain over another, or as their views of annoyance were likely to be answered by the measure, they set on fire (as has been done recently against the royalists in France) their adversaries' forests, thus destroying their strongholds,

and despoiling them of their hunting grounds. The consequences were such, that many of the trees, only partly consumed by the fire, were thrown down by the succeeding winds, into and across the rivulets, by which the drainage of the country was naturally performed. An obstruction to the usual discharge of the waters was thus produced, and a large pond or lake of water soon spread itself over the whole level, which heretofore drained voluntarily through those channels that were thus choked up. A prodigious quantity of putrified and putrifying vegetable matter in the stagnant waters gave immediate encouragement to the vegetables of the aquatic tribe, which, annually growing and annually proceeding to decay, proved a constant and regular cause of the accession of vegetable matter, and finally became a marsh; from which stage, by gradual means, it has increased to its present bulk, forming what, in Ireland, is called a Bog, which, like a sponge filled with water, swells in many places above the level of the country by which it is surrounded.

The mosses of Scotland seem to be derived from an accidental and similar cause; and the swamps of America, though evidently of a later date, are chiefly to be imputed to an accidental origin.

Many of the swamps of America (and some of considerable extent) are produced from the ingenious and unparalleled labours of the half-reasoning beaver. At the back of the town of Frankford, in Kentucky, I was present at the cutting of a beaver-dam; the heart of which consisted of a very large locust or acacia tree, which had been cut and thrown down by these animals across one of the principal drains which discharged the waters of that plain, and of the higher lands, into the Kentucky river. About 200 acres of land were immediately recovered, the surface of which was composed of putrid vegetable matter, fen-mould or peat-moss, clear from growing wood, and ready for the ploughs. It was in the early settlement of that town, and before any idea was entertained of its being made the seat of the present government, that I was called upon, in conjunction with another person, to value this reclaimed land; and although the current price in the neighbourhood for the uncleared land of the first-rate quality did not exceed one guinea per acre, we readily agreed to a valuation of L. 5 per acre for the reclaimed beaver-pond. On the rich bottom lands on the margin of the Ohio river, and all the river bottoms throughout the whole extent of that

delightful country, forsaken beaver-ponds, and those still inhabited by those sagacious animals, of several miles in length, and very wide, are gradually assuming the appearance and nature of morass; but which, by cutting away the beaver-dams, and opening the natural passage for the water, are hourly, and easily, reclaimed; and prove, in a country like that (where the clearing of heavy timber-land is an expensive, tedious, and Herculean labour), an immediate convenience, and an acquisition of considerable value, to the owners and occupiers of them. The Shades-of-death, as they are called, on the top of the Alleghany Mountains, the Buffalo Swamp in the lower part of Pennsylvania, and the Dismal Swamp in Virginia, all seem to owe their origin to the accidental arrestment of their natural waters,—but for which cause alone, their superior elevation would have left them dry ages ago, like the adjacent country.

Account of Experiments, by the Author, as to the Effects of Peat as a Manure, and its Use as a Soil, on a small Scale.

On the 12th of February 1796, I tried the effects of the following manures, as a top-dressing, on separate patches of old grass-ground, equal in the quality of the soil; viz.

Peat-ashes;
Greenwood-ashes;
Coal-ashes;
Soot;
Quicklime;
Magnesia alba;
Gypsum;
Dunghil water;
Pigeons' dung;
Common sea-salt.

In the month of June, after putting on these manures, I found the grass of a deep-green colour, and greatly superior to the rest of the field, and vigorous in the first degree, where the greenwood-ashes had been put; in the second degree (and

difference in degree scarcely discernible), by the peat-ashes; thirdly, by the pigeons' dung; fourthly, by the soot; fifthly, by the dunghil water. Of the other manures I observed very little immediate effect. Indeed, the common salt, being laid on in too great a quantity, burnt up the grass; and laid on in smaller quantities I observed no effect produced by it. I thought the grass was rather the worse for the magnesia (though this earth, when afterwards mixed with other earths in pots, did not seem, on a fair trial, inimical to vegetation); and the soil seemed neither better nor worse (during the short period of my observation) for powdered peat-earth that was not reduced to ashes.

On 30th April 1801, I took some peats that had been dried for fuel, and crumbled them down into earth, which I put into eight flower-pots. The peats were porous and light, being mostly composed of heaths, *Erica vulgaris* and *cinerea;* bog-cotton, *Eriophorum;* and bog-moss, *Sphagnum palustre.*

Pot 1. contained this peat-earth alone, without any mixture.

Pot 2.—Peat, with a proportion of one-twentieth part of its contents of quicklime.

Pot 3.—Peat, with the same proportion of rich earth.

Pot 4.—Peat, with clay in the same proportion.

Pot 5.—Peat, with gravel in the same proportion.

Pot 6.—Peat, with pigeons' dung in the same proportion.

Pot 7.—Peat, with peat-ashes in the same proportion.

Pot 8.—Peat and quicklime in equal quantities.

The contents of these pots were kept moist with water from a pump-well, which was somewhat hard. Oats were sown in the pots. I observed, that moistened peat-earth, almost as soon as it is mixed with any other earth or dung, acquires a much darker colour than it had before, which denotes incipient putrefaction. This was particularly remarkable in respect to pot No. 6., containing a mixture of pigeons' dung with the peat. In twenty-four hours after this last-mentioned mixture was formed, it also emitted a very strong smell, precisely the same as newly made lime-mortar. Pigeons' dung seems to have a powerful effect in rotting peat-turf. Hence, I presume, peat, well mixed with a small

proportion of the dung of fowls, will make an excellent compost for manure. Here I take leave to observe, that, though peat, like other vegetable and animal substances, turns black by putrefaction, yet the intense blackness of oak-ebony found in mosses, I presume, is obviously derived from iron, which pervades all things, and which, in this case, mixes with the gallic acid and tanin of the oak, and forms with them a deep black dye.

The mixture in pot No. 6. had so brisk an effervescence, that, though oats were sown in it several times in summer 1801, they never vegetated: and the same was the case with pot No. 8., which contained equal quantities of peat and lime. Next spring, however, both these pots being sown again with oats, produced healthy plants. The oats in all the other pots vegetated very well the first as well as the second year, and brought their corn to great perfection. But what surprised me much, as being contrary to my expectation, was this, that the pot containing pure peat-earth unmixed, bore a crop as good as any of the rest, and fully earlier, and better than another pot of rich garden-mould that I placed along with the other pots, and sowed at the same time, for a comparative trial. I presume that

perhaps the watering of the peat in this manner had carried off its antiseptic juices, and the separation of the parts of the turf admitting of its easy filtration, together with the warmth of the situation in which these pots were placed by me, had occasioned a more rapid decomposition of the turf than what in general takes place in any drained peat-bogs. Of course, a sufficient quantity of vegetable food might be produced for the nourishment of the plants, and as quickly as those sown in this case required. Hence, may it not be presumed, that peat-earth, well pulverized, may be a good and lasting manure for dry lands, and especially for gardens and other warm and sheltered soils, without the necessity of fermenting it in compost-dunghils, by which, when the heat is raised too high, perhaps much dung is wasted?

Soon after these pots were sown with oats, in the manner above mentioned, I had a call from Dr COVENTRY, the Professor of Agriculture at Edinburgh, who suggested to have oats also tried to grow in another pot of peat-soil, taken with its original moisture from a different peat-bog. I accordingly, that nothing might be wanting on my part to elucidate the matter, sent to a friend for a piece of

fresh peat, to be dug out of a moss in Linlithgowshire, who, in return, transmitted me a clod of peat-turf, with a label attached to it, denoting it to be "Heath-moss, taken out four feet below the surface, but not so deep as the brushwood." This clod of unbroken peat-turf still retaining its natural moisture, was put into a pot, which was placed with the other pots in my greenhouse, and oats were sown in it, and the earth kept moist by watering, in the same manner as in the others. To prevent the contents of these pots from imbibing any nutriment from the ground, they were kept standing on brick flats.

The oats sown in the fresh peat-earth vegetated, and throve as well as those sown in any of the other pots. Hence seems to arise evidence, that peat-mosses are barren, principally from their tanin or other antiseptic juices. Others have since tried experiments of the same nature with equal success. This leads to conclusions that may be useful to future cultivators of moss-grounds; and if credit is due for this last experiment, which I humbly think may tend to important consequences, it entirely belongs to Dr COVENTRY.

If the antiseptic or poisonous qualities of the peat-

moss may be purged from it by filtration of water alone, there seems only necessary for reclaiming it, deep and effectual draining, together with what is still more difficult, viz. rendering moss-soil, in its native situation, permeable to water.

On examining the contents of these pots, at the distance of nearly two years after they had been thus used as a soil for corn, I find the peat-earth contained in the pot, that had a mixture of one-half lime, is most reduced and decomposed. But the lime in it, though finely powdered, when put in, is now granulated. The mixture in the pot that had only one-twentieth part lime, is now also somewhat in the same situation as that last mentioned. But the corn that grew in these pots the second year, was by no means better than that which grew in the other pots.

The turf in these other pots has acquired somewhat of the smell of rotten wood, and is friable and tender, from the decay of its fibrous structure, thereby showing that it has in some measure undergone the putrid fermentation, by which alone, perhaps, vegetable and animal substances become soluble in water, and are thereby fitted to be imbibed as the food of growing plants: For the new doctrine of

the gases or airs generated from the corruption of such substances, affording part of the nutriment of plants, I think has not yet been proved: and, indeed, I have made some trials in this matter that were unsuccessful in convincing me of the truth of the theory.

Letter from the AUTHOR *to* WILLIAM LOCKHART, *Esq. of Baronald, Lanarkshire.*

14th October 1802.

DEAR SIR,

I HEREWITH send you my remarks on peat-moss, on which I hope you will be pleased to favour me with your observations. This kindness I expect from you, as a fellow member of the Edinburgh Natural History Society.

When I was lately in the Carse of Gowrie, Perthshire, I observed in one of the steep banks of the river Tay, a layer of peat-turf, eight or ten feet beneath the surface of the earth. This led me into a train of conjecture as to the manner in which this stratum had been buried to so great a depth. I was inclined to suppose, that perhaps that whole

plain, now the fertile Carse of Gowrie, had been probably at first levelled by the meandrings of the stream, and became afterwards at one period a peat-moor; that, in an after period, at the time when the river Tay was enlarged by heavy falls of rain, or by the sudden melting of snow, it might inundate all those plains, except the rising grounds, now called the Inches, or Islands, of the Carse, and leave a sediment of that fine soil, brought from the higher grounds, now called the Carse Clay, over the peat-bog.

That the bed of the river is now much lower than it must have been in that remote period, is most obvious. All streams, till they become staid on a level with the ocean, are in unceasing progress of dissipating their channels, and changing and lowering their beds. Hence we trace in the course of rivers one of the strongest marks of the antiquity of the land in its present state, since its emergence from the sea.

Sir GEORGE STAUNTON, in his Account of China, mentions an immense tract of level ground along the banks of the Great River Peiho, upon which no stone is to be found of the bulk of a pebble, and I think he observes that this now fruitful

plain must (like Lower Egypt, &c.) have been formed of the sediment of the river. It appears probable, that the soil of the extensive plain called the Carse of Gowrie, in which, I believe, no stones are to be found, as well as the plain called the Carse of Falkirk, in which I know there is not a stone to be seen upon the surface of the ground, have been formed in like manner by sediments of these large rivers, the Tay and the Forth, when flooded by rains, or driven back by the flowings of the sea. That the ground so overflowed in the Carse of Gowrie, may have been a peat-bog, is aided by this circumstance, that I was informed by several gentlemen residing in that Carse, that they can no where find any water in pit or pump wells, without digging through not only the carse-clay, but also a stratum of peat-moss.

Perhaps this may lead one to conceive a new plan for improving a moss by following nature in this way. All deep mosses, as far as I have been able to observe, have narrow outlets for their superfluous water. I suppose some of them could be inundated without much damage to the adjacent grounds, and thereby, possibly, a sediment from the waters might be deposited on them, that would ren-

der their surface fertile soils, when drained. This might also tend to consolidate as well as decompose the moss.

Another thing worthy of remark with regard to the peat stratum in the Carse of Gowrie, is this, that it has very much the appearance of being in an intermediate state betwixt peat-moss and pit-coal. Thence may it not be conjectured as probable, that pit-coal, which is understood to be of vegetable origin, may, in most cases, have been originally peat-moss upon the surface of the earth, and have been thus altered by heat or pressure, and sunk by the slow processes of nature, or by some of those terrestrial convulsions, the traces of which appear upon almost every part of the earth? I think I can also conceive, that the different sorts of pit-coal may give some indications of the species of wood or plants from which each is derived. For instance, that sort of Newcastle coal in which there is much tar or bituminous matter, may perhaps have been produced from fir or pine wood, &c.

What favours the hypothesis that coal has been at one time a superficial stratum of the earth is this, that I believe it is never found beneath primitive strata. Neither is coal commonly found in any

country that does not produce peat. It is seldom found in low grounds in the intertropical regions.

I beg to know if you have ever observed what I have heard of the *Drosera rotundifolia*, or sun-dew, a plant commonly found on mosses. It is said that, like the *Dionœa muscipula*, it has the power of catching small insects, particularly ants. The leaves of the drosera are furnished with bristles, each of which is tipped with a small drop of a glutinous fluid. Upon an insect being entangled by these bristles, the leaf itself closes round it, and holds it fast. For what purpose these plants are endowed with a sense resembling the feeling of animal life, unless to save themselves from harm, is not so obvious; for they are not like the plant animals, the zoophyta, which, though rooted to the earth as plants, yet, as animals, have mouths at the extremity of each branch, for seizing the insects which are their food, thereby shewing themselves to be the link in the great chain of nature that connects vegetable and animal existence; as peat seems, in its nature, to connect the vegetable with the mineral kingdom.

Mr Lockhart's *Answer*.

Dear Sir,

I have perused your Essay on peat, and your letter to me, with great pleasure, and shall write down what observations have occurred to me on reading them.

Besides oaks, &c. the herb *Tormentilla erecta*, used as a tan in the Western Isles, and growing in moory and heathy soils; heath, mosses, and lichens, afford the tanning principle. The sphagnum or bog-moss does greatly increase the peat turf from its rapid growth. Alder is used in some places in Scotland for dyeing black, in place of logwood.

The kit you mention as containing butter appears rather to have contained tallow. Certain it is that the Danes, and other northern nations, were in use to deposit their tallow under ground, for some time before using it; and, about forty years ago, a large hide, full of what was afterwards discovered to be tallow, was found in a moss at Carstairs. The inhabitants of Ireland and the Fero Isles still keep

their tallow buried in moist earth for months, before using it, which they do as we use butter.

I have seen chairs inlaid with moss-oak found here, hard and black like ebony. Evelyn says the same of bog-elm found in England.

A collection of mosses, lichens, and other herbage containing the tanning principle, if only slightly wetted, will heat, ferment, rot and putrefy; but the same collection in a pool of water will have the tanning principle extracted by the water; and, instead of putrifying, will resist putrefaction, and in time become peat-bog. Water is therefore necessary in the production of peat; but more water, without the tanning principle from the vegetables, would rather assist the putrefaction of animal substances than otherwise. Forests decaying upon dry ground, or in warm climates, cannot mossify, from the want of water to extract the tanning principle from the woods. Bogs or peat-mosses are, however, often found on hill-tops, in weeping climates, where the bottom is cold and tilly, and does not part easily with moisture.

Every shallow pond of water will not, I think, become peat-bog, unless where vegetables, affording the tanning principle, grow in abundance in and

around it; or that oaks and other trees have fallen into it. A lake will always continue so: or, in time, from the growth of rushes and float-grass, &c. where not deep, it will become firm ground, but never a peat-bog, unless filled with timber or plants containing the tanning principle. In short, the debris of old forests, when the trees fall from age, and occasion a stagnation of water; or decayed fields of lichens, mosses, and heaths, in a watery weeping climate, can alone give rise to peat-bogs.

I have on my grounds a small moss, which I cut out in summer, chop it as small as possible with a spade, and mix it, wet from the bog, with dry stable dung, in alternate strata, so as to ferment a little. Then I turn, chop, and mix it two or three times during the summer and autumn, and use it in the spring, with advantage, as manure.

I regularly bed my dunghils with moss every time they are carried out from stable or byre.

When I use lime and moss, I dig out the wet moss, cut it small, and constantly mix it with lime-shells hot from the kiln, the wet moss slaking the lime, and the dry lime reducing the moss.

Dung from the stable or cow-house, laid on moss land, and ploughed in, I think would answer well,

as also would lime-shells broken and ploughed in. But when the moss land is perfectly dried into peat earth, perhaps neither would answer, though dunghil-water or lime-water might do it.

That lime resists putrefaction, in some instances, may be true; but, with the assistance of moisture, it certainly resolves organic substances into a mucus; so hot lime from the kiln should have this effect, when properly mixed with moss. Gypsum, as a greater promoter of putrefaction, may answer better; but of this I have no experience, having never seen it in this country, but in very small bits about Craiglockhart Hill.

Your remark respecting chemistry is certainly true. We have old Chemical Husbandry from HOME and FORDYCE, and new Chemical Husbandry from Lord DUNDONALD and KIRWAN, without much aid to practical husbandry. We are told by these, that the great pabulum of plants is carbon, water, silex, argil, calces, with a small proportion of saline and other substances, some of all which are found in vegetables. Now, from the great perspiration in vegetables, occasioned by heat, absorption from the root may be stimulated to such a degree that often matter foreign to the growth of plants,

and even poison to them, is absorbed, which occasions their death. This is known to gardeners ; and many of them would hesitate to say that every substance discoverable in plants made part of their food. Any animal afflicted with the gravel or stone, may as well be said to have fed on gravel or stones. The evolution of caloric, in certain plants, may produce sugar, salt, and oil, without either of the three being used as a manure to them ; and may not coaly matter be produced in the same way? Sugar canes will grow where no sugar can be traced in the soil. Fern, where no salts can be traced ; olives where no oil. Grasses that thrive so well with coaly matter contain less of it than wood and and corn; and WIEGLEB found that beech-wood contains one-fifth of its weight of coal or carbon, though a plant that grows in barren soil, where little coal is to be found. Fertility in a soil bears a certain general proportion to climate and the sun's influence, which last is certainly the grand source of vegetable life. In a warm climate, an indifferent soil, that would *here*, without the assistance of manure, produce no vegetables, will there produce them in perfection. Caloric, therefore, ought not to have been so much overlooked in the chemical husbandry. In-

deed manures would seem to be caloric in a fixed state, and apt to assist a languid sun in a cold climate, towards the promoting of vegetation, which a warmer sun could do alone in a higher latitude. Electric matter, charcoal, inflammable and fixed airs, seem also to contain caloric, and promote vegetation highly. Wherever lightning is the most prevalent, there vegetation is the most rapid; and, in our climate, the crops do not receive a sensible growth till the sun, by long-continued warmth, has generated electric matter, and the gaseous substances above mentioned, more abundant in July, August, and September, than before or at the solstice;—the common remark of the country people being, that the crop comes not rapidly forward till the nights grow long; and the same observation has been made as far north as the Fero Isles.

You are perfectly right in your conjecture about the carses of Falkirk and Stirling. Mr D. YOUNG, in his Essays on Agriculture, is of the same opinion.

Your idea of inundating a peat-bog, when practicable, is certainly proper. A little mountain stream would not have the best effect, though a small river, or a cut from one such as the Waters of Leith or

Mouss, would be of consequence, as containing fine nutritive particles from the rich soils around it.

I have often had the same ideas with you as to the origin of coal. WILLIAMS, vol. ii. p. 194, says, that he has seen strata of coal that had all the imaginable marks of being composed of peat:—"The colour, quality, and form in the stratum, the manner of burning, the ashes, and every thing else relating to these coals look like peat," &c. In vol. i. p. 251, he imputes it also, in part, to floated timber imbedded in earth, and thinks that "the long grained resinous pines and fir timber are the principal ingredients in our fine flaming splint coal, which, like the fir timber, will readily cleave from end to end, and will handle almost as easily as the resinous fir timber itself."

Coal is certainly rare in the intertropical regions, as far as we yet know.

I am ignorant of what you mention as to the *Drosera*; but, as it grows plentifully in our moor, I shall notice it next summer. I am, &c.

BARONALD,
28th Nov. 1802.

Letter from the AUTHOR *to* DR ANDREW COVENTRY, *Professor of Agriculture in the University of Edinburgh.*

7th October 1802.

DEAR SIR,

I SEND you herewith a paper on Peat-moss, for your perusal and observations. I know you will favour me with your opinion on the subject, whether it agrees with mine or not. I am, &c.

Answer by DR COVENTRY.

SHANWELL, *8th November* 1802.

DEAR SIR,

ON my return to Shanwell from Dumfries-shire, I had the pleasure of finding your letter of the 7th October last. I have received much satisfaction from the perusal of your Essay on Moss. Some days before I saw your papers, I read over to our friend Mr STEDMAN, some observations of my own, and he was surprised to find many of the remarks and the scope of both the very same, in so far especially as they went to doubt the conclusions

which have been drawn from confined experiments, and partial trials, regarding the use of lime and limey manures for peat-soils. I prize much your collection of modern Scotch facts about the improvement of mosses. They are truly valuable, as they exhibit the results of practices radically different, and tend to show the folly of forming general conclusions from facts few in number, and not very accurately ascertained in respect to the effect of particular circumstances.

I have sent you a copy of a few sheets of the notes or heads of my lectures on the subject of moss, which shows my opinion of this improvement. Likewise I have sent you MAXWELL'S Husbandry (a book almost out of print), which contains some papers on Peat-moss; and also TURNER'S Essay on that subject. I am, &c.

DR COVENTRY'S *Remarks on Peat-Moss.*

MOSSES occupy no inconsiderable portion of the surface of this island, and, indeed, of most other countries in the higher latitudes, or which have a

cold moist climate. They are found likewise, no doubt, in the warmer regions of the earth, but there it is chiefly in particular situations, where the materials of the vegetable mass are so placed as to be less liable to decomposition. Accordingly, peat-mosses occur there only, or chiefly upon the tops of mountains, or very high lands, and peat-earth is very rarely to be met with in the low grounds, but some considerable way beneath the surface,—situations obviously calculated to preserve that substance. Indeed, in no situation, even in this country, has the formation of our peat-mosses been at a very remote period, though doubtless some have been greatly more remote than others, and the length of their duration under that form, has been, and must ever be, merely relative. Hence it happens, that in these spots of the earth favourable for the growth and accumulation of much vegetable matter, and where the mass so formed and collected, is, from its nature or situation, not prone to change, the oldest and most entire mosses are found. Hence, too, it happens, that in wild, woody and uncleared countries, such mosses most frequently occur, and, for the longest period, continue to bloat the surface of the ground, and by their exhalations, add to the

moisture, and very probably also to the insalubrity of the atmosphere, or climate in general. It must evidently be a great object to convert to use such extensive tracts of surface, at present in a barren and bad condition. It must be known to every one that mosses are liable to decompose, and to change, so as to lose all appearance of being peaty, becoming a soft vegetable earth, resembling a good deal the soil of haughs, holms, and carses, or other low, flat, soft, and apparently clayey grounds. Indeed, our flats and carses have either had this origin, and are composed of the remains of peat, or they are made up of alluvial particles, the deposit of water; and from many observations, I am inclined to think there are in Great Britain as many of the former description as of the latter; but I can likewise discover, that a great many of our low flats or carses have had a double origin, having been bogs or marshes, subject to inundations from rivers or irrigations from streamlets.

In considering mosses, we shall find occasion to attend to the chief circumstances which diversify them, and contribute to vary their treatment and application, and which are chiefly three: 1*st*, The original nature of the ingredients, whether more or less homo-

geneous, or mixed with different substances. *2dly*, The condition of the mass, as more or less entire or decomposed, distinguishing here particularly the state of its surface; and, *3dly*, The climate or situation of the moss, as whether occupying a low or elevated situation in the atmosphere.

We shall find, too, that the improvements hitherto attempted upon mosses have been chiefly of two sorts. One of them, which can hardly be called an improvement of the moss, consists in removing the mass of peat, more or less completely, by different means, such as cutting it in pieces, and floating it off; burning it, &c.; and then cultivating the soil underneath. The other way has been by improving the superficial mass of peat-earth, in different ways, by removing excessive moisture, levelling inequalities, by the application of manures, chiefly the calcareous manures, &c. It must be known to every one, that, of late years, a great many trials have been made, with various success, to improve what we may call the soil of mosses, of different sorts, that is, of different natures and conditions, and lying in situations where the temperature and humidity of the climate are considerably different. Without intending to discourage the further prosecution of such attempts,

perhaps it may be hinted, that it is doubtful whether the advantages gained by reclaiming several of such grounds have defrayed their cost. Cultivators have very often run into opposite extremes: they frequently underdo, and not rarely overdo, their meliorations,—so far, at least, as these must be estimated by the ordinary principles which direct husbandry, those of productive and profitable labour. As the peat-earth composing the substance of mosses decomposes but slowly till the redundant water therein has been discharged, and as it goes on to change very rapidly thereafter, that is, whenever the over-wetness has been anyhow removed, perhaps it may be sufficient in most cases, in three probably out of four, to do little more, for some years at first, than to perform the drainage of them, and to see that the drains are afterwards preserved clear, leaving the rest to nature. From numerous observations, I am inclined to think, that doing this much is not only performing almost all that is necessary, but that it can be accomplished with a great, and not very distant, prospect of success and remuneration, in all mosses that are not too low placed, so as to have their level above that of the sea, or adjacent rivers, and yet that have not an elevation

exceeding, in this island, 350 feet above the same level,—though, no doubt, if screened by plantations, they may be improved in this way, even where much higher situated. The proprietor, though he may not derive any great or immediate profit himself, will, in this way, lay the foundation for a future fortune to his descendants; and that at a period little more remote than were he to raise for them a plantation, and with a prospect much more certain than were he to attempt the reclaiming of a moor, or even a moss, by any other means. These hints, by the way, to encourage every one to second the efforts of nature, presently going on, and that, too, very strikingly, in the change, improvement, and final removal, of all or most of the lower and partially dry mosses in Great Britain. This last mentioned circumstance is observed to take place most obviously where the moss has been formed in situations where the waters of the morass had formerly stood at a higher level than now, and where the river, which generally flows from or through such collections, has cut for itself a deeper channel, and so performing, in a greater or less degree, often very completely, the office of a drain. In such instances where the drainage, whether natural or assisted by

art, has been pretty complete, the moss becomes susceptible of a rapid change in the condition of its component parts; which altered condition, and the accidental mixtures in a peaty mass, require to be particularly adverted to, for the successful direction of any after improvements. Many mistakes and malpractices have arisen, from not duly discriminating between different states in which this earthy mass is found in different situations, and which require, for the successful management, application, and use, of peat and peaty soils, to be accurately distinguished, especially if the reclaiming of such be immediately attempted, by draining, tillage, manuring, &c. The surfaces of many mosses are occupied almost entirely with heath, or with heath and some purely moss-plants, as the *Sphagnum palustre*, LIN. &c. But others, again, have a crust or covering of mould, or vegetable earth, and that even tolerably good; and they support different sorts of herbaceous plants, as certain carices, the coarser grasses *(gramina)*, rushes *(junci)*, moss-crops *(eriophora)*, and such others, as suit jointly the climate, the degree of moisture, and the fertility of the ground in which they grow. Some soils composed mostly of peat-earth, are found in low-lying wet,

but warm situations, and support herbaceous and aquatic plants, and require, to render them useful, little more than draining, which, in many cases, is not a difficult operation; while other mosses are high, placed in a very cold and wet climate, have hardly any vegetable mould on their surface, and may be deemed almost irreclaimable as a soil, particularly as an arable soil. Some are chiefly made up of the parts of softer plants, easily divisible; others of harder, ligneous, and slowly-decomposing vegetable remains. Some are more, and others less, in a state of decomposition. All of which circumstances, unless duly distinguished, must make what is said about one moss, and the modes of treatment suitable for it, altogether inapplicable to and unfit for others.

Letter from the AUTHOR *to* DR COVENTRY.

15th November 1802.

DEAR SIR,

HAVING perused the books and papers you have been so kind as send me about peat-moss, I have a few remarks to make on them.

What appears to me most valuable in Mr TURNER's Essay, is his own experiment of improving a moss by watering it,—a plan I have thought practicable, but did not before know had been ever carried into execution. He states the fact as follows.

—" The cheapest method of converting a bog is, if there is any river or stream that can be brought above its level, when drained, to make proper dams, heads, and cuts, to water it. Having about six acres of peat-ground, through the middle of which there is a stream, particularly in winter, I ordered it to be cleared, and what came out, to be cast on the one side only, that I might turn and keep the water over one-half of the bog. I had no other object then but to keep the old ditch dry, that the peat might be more conveniently dug on the lower side of the bog. The water was thus continued for near two years, when part of the mound gave way, and, not having occasion to dig any more peat, the water resumed its natural course. The side where the water ran is now a very tolerable meadow. The moss, rushes, and other aquatics, are nearly gone; and it affords such forward pasture, that I reckon one year's grass to be worth more than it yielded for seven years before watering."

It may be conjectured, that, by pure water running over the surface of the moss, in this case, the peat was in part deprived of its antiseptic juices (supposed to be baneful to the generality of cultivated plants), and had become somewhat decomposed.

He, however, also mentions a cheap improvement, of about a mile (as he says) in extent, on a bog that he names Amberly-wild-brook. By deep draining, and burning the surface of it, this peat-moss, he says, has become a good meadow. The ditches, he observes, were of six feet, every ten rod, and the whole expence of draining and burning was L. 2, 7s. per acre. I presume, from his manner of stating this fact, that it likewise came within the sphere of his own knowledge. Facts distinctly stated, and well authenticated, are every thing in agriculture. Theory is nothing.

Mr MAXWELL's Essay on Peat-moss is, in my opinion, extremely judicious, and I have transcribed a copy of it. As to the documents preserved by him, relative to the improvement on the surface of part of Moss-Flanders, by HUGH GRÆME of Ardgomerie, in 1754, they are very curious. From these documents, it appears to be authenticated by

the Justices of the Peace of Stirlingshire, that Mr GRÆME raised excellent crops, of all sorts of cultivated plants, on that moss, by burning and earthing the surface of it, after drainage, to the astonishment of all the neighbourhood, who had been long accustomed to see it covered with only black heath. It appears, also, that Mr GRÆME made use of no lime for his moss improvements.

While I am an advocate for deep draining, where there is level for it, I am by no means inclined to go such length as to say that a moss cannot be improved that has only a level of a few feet. The case of Captain CHEAPE, who has a level of only three or four feet, demonstrates the contrary. But I think, that, if a peat-bog is drained to the bottom, it is then with more certainty permanently improved.

As to the notes or heads of your lectures on draining mosses, &c. sent me, I am very happy to find we agree on that most material point, that effectual draining is the principal improvement for a moss.

I have no doubt that complete drainage will in time convert a peat-bog into a fertile soil, productive of abundance of grass; but as I am afraid, from what I have seen, that the grasses so produced, will

be for a long time of the coarse kinds, I think, when the moss becomes consolidated after the drainage, it should be earthed, incinerated, marled, limed, dunged, or manured in some way. In Dunnichen Moss, though drained forty years ago, and though the water that runs in its drains is now not black, but clear, yet the grasses that have taken place of the heath are mostly of those kinds peculiar to wet lands, except where it has been tilled. Notwithstanding this long drainage, the peat beneath, it is observable, makes good fuel.

Nor can I resist being of opinion, that, if a moss so drained, is not earthed, or manured on the surface, it should, with convenience, be ploughed and sown, or the methods of Mr KINNEAR and Captain CHEAPE, for producing more quickly on it the best grasses, should not be omitted. In short, in improving a moss, I would keep the advice of Mr ST. GEORGE, quoted from the Statistical Survey of Kilkenny, before my eyes.

But, I apprehend, it is not every moss that may be expected, in a reasonable time, to produce even tolerably good pasture-grass, merely in consequence of drainage, though drainage may be all that is necessary for others: for I have known some mosses

that, where dry, have not perceptibly been improved even in ten years. I judge it probable, that the cheapest mode of making drained grounds in general carry good grass or trees, would be by earthing their surface from the nearest dry lands. I mean by the word earth, that mixture of the common earths called by farmers loam. Sand, one might theoretically argue, should, for such a purpose, be best for improving the texture of peat-soils, from its superior capacity for insinuating itself into the interstices of the spongy moss, and thereby making it more fit for transmitting water: but I have not practically found it so. Clay is a ponderous substance, and, with that quality, should be good for improving peat-soils; but it seems not readily to incorporate with such soils, and it does not easily transmit water, and therefore it is too slow in its operation. Sandy loam probably is the best for this purpose, if it can be had easily; and if it can be cheaply mixed with calcareous earth, it would be still better.

There is one thing that here occurs to me as of great importance for the consideration of farmers that use much lime; that is, to try the quality of the lime they buy; as it is not always the lime that

lies nearest to them, or that is cheapest in price, that is really the most advantageous for them. Sometimes what is sold as lime, is not above the half of it really calcareous earth. A chemist can easily try this. By putting a little of the lime in diluted muriatic acid, and by observing how much of it is not dissolved in that menstruum, he sees what is refuse. But, perhaps, most farmers would prefer trying the quality of lime in the masons' way, which would give them some general idea of its quality, viz. by observing what proportion of good sand is requisite to be mixed with the lime, to make such mortar as will not stick to the trowel in building. If burnt limestones may be slaked to double only of their bulk of powdered quicklime, and this quicklime requires no more than an equal quantity of sand to make good mortar, the farmer has carried home too much dross. If, however, a bushel of burnt limestones may be slaked to three bushels of powdered lime, and these three bushels require six bushels of pure sand, to make good mortar; this, I think, is good lime, indeed better than what is common here.

I approve of your observation, that people in general either underdo or overdo the improvement of mosses.

No doubt, all those that do not drain bogs radically, underdo that business. But, in general, undertakers of moss improvements egregiously overdo the affair.

The most of the moss improvements in England and Ireland that I have read of, and indeed most of those in Scotland also, have been overdone. I can recommend no case, unless the improvement has been performed not only in the most effectual, but in the cheapest manner. If otherwise, the case becomes a discouragement to moss-improvers, instead of an incitement to them to make a trial.

I observe you say mosses are found not only in cold moist climates, but also in the warmer regions of the earth.

Moss may no doubt be found, or, at least, it is naturally to be expected on the elevation of mountains, even within the Tropics. Such situations are literally cold and moist. The height of 15,400 feet, even beneath the vertical rays of the sun, is subject to perpetual frost and snow. Perhaps the height of 10,000 feet in that latitude may be adapted to the production of peat. Its moisture may be presumed, as all high hills are attractive of the clouds. Hence, perhaps, the appearance of peat on the sides of high mountains, and in moist and cold situations of many

sorts, without any apparent cause for detaining the water necessary to form it, may be accounted for. Many of the cryptogamic class of plants, seeming to derive their nourishment from moist air, will live, and begin to form a soil, that may accumulate into a moss on stony and other barren situations, where no plants beside could grow.

It admits, however, of considerable doubt, whether much peat is to be found in other situations in the intertropical regions. Even in Spain and Portugal, and other countries of Europe in the same latitude, peat-moss is scarcely known, except on very elevated tracts. I have made inquiry also at several gentlemen who have lived in the East Indies, and none of them, in their progress through many large tracts of the great Eastern Continent, or through the islands in that quarter, ever saw any moss. And I am, in like manner, assured that neither peat nor coal have ever been found, except perhaps on very high lands in Africa. Dr ANDERSON, indeed, in his Essay on Moss, mentions peat found in Sumatra; but this, I apprehend, must have been got from some mountain. I observe you allege peat is very rarely to be met with in low grounds, in warm latitudes, but that it is found some considerable way beneath the surface. Now, it must occur, that, as

all peat is formed on the surface, if it is rarely found on the surface, it must be still more rarely found beneath it.

There is another of your observations that I cannot subscribe to.

You seem to think that mosses, in situations exceeding, in Great Britain, 350 feet above the level of the sea, in a very wet and cold climate, may be deemed almost irreclaimable as a soil. From my conversations with you, I understand you mean only that such mosses are not proper to be cultivated for the purpose of being cropped with corn.

The height of 350 feet is not so very great above the level of the sea, as, in general, to deny the prospect of corn ripening there, through the greatest part of this island, where 5000 feet in height above the sea level is the point of congelation. Indeed where it is any thing near twice the height you mention, I believe it were better that the grounds were destined for a perpetual pasture of grass. But, in very elevated situations, where none but alpine plants can exist, that is, upwards of 1500 feet above the level of the sea, in this climate, it were needless to attempt the improvement of deep barren mosses.

We are agreed, I believe, that every moss that is

sufficiently drained (except perhaps such as are on the highest mountains), will, in time, fall into a state of decomposition. In any situation on the globe, where a dunghil will rot, there is no reason to suppose that peat, deprived of the antiseptic moisture that detained it in an inert state, will not be liable to decomposition.

One thing in peat soils appears to me very unaccountable. In all improved mosses, I have seen small patches which, although they had received the same culture as the rest of the field, were very barren: so, in the uncultivated part of Blackburn Moss, in Linlithgowshire, I observed a piece of ground, of near a quarter of an acre in extent, which, though in appearance of the same soil, and as dry as the rest of the moss, yet has scarce any vegetable production upon its surface. The cause of this remains to be explored. It may arise from mineral acids or bituminous substances. Neither do I understand why stones that have been long in mosses are uniformly blanched.

Peat earth is found sometimes at the bottom of ponds and of rivers, and even of some parts of the sea: and, although some think this phenomenon inexplicable, yet it does not appear so to me: for,

although turf is specifically lighter than water, yet I have observed that moss-water deposits a black peaty sediment, which may have happened in such cases; or perhaps these peaty bottoms have been once peat-bogs.

There seems to me to be no solid ground for distinguishing deep flow mosses in general as of different sorts: for they have all had nearly the same origin, and have all passed through similar changes of surface. There are, indeed, some exceptions. I have seen a small peat-bog composed almost entirely of *Ranunculus fluviatilis*, *Caltha palustris*, and other tender plants. But mosses are generally composed of very tough aquatics, that in no stage of existence are easily pulverized.

Mosses are frequently divided into two sorts, viz. into that of black peat-moss, and that of red bog; or, as some call it, white flow moss. But is not the latter species only the wettest, for the time, of two portions of a bog? Of course red bog, or white flow moss, is the most spongy; its surface being mostly composed of *Trichostomum lanuginosum*. But if we examine the structure of those called black mosses, we shall find that they also have generally

been covered with the same plants at one or more periods of their existence; and they will recur to the same situation, if, for a length of time, they are drenched with more water than usual.

A red flow moss, however, seems, from the nature of the plants on its surface, to require longer time to be decomposed than those peat-bogs that are not so much covered with the *musci*. Before any crop can grow well on it, I apprehend all the soft spongy substance on its surface must be destroyed. This operation is perhaps best performed by earthing or incineration.

If the same causes conspired originally to form such deep turf-bogs as I have been treating of, it does not occur that there is any sufficient reason to consider any of them as essentially different from one another in substance. Though particular mosses, or rather parts of all mosses, are marked by special qualities, I apprehend the materials of all of them, in general, will suffer a gradual decay on drainage. They will all return to the dust of which they were formed. No doubt, however, their decomposition will be favoured by the warmth, and protracted by the coldness and moisture, of the climate in which they are placed.

That mosses are originally the same in their formation, nature, and qualities (except in peculiar cases of mineral impregnation, and a few others), cannot be too much inculcated or too often repeated, when a zeal for the improvement of waste lands is the object in view; for every indolent person excuses himself from the trouble of probably enriching his posterity, and of benefiting his country, with an exclamation of "Alas! my moss is of a very bad kind."

No doubt, where mosses have been long drained, either naturally or artificially, or have a sediment deposited on them by the overflowing of waters, or are mostly composed of wood, or of materials easily pulverized, and with little of the bog-moss or other *musci* in their composition, they are in a much fitter situation for bearing crops of cultivated plants than others that have not had these advantages. In like manner, that sort of firm, black peat, growing on the sides of hills, called bent-moss, is also fitter for cultivation than deep wet mosses.

The distinction of living and dead mosses I do not recognise. All mosses have living vegetables upon them, which, along with the soft and unsolid substances on the surface of the moss, it should be the first object of the cultivator to destroy.

It is a matter not easily ascertained, how many acres of Great Britain and Ireland are covered with peat-moss. The number is certainly greater than most people imagine. It seems likewise highly probable, from the coldness and wetness of this climate (*cœlumque nebulis fœdum*), that it is even greater in proportion to the other lands, than that of almost any other country in the same climate. Dr MACPARLAN, in his Survey of the county of Leitrim, in Ireland, says, that nearly one half of that county is bog: and Mr WEDGE, in his Survey of the county of Chester, in England, calculates on 20,000 acres in that county as peat-moss. Sir JOHN SINCLAIR, likewise, in his Survey of the Northern Counties of Scotland, estimates, in the county of Caithness alone, 348,000 acres (out of 431,000) to be moss and moor. The small Isle of Lewis has a peat-moss thirty miles long, situated not much above sea-level. The Bog of Allen, says Mr YOUNG, in his Irish Tour, extends eighty miles, and is computed to contain 300,000 acres. Peat-bogs are also, I presume, constantly on the increase in the more deserted parts of the island; whereas, in the more populous situations, they are not only prevented from being formed, but also those that are ancient, are gradually extirpated, in a vast variety of ways;

generally, indeed, by expensive methods, or, as you properly express it, by overdoing the business. Mr ABRAHAM DE LA PRYME, in his Account of the Draining of the Level of Hatfield Chace (dated 19th November 1701), mentions 90,000 acres drained there by one VERMUIDEN, a Dutchman, in CHARLES the First's reign, at the enormous expence at that period of L. 400,000.

You seem to think that mosses contribute considerably to the insalubrity of the atmosphere. I am naturally led to agree with you in thinking, that the damp vapours that arise from them must tend to the unwholesomeness of our climate in general; yet it appears from experience, that people who inhabit mosses and mossy grounds, more especially in the higher parts of Britain, or where the peat-waters are incorruptible or antiseptic, are very healthy. Almost every one that lives near such bogs, agrees in this remark, which I think was first made by Dr PLOTT; but it is very particularly noted in Dr BOYD'S Statistical Account of the Scotch parish of Penningham, in Wigtonshire, in the following words: "Cree Moss extends in length and breadth about four English miles. It is of a deep clay bottom, and was once undoubtedly covered with the sea, and afterwards with wood. The

inhabitants living upon this moss are the healthiest in the parish, and arrive at the greatest age. They seldom complain of any ailment." The inhabitants of the mosses of Kincardine and Dunmore are also very healthy.

I submit these observations to you, that we may talk over them at our next meeting.

Essay on Moss, written at the desire of the Society of Improvers in the knowledge of Agriculture in Scotland. By ROBERT MAXWELL Esq. of Arkland, in 1753.

THE nature, qualities, and methods of improving moss, whereof there are so many vast tracts in the kingdom, never having been, so far as I know, treated of at length, by any author who has wrote on husbandry, I, with submission, offer my thoughts on the subject. I am not so vain as to think, that, what I can say will be considered of any great importance; but perhaps it will, as I wish it may, induce some one or other better qualified to correct, and to make further discoveries for the good of the public, and then I attain what I aim at.

Moss is almost the only deep soil, and perhaps the best of several whole counties, were its qualities

well understood, though at present by the greatest part little valued, which makes the knowledge of the proper improvement of it the more necessary and useful.

The whole mass and body of it is a dunghil, made up of rotten timber, grass, weeds, and often mud washed off from the higher grounds about it, by the land-floods, than which there are few richer composts: only by age, and its cold situation in water pent in about it, by the neighbouring rising grounds, its salts are weakened, and spirits become languid.

The same will happen to the richest midding that can be made, of any composition whatsoever, if too long kept; yea, it will become such as not to be distinguished from ordinary moss by the eye-sight, and no more useful as dung than it, except either in proportion to the shorter time it has been kept, or the better situation of the place where it has stood.

I believe the qualities of mosses differ very little from one another in any other respect than with regard to the mud, which makes a part of their composition, its being of a better or worse quality, and as they happen to be in warmer or colder countries, or more or less spongy, occasioned by the

greater or lesser quantity of water stagnate in them. The more water the more spongy; the less water the more short and rotten, and the rottener the fitter for the vegetation of any thing that is planted in or sown on them.

Spongy moss grows indeed very well, and increases its own quantity, but becomes the fitter for the production of plants, roots, or herbs, by putting a stop to its growth, the most proper method to effectuate which is draining.

From this it follows, that draining is the first improvement of moss; and so necessary, that other improvements cannot be made upon it till that be executed; and if well improved, it will produce and nourish vegetables to equal profit and advantage as perhaps any sort or kind of soil.

I have seen upon it mighty crops of rape, wheat, barley, oats and pease, parsnips, carrots, turnips and potatoes; large and good coles, and herbs of various kinds; most sorts of fruit-trees, thriving well, and good bearers, and forest trees of several kinds; and it is good and convenient for meadow, being (besides other considerations) free of stones.

If moss improven be fit for so many good purposes, it seems very material to consider which are the most proper methods of improving it. The

best way, in my opinion, is to pare off the surface with horses and a denshiring or paring-plough; then to burn it, spread the ashes, and plough them in with a light fur for a crop of rape, or such other crop as the master of the ground is most disposed to have. But, besides that the rape is a valuable crop, in consideration of the seed, it gives this encouragement also for the sowing of it, that the large bulky stalks on which the seed grows, afford a fresh supply of salts when burnt; and even while it is growing, the falling leaves, for want of air to exhale their moisture, become of a slimy, oily substance, rot the surface, and enrich the earth by their juices, salts, and rotting upon it.

It is proper with the second crop, or at least with the third, to sow clover and rye-grass, or seeds from hay-lofts; for it is a prodigious error to over-crop ground before laying it down with grass-seeds: But a third crop, if the second show that the ground is in heart to yield it, is the more necessary on this soil (which is, as it were, stitched together), that clover or such small seeds require the ground to be more pulverized than one or even two ploughings can, unless the fog hath been wasted by burning, and that the quantity of ashes arising therefrom was considerable.

The more ashes there are, unless the quantity be extravagant, and more than ever I saw the surface of any moss yield, the better will the third crop of grain and the after crops of grass be; for they help much to cut and divide, and so to pulverize, which, with due expositions to the benefits of the heavenly influences, is almost all that moss wants to make it fertile, if sufficiently drained.

The grass ought to be mowed, not pastured, till the surface become of sufficient strength to bear cattle. Thereafter it will not be improper that it be mowed and pastured alternately, until the master of the ground incline to have more crops of rape or grain. Then (in case either the deepness of the moss or a clay bottom will allow of it) he may, from time to time, proceed in the foresaid method of burning, cropping, and laying down with grass-seeds.

This, however, can only be done after the moss is become so firm that it can bear the labouring cattle, which requires a good level, and considerable time to drain it; but that such a beneficial improvement may not be retarded, the moss, if once tolerably dry, may be pared by an English turf-spade, with which a man will pare as much in one

day as in a day and a half, or perhaps two days, with the ordinary turf-spades of this country; and the turfs being burnt, the ashes may be ploughed in by one man, with a breast-plough, for 4s. per acre, for the labour is not hard.

I humbly propose to those that do not incline to sow rape, to plant potatoes. It is observed that the blue or white kidney kind thrive best on this soil; but any sort will do well; and, if early planted, will be ready before the frosts can endanger their rotting.

It is plain that the denshiring (burning) is not only the most ordinary, but also the most proper way to improve moss; which for the most part is either deep enough to bear it, or has clay below; for the fire revives the weakened salts: or, as VIRGIL says,—

> Whether from hence the hollow womb of earth
> Is warm'd with secret strength, for better birth;
> Or, when the latent vice is cured by fire,
> Redundant humours through the pores expire;
> Or, that the warmth distends the chinks, and makes
> New breathings, whence new nourishment she takes;
> Or that the heat the gaping ground restrains,
> New-knits the surface, and new-strings the veins.

And if a clay-bottom can be got at, the mixture of the clay, moss, and ashes, make one of the best of moulds.

To sum up this head, I hope it is made pretty evident, that, if mosses be drained upon moderate charges, and if, by the burning, a quantity of ashes be obtained, sufficient to enliven, strengthen, and enrich them, there can no danger arise from the undertaking.

But the shortest work of all for the improvement of moss designed only for grass, where the situation gives opportunity for it, is this:—First, drain the moss. If there be heath upon it, burn it off, and make the surface equal. Then make a dam at the lowest part, and a sluice, and work the water upon it through the winters. The mud that comes by the land-floods will, in two or three years' time, bring a fine sward upon it, and thereafter be a yearly dunging; so that it will bear annual cutting, and besides bring a good foggage for pasture, after the sward is become strong enough to bear cattle. Or, where the conveniency of water for flooding cannot be got, if a moss, after draining, be covered two or three inches deep with other earth, it will also bring a good sweet grass upon it. Gravel has this effect more than other earth, because being a weighty body of separate gross parts, and of a hot nature, it sinks into, incorporates with, heats, divides, and pulverizes the moss.

Dung or lime where it can be got, will also contribute to the improvement of moss, as well as any other ground; yea, there is this particular encouragement for the dunging of it, that dung will last, and do service longer, in moss, than in any other soil whatever, which is owing to the preserving quality of the moss. But whether dung or lime be used, the nicest ploughing is requisite to keep them from sinking too deep into this light and open soil.

Besides the regard that ought to be had to moss for its own productions, it has this further to recommend it, that it is not only excellent compost for middings to be laid on clay-soils, but also adds much to the fruitfulness when laid on that soil green; which, perhaps, by some, will only be imputed to the opening quality of the moss separating the bound particles of the clay; but it is known to have the qualities and effects of dung upon light hazely ground, not only when compounded with dung, but also when laid upon the green sward.

A gentleman, renowned for knowledge of gardening and agriculture (Mr HERON of Bargaly), is in practice, after taking two crops of oats from folded (or tathed) ground, to lay on of moss double the quantity he would lay on of stable or byre dung; and he gets thereafter a crop of barley or bear, and

another of oats, and lays down his ground to grass, notwithstanding, in good heart; which crops his light weak soil could not bear, were it not for the benefit or enrichment it receives from the moss.

Report by a Committee of a Quarter-Session of Justices of the Peace of Stirlingshire, appointed to examine the Improvements of Mr Græme *of Ardgomerie, upon Moss Flanders, 6th August* 1754.

As the gentlemen named by the Quarter-session were very willing to accept of the task appointed them, from a view of doing service to the country, so they now, with equal pleasure, give in their Report, as they hope it will be of use to engage others to follow the laudable example set them by Mr Græme, and as they have now an opportunity of doing justice to Mr Græme's attempt to cultivate these barren fields, who may well be considered as one of the most useful farmers that ever settled in this part of Scotland.

We are very well apprised that what we are about to say of these fields may shock vulgar prejudices, and appear romantic to those who never

examined Mr GRÆME's husbandry, with the care and attention we have done. Many examples may be given of the most beneficial inventions ridiculed in their infancy, which, after repeated trials, and length of time removing these clouds, have been found of the greatest utility to mankind: but truth, however obscured and damped at first, will always remain truth; and the more pains men bestow in finding it, the greater pleasure will result from the valuable acquisition.

Certain it is that the uncouth aspect of these fields, which our forefathers have for so many ages considered as absolutely useless and barren, must naturally revolt a cursory inspector, and send him away with a very unfavourable opinion both of the soil and the attempts to cultivate it. Nothing, at first sight, can appear more ridiculous than an effort to raise grain in the middle of heather, standing upon a moss fifteen feet deep. We are very sure that others must consider it as impossible, because it appeared in the same view to ourselves, until, by repeated inspection and accurate examination, we began to be sensible that the thing was practicable; but when Mr GRÆME advanced in his improvements, the conviction of the truths we now offer to

the public overcame our prejudices, and fully convinced us that moss-farming must turn out to advantage by the most cogent of all arguments, ocular demonstration.

Last season we were shown upon the moss many fields of as good grain as any in the county. This appeared the more extraordinary, as it is well known that Mr GRÆME began, and carried on his method of agriculture, through a series of as bad seasons as ever were known in Scotland. We are of opinion, that the barley we saw, even upon the worst soils in the moss, would weigh against most barley in the country. His common rough bear was inferior to none, and the flax and potatoes appeared exceeding good in their several kinds.

Such was the appearance of his fields last year; but this season, he has reduced many more fields to carry grain, and can now show wheat, oats, pease and beans. The wheat appears thin in many places, but nobody will wonder at this, who knows that the best wheat-fields in Scotland have failed this season, by the violence of spring frosts,—a misfortune which affected Mr GRÆME in common with his brother farmers; but we can truly say, that the wheat still

remaining has the stalk abundantly strong, and the head or ear of the usual size of that grain.

His oats are as good, if not better, than any we have seen this season on any soil. The barley and bear appear not so promising, occasioned by some obvious mistakes, one of which we shall mention, viz. the sowing of the barley late in the season, and with a single ploughing. Hence the grass and weeds, not being destroyed by more frequent tillage, overran the grain. Though this is now found to be bad husbandry on the moss, as well as on other soils, yet we do not look upon this as any bad symptom of mossy soils, that, by earthing them, runs so fast to grass, as we are sure that many gentlemen would be heartily glad to see all the mossy valleys on their estates covered by the same grass that destroyed Mr GRÆME's barley. Nay, we are glad to take notice of this accident, as a corroborating proof of what we have seen on this moss, that, where it has been earthed, two years ago, but not sown, it is now as full of natural white clover and other grass, as any field generally is in twice that time. Hence, we are of opinion that the moss would, when well earthed (which, in Mr GRÆME's way, is performed at an easy expence), hold out a long time in good

grass, without sowing, or danger of heather springing in it, because the soil, by the first earthing and tillage, is changed from its original quality. The earthing is certainly the principal article of the moss-husbandry, as it thickens and changes the soil. The ashes give it fertility; the tillage, raising the ridges to a proper height, leaves it dry; and thus it becomes one of the best soils for good pasture, which is a black loamy soil, with a mossy bottom.

We have already mentioned the flax and potatoes we saw last year. These were sown and planted by Mr GRÆME. This season we inspected several fields of flax on the moss, laboured by country people, Mr GRÆME's tenants. It is not to be expected that country people, who are but just initiated in the new husbandry, will do as well as Mr GRÆME; but this has not hindered even their flax-crops from being tolerably good; and it may be justly expected that their future crops will increase in value, in proportion to the advancement they make in their knowledge of this method of culture. For our own parts, we are unanimously of opinion, that no soil around it will give better crops of potatoes and flax than the moss will do, when properly dressed according to Mr GRÆME's method.

This season, also, in our late visitations of these fields, has afforded us a very agreeable surprise, from the appearance of a crop we always wished, but never hoped to find on these lands. Mr GRÆME showed us a crop of pease and beans, rather stronger and better than any we have seen this season, either in the kerse or dry fields. We, indeed, imagined, formerly, that it might grow pease, though not beans; but now, by inspecting this crop, we are convinced, that, though it be already very good, yet it would have been still richer, had a greater number of beans been mingled with the pease, as the latter, by their prodigious growth, are apt to fall down by their weight, for want of the friendly support and assistance of more beans. We are now in no doubt that the beans would be a favourable crop, as those few which we saw amongst the pease are increased to a surprising magnitude. The great plenty of pods which now load this crop, assures us, that they will appear upon the barn-floor, at harvest-home, to as great advantage as they now do in the field. We are therefore of opinion, that a soil, which now affords such heads of wheat, such pease and beans, may, by proper culture, produce any thing else this climate yields, and with a very moderate expence.

This naturally brings us to consider the charge of the husbandry practised on this new soil. When we first saw Mr GRÆME's works, and his set of utensils entirely different from those commonly in use, we imagined that any thing so uncommon must be very expensive. But now, on a narrower inquiry, and by frequent conversations with Mr GRÆME and his workmen, we are well assured that his method of husbandry is the cheapest, and his fields more easily laboured than any in this country. The detail of his utensils, and the methods of using them, are foreign to our present purpose, and may be better learned on the spot than from any thing we can say of them.

In order to convince this meeting that the Committee were not willing to take any thing on trust, we were not satisfied even with Mr GRÆME's account of his expence and method of husbandry, much less with that of his workmen. The Committee, therefore, determined to examine some of the most understanding farmers in that neighbourhood, and who had been present ever since Mr GRÆME first broke ground in these fields, not in a cursory manner, but upon oath, with relation to the truth of Mr GRÆME's plan of culture, and

the advantages he pretended resulted from his methods of husbandry.

For this purpose, we took the printed Memorial relating to the moss culture, bearing date the 8th of March last, herewith produced, and after solemnly taking their oaths before two Justices of the Peace, they all unanimously deponed, that the said memorial contained in most things their own opinion concerning the moss husbandry, particularly in relation to the four last positions advanced in that memorial, which are indeed the principal and most valuable parts of the whole, viz.

1*mo*, That the moss could be brought to carry good barley or any other grain, with less expence than the outfields either of kerse or dry field.

2*do*, That it can be kept in tillage cheaper than any of these soils, and yield as good grain of all kinds.

3*tio*, That any country man can labour a farm of moss with less than half the stocking necessary for any other farm, with less hazard of failing, and have as good a return.

4*to*, That when it is properly cultivated, the moss will stand wet and dry seasons better than any soil around it.

Such were the opinions delivered to us by the neighbouring farmers, as will appear from the printed memorials, signed by the two Justices of the Peace, before whom the affidavits were made, and their own subscriptions to their oaths herewith presented to the court.

We can easily observe that these mosses improve every year by tilth, and the small addition of earth which they receive, the expence of which is very inconsiderable. The only improvement we could propose at present is, that the moss, for a second crop, should have two ploughings, in order to kill the luxuriant growth of grass and weeds which arise from the earthing, unless the field is sown before the middle of March.

It may be proper, in the conclusion of this report, to make a few general observations on the utility of, and advantages that might follow from, this cultivation of moss after Mr GRÆME'S plan. We are humbly of opinion that these must be very considerable to North Britain in general, and more particularly to the Highlands; nay, of more consequence than many at first view will be ready to see. It is allowed, that agriculture properly pursued, is the first and surest foundation of wealth to

any nation. Of what immense value to the country must it then be to have such large tracts of barren grounds reduced into tilth, especially as we can demonstrate that it can be done after Mr GRÆME'S method, at an easy charge, even when it is designed to return good crops of barley and of flax? To this we must add, that even the present charge (though very moderate) will lessen, when this method comes to be understood and followed by more people. The poorest farmer in the country has stock sufficient to enable him to cultivate a moss-farm after it has been once brought to tillage, and besides he has the advantage of being at once taught a proper and useful system of agriculture, the want of which knowledge daily ruins many of our country people, while they obstinately adhere to the absurd practices of their ancestors, and refuse to follow a better method of tillage, merely because it is new.

The extent of these barren fields over Scotland, the hands they may employ, the mouths they may furnish bread to, the quantity of flax they may afford to our manufacturers, and the sufferings of the country for want of grain these last years, are all so obvious, that they need not be enlarged upon.

These are a few of the advantages that must redound to the country in general from Mr GRÆME'S plan of improvement; but, with regard to the Highlands, it appears in a much stronger point of light. When we cast our eyes over this country, we find little but barbarity and idleness, with all the train of vices which generally follow these evils; or, at best, the rude and unpolished beginnings of society. In considering the present state of this large country, we are of opinion that this system of husbandry is most opportunely come in the way as a mean to cultivate that country, and civilize the manners of the inhabitants. The method of agriculture proposed by Mr GRÆME will produce plenty of potatoes in the low mossy valleys, lying at the bottom of the high hills in that country, and at a far less expence than it has cost Mr GRÆME to raise them from his mosses, because the mossy valleys in that country have generally a larger proportion of other earth mixed in them. The potato-crop must evidently be of great use in a country where grain is so scarce and dear.

This husbandry will also produce enough of flax to employ their families all the year round, and furnish the manufactories lately erected there with

proper materials. One particular advantage of Mr GRÆME'S method we cannot omit to mention, viz. that it is performed, in all its branches, by men alone, without the help of working cattle, which they neither have in that country, nor have they food to maintain them, though they had. And we can demonstrate, that a smaller stock will make a Highlander a farmer fit to cultivate these mossy soils, with which his country abounds, than was formerly requisite to furnish him with the arms and accoutrements he used to wear and employ in the worst of purposes.

The funds set apart, by the wisdom of Parliament, and mentioned in the statute annexing certain estates to the Crown, will, no doubt, when applied in the designed manner, be of the utmost advantage to the nation, as the Highlanders will be furnished with something to do, and so prevented from disturbing the tranquillity of others. We are humbly of opinion, that the introduction of Mr GRÆME'S husbandry would greatly contribute to this valuable end; and therefore we think the Quarter-Sessions should think of some proper method to recommend this system of agriculture to the notice of the public, and particularly of those in power,

many of whom have distinguished themselves by a diligent pursuit of every thing that might contribute to the wealth and grandeur of their native country. The small expence that accompanies these improvements renders it particularly adapted to the situation of the Highlands; and the industry it requires appears to us very proper for civilizing the country; an object that has deservedly engaged the attention of the Ministry, in several preceding reigns, as well as the present.

As, in every new scheme, of whatever kind, many objections may be started, so in this we are now recommending. But we are certain that any objections we have yet heard against this undertaking, are easily removed, as they proceed more from prejudice and old opinions, than from any difficulty in the thing proposed to be executed. From hence we are induced to believe, that the more this husbandry is recommended, and the sooner it is countenanced by those in power, the more quickly will it spread, and its advantages be sooner and more universally felt over the nation, and particularly in the Highlands, where it seems to be most wanted, and where, indeed, the greatest field for this species of agriculture seems to be, by nature herself, pointed out to us.

We have now gone through the principal articles we thought necessary to lay before the Quarter-Session, in consequence of their directions to us; and we shall think ourselves amply rewarded for our trouble, if what we have here said be of any use to dissipate the prejudices hitherto combating the laudable design, and to engage the gentlemen of this or any other county in North Britain to emulate Mr GRÆME in his useful labours, while they have the pleasing reflection, that, by this method of agriculture, they approve themselves patriots in the best sense of the word; improve their paternal estates; and enjoy, before-hand, the blessings which late posterity will not fail of bestowing on those who open new sources of plenty and wealth in their native country.

Sic subscribitur,

JOHN CALLANDER, J. P.
THOMAS GRAHAM, J. P.
JOHN STIRLING of Garden.
JOHN BUCHANAN, J. P.
DAVID GRAHAM of Meiklewood.

Letter from the AUTHOR *to Captain* JOHN SMITH *of Swindridgemuir, Ayrshire.*

1*st December* 1802.

DEAR SIR,

BEING desirous to know the present state of your improvements on peat-moss soil, I take the liberty of troubling you with a few inquiries on that matter. I have several hundred acres of this sort myself, which I propose to improve; but, wishing to be well informed on the subject, before I do much, I am not only collecting the accounts of the practice and principles of others, but also committing them to writing.

The printed account of your improvements, published in 1796, when there were about 150 acres of your formerly heath-covered moss grounds, then bearing good crops of cultivated plants, I have perused with much satisfaction. No doubt there will now be many more acres improved; but may I beg leave to ask if any other or better modes of cultivation have been since discovered? Have any moss lands been attempted to be cultivated by you with-

out lime or other calcareous manures; for I have some doubts of the necessity of using calces for the improvement of peat-bogs.

I would farther presume to ask, if there are any improvements made on your mode of drainage, and whether you still continue to dig over your moss grounds for the first and second crops with the spade, in place of using the plough.

No doubt, moss ground is very easily dug with the common spade, but it occurs that ploughing it with the ordinary plough would be a still cheaper operation. In moss grounds, a plough with two horses (and sometimes only one horse is used), can execute nearly double the work in a day that it can perform on other lands.

The moss improvers in Fifeshire allow their bogs to subside for some years after effectual drainage. In the mean time, they level any inequalities that may be found on the surface; pare and burn all the lightest and most porous substance generally growing on the top, and sometimes a good deal of the more solid moss soil, for the sake of the ashes, which proves, they think, a better manure than lime. The moist spongy soil, becoming consolidated by the drainage, is at length able to bear a plough and

horses; is sown and harrowed, and sometimes rolled, all in the ordinary way; and, without more ado, produces good crops.

I perceive it stated that your mosses have sunk three or four feet, which I apprehend must be principally, if not wholly, occasioned by their drainage. No doubt, the operation of reducing the surface of mosses into a fine tilth, and forwarding, by any means, their decomposition, will make them also appear to sink in a certain degree; but the great sinking of a moss, by drainage, may be fitly compared to the collapsing of a sponge, after squeezing from it the water which had been the cause of its intumescence.

Our friend Mr MARJORIBANKS uses your method, and bestows lime plentifully on his mosses: but he neither burns nor carries off the light superficial substance, nor do I think his drainage effectual; the proof of which is, that his bog is not sunk or consolidated, and his fields that are only limed produce poor crops.

Neither do the Fife improvers, and among these Captain CHEAPE, your regimental acquaintance, find that lime is essentially necessary for the improvement of a moss-soil.

Answer by Captain SMITH *of Swindridgemuir.*

16*th December* 1802.

DEAR SIR,

I RECEIVED your letter. It is obvious that in all fertile soils the decomposition of animal and vegetable matters by putrefaction is going on rapidly; and, in such soils, little or no acidity is found. On the contrary, in all unfertile soils, vegetable and animal matters are found in a dormant or inert state; and the cause may be traced to a combination of the mineral or vegetable acids, or to some one or other of them present in the soils.

Peat-moss is unquestionably a vegetable substance, but whether in a living or dead state, is a matter of doubt: yet all must agree that it is in a state of preservation. With due deference to the opinion of others, I am clear that the surface of a peat-moss is a living, or rather a congeries of living, astringent vegetables of the cryptogamic class of plants, holding other vegetable substances in a state of preservation, or nearly so, a consequence of the astringent or antiseptic juices with which the moss is saturated.

The red or spongy moss is in the highest state of luxuriant vegetation:—the black, of a compact and firm texture, in a matured state; and the intermediate kinds in different degrees or stages of vegetation: and in whatever stage, by nature it seems to have no tendency to the ordinary course of animal and vegetable matter, death and dissolution.

Therefore, to convert moss into productive soil, it is necessary to induce putrefaction, by disengaging or neutralizing its acidity, or antiseptic juices: and, in proportion as neutralization is effected, will putrefaction or decomposition take place, whereby the moss-soil is rendered fit to produce a luxuriant vegetation of sweet or cultivated plants. I know of no instance where moss has been improven or rendered in the least productive, but by methods in which this principle can be recognised; and, of all the various modes that are known and practised, I know of none preferable or equal to the application of lime or calcareous earth as a manure: whether in the caustic (which is preferable) or in the mild state, it is always in a situation of activity, ready to combine with and neutralize acidity or antiseptic juices.

You mention the mosses of my friend Captain CHEAPE of Rossie, which he hath improven without calcareous manure. If it is the moss near to his house, it will be found in part decomposed by the former overflowings of the adjoining loch; and he would find that the application of some of his excellent shell-marl would be attended with further beneficial effects.

You likewise mention Mr MARJORIBANKS's improvements upon the plan practised here, in which he has failed, as you suppose, by insufficient draining. It is by no means necessary to be at great expence in draining. All that is necessary is to drain the moss of subterraneous water or springs (which may be done upon the improved principles of draining), and of surface water, which may be done in most cases by the ridge division furrows. There is danger in laying the moss too dry at first. By hardening the antiseptic juices upon the vegetable fibre, effects are produced similar to that of *barking fishing-nets, or tanning leather*. In this way putrefaction is counteracted, and cannot afterwards be effected by lime, without the application of dung in considerable quantity. The volatile alkali in the dung readily

combines with the astringency in the dried moss, while the animal and vegetable mucilage acts as a putrid ferment.

It is upon these principles that Lord MEADOWBANK has, by very correct practical experiments, founded a successful method of making compost dunghills of moss. His Lordship's experiments are of great importance to the scientific agriculturist, as well as to the practical farmer.

But moss cannot be converted with success into good soil by the application of dung alone.

I cannot help thinking that something must be radically wrong in Mr MARJORIBANKS'S practice, as I know of no other instance whatever of my plan of improving having misgiven. At a much greater elevation above the level of the sea, Mr FULTON of Hartfield, in Renfrewshire, has, with great success and profit, improven above 500 acres in a way exactly similar to that practised here, and he is going on adding to his improvement at least fifty acres per annum. The elevation of his moss above the level of the sea is considerable, and is certainly greater than that in which Mr BELL, in his Agricultural Essays, supposes corn can ripen.

I have only farther to remark, that as chemists

are not agreed as to the peculiar acid in moss, I give it the generic name of antiseptic. I know that lime, in the caustic state, in some circumstances, is also an antiseptic; but, from experience, I find, that it rapidly regains from the moss the carbonaceous principle, and, consequently, deprives the moss of an excess of carbon, in converting the lime to the mild state, and thereby the decomposition of the moss is accelerated.

If any hints I have given be of the least service to you, I shall think my time well bestowed. I am, &c.

Reply to Captain SMITH.

DEAR SIR,

I SHOULD be deficient in my duty towards you for the trouble you have been pleased to take for me, if I did not immediately acknowledge and thank you for the favour of your letter.

With the greatest deference, I presume to offer you in return a few observations for your consideration.

Peat contains so little of any acid, that the ablest chemists cannot, as you observe, agree about the name of it: and some doubt if peat has any free acid at all, though some peat, as other soils, certainly has acid. I can discover in peat (unchanged by any chemical process) no appearance of the obvious qualities common to all acids. It does not in any degree effervesce with alkalies or change vegetable colours to red. Hence, peat-soils generally should not be more acid than the most fertile ground. Neither does it seem to contain more, but rather less acidity, than fresh vegetables (subject to ordinary decay) of the same kind as those of which peat is composed.

If it is by an unneutralized acid juice, in every peat-bog, that vegetables in it are preserved, How is it possible that a calcareous mass of shell-marl could so often, as you know, be found existing in the middle of such bogs? If calcareous substances decompose peat by neutralizing the acid that is supposed to preserve it, Would not the marl, in this case, prevent the possibility of peat being formed?

I subscribe to your opinion, however, that it is by the astringent or antiseptic juices with which peat-mosses are saturated, that the vegetables in

them are preserved from putrefaction; but astringents and bitters counteract the effects of acids. Wormwood is used by distillers to check acidity; and physicians say, that astringents are powerful absorbents of acids. This is the language of Dr CULLEN.

Tanin, or the tanning substance, is now discovered, you know, to be a matter possessing no acid property, and that exists in the astringent vegetables, separate from their peculiar acids. By it, and not by acid, the tanning of leather is performed; and fishermen's nets are by it tanned, to preserve them long from the ordinary progress of decay.

In agriculture, let us rest on facts sufficiently proved, not on chemical principles, which, in agricultural matters, are apt to mislead those that trust to them. The speculations on agriculture by the chemists of one generation have been laughed at by those of the following, and the principles of the present chemists will probably be ridiculed by the next generation. It is a science still in its infancy; and it is doubtful to me whether it shall ever be the gift of man to know the first principles of things, either moral or physical.

Account of the Expences of improving an Acre of Moss on the Plan of Captain SMITH *of Swindridgemuir.* By Mr LUMSDEN.

NOTE.—The acre, in this account, is always meant the Scotch acre, being nearly one-fifth larger than the English acre.

The average size of the inclosures is eight acres; to inclose which by the main drains, will require 143 falls of 18½ feet each, at 1s. per fall, in proportion for one acre, 17¾ falls, - -	L. 0	17	9
Digging and forming the ridges with the division-furrows, is from £1 : 13 : 4 to £2, 2s, say -	2	2	0
Prime cost lime for top-dressing one acre, from 4 to 8 chalders; 5 Winchester bushels make a boll, and 8 bolls unslaked shell-lime a chalder, producing 16 bolls powdered lime; say 8 chalders, being 320 bushels, or 64 bolls, at 1s. 2d. per boll, - - - - -	3	14	8
The distance here is from one mile to one mile and a half, 64 bolls may at a greater distance be carried for - - - -	0	10	0
Laying on the lime, - - - -	0	8	0
Value of the dung, supposing it bought, laid down at the side of the field, 3s. per single horse-cart, 20 carts, - - - - -	3	0	0
Laying on the dung, - - - -	0	8	0
Trenching lazybeds for covering the potatoes, -	0	6	0
Price of three bolls of potatoes for seed, at 8s. -	1	4	0
Taking up the potatoes, and carrying home, -	1	10	0
Over,	L. 14	0	5

Brought over,	L. 14	0	5
Add interest of L. 14, 5d. for two years, -	1	8	0
Total expence, - -	L. 15	8	5
Produce of potatoes from 40 to 50 bolls, say 40 bolls, at 8s. - - - - -	16	0	0
Gain upon the first crop per acre, - -	L. 0	11	7

Second Year.

Reducing the lazybeds into ridges, - -				L. 0	18	0
One boll of oats for seed, - - -				0	13	0
Four men harrow one acre one rood, say one acre per day, at 1s. 6d. each, - - -				0	6	0
Reaping, - - - - -				0	6	0
Carrying off, - - - - -				0	2	6
Leading and stacking, - - - -				0	2	6
Thrashing, - - - - -				0	5	0
Dressing, - - - - -				0	1	0
Carrying to market, - - - -				0	5	0
				L. 2	19	0
Interest for one year, - - -				0	3	0
				L. 3	2	0
Produce, 10 bolls per acre, at 13s.	L. 6	10	0			
Value of the straw, - -	0	15	0			
				7	5	0
Gain the second year, - -				L. 4	3	0

Third Year.

Digging the ridges,			L. 1 6 0
One boll of oats for seed,			0 13 0
Harrowing,			0 6 0
Reaping,			0 6 0
Carrying off,			0 2 6
Leading and stacking,			0 2 6
Thrashing,			0 5 0
Dressing,			0 1 0
Carrying to market,			0 5 0
Clearing main drains,			0 1 0
			L. 3 8 0
Interest one year,			0 3 4
Expences third year,			L. 3 11 4
Produce 10 bolls oats, at 13s.	L. 6 10 0		
Value of the straw,	0 15 0		
			7 5 0
Gain third year,			L. 3 13 8

Fourth Year.

By this time the moss is so consolidated as to be ploughed by horses within two bouts or stitches of the division-furrows, and the crop removed by carts.

Ploughing,	L. 0 6 0
Digging two spits or stitches, and clearing division-furrows,	0 4 0
Over,	L. 0 10 0

Brought over,		L. 0	10 0
One boll of oats for seed,		0	13 0
Grass-seeds,		1	0 0
Harrowing with horses,		0	3 0
Reaping,		0	5 0
Leading off and stacking,		0	3 0
Thrashing and dressing,		0	3 6
Carrying to market,		0	4 0
Clearing main drains,		0	1 0
		L. 3	2 6
Interest one year,		0	2 8
		L. 3	5 2
Produce, six bolls oats, at 13s.	L. 3 18 0		
Value of straw,	0 8 0		
		4	6 0
Gain fourth year,		L. 1	0 10

FIFTH YEAR—Hay.

Cutting,		L. 0	3 0
Winning,		0	3 0
Leading and stacking,		0	5 0
Clearing main drains,		0	1 0
		L. 0	12 0
Produce of 200 stones of hay, at 4d.	L. 3 6 8		
After grass,	0 10 0		
		3	16 8
Gain the fifth year,		L. 3	4 8

The moss will now be sufficiently consolidated and fit for pasture, and will let as such for L. 1, 5s. per acre.

RECAPITULATION.

Gain the first year, - -	L.	0	11 7
second year, -		4	3 0
third year, -		3	13 8
fourth year, -		1	0 10
fifth year, - -		3	4 8
	L.	12	13 9

It may be added, the reclaiming of moss upon this plan, bids fair to be of very great consequence; and, when it becomes better known, will, from experience, gain farther improvement. There are many thousand acres of this sort of ground in Great Britain, situate in climates where corn thrives well; some in the very best corn countries, where lime, marl, or other calcareous matter, can be obtained at a moderate expence, which appears to be what is most essentially necessary in this improvement; and much greater quantities of moss abound in Ireland, none of which produce a penny per acre in its natural state. There is no danger of not obtaining a proper level, for, in most large mosses that I am acquainted with, a river runs through them; and, were it otherwise, and that they had no level, they would in time become lakes.

There are no waste lands, that I know, which can be improved with equal advantage as moss: none will give so quick or so large returns, or be so permanent.

Letter from Dr JAMES JEFFRAY, *Professor of Anatomy in the University of Glasgow, to the Author.*

2d February 1803.

SIR,

IN answer to your letter, what information I can from experience give, on the subject of improvement of moss-land, is nearly the following; and if it prevent you from falling into some of the errors into which I was led, or diminish your expence, I shall be very glad.

When I began with the moss, I followed as nearly as I could the plan recommended by Mr SMITH of Swindridgemuir: 1*st*, By delving the moss, so as to imitate ploughing; 2*dly*, By laying on lime and dung as manure, and planting potato-sets on the delved ridges; 3*dly*, These I covered with stuff thrown up from trenches made across the ridges, lazybedding the whole; 4*thly*, When the plants

began to come through the ground, they got a new covering of moss thrown up from the trenches and side furrow-drains; *5thly*, As much care was taken as possible to keep the manured mould above, in digging the potatoes, and filling up the cross trenches. But I had neither pleasure nor profit in following this method. For, in the *first* place, the sods having been turned over as they lay, whether on height or hollow, the ridges were exceedingly unequal on the surface, and I had no satisfaction, after all my expence, in looking at the field. *2dly*, I never could get the people to be so careful, in digging the potatoes, as not to turn much of the manured soil into the lazybed trenches, where, to me, it was for ever lost. *3dly*, In harrowing the field next season, I always found that the heights between the trenches were bared of a great part of what manure did remain, so that ultimately the trenches became filled up and enriched; but the intermediate spaces were impoverished. The effects of this were not only evident in the grain-crop, but in the grass-crops afterwards, among which the heath began soon to spring. *4thly*, The first covering given to the potatoes, if the weather was dry and parching, very soon dried, and shrunk into fuel-peat,

leaving gaps, through which the air and sun got access to the sets, preventing them from beginning to spring, either till rain came, or the second covering was given. This rendered the crop very unequal, and, on the whole, late. *5thly*, But what gave me most uneasiness, was, that after every thing had been done, and the crop had come up, and was promising to do well, it never failed to be greatly damaged by the late frosts in May, and even June, and this, too, when by the same frosts the same kind of crop on the uplands was little injured. The same misfortune was apt to happen from the early frosts in autumn. *Lastly*, The expence of all the different operations I found was great, while the crop was very precarious. These circumstances had almost induced me to give up the business altogether; but the following casual observation led me to go on. Some ditches had been cast so deep in some places, that sand, &c. had been thrown up, and, on dressing up the side of the ridges, this earth had been spread. Wherever it had come, the grain-crop had been better than elsewhere; and now the grass that followed, was not only more luxuriant and close than elsewhere, but consisted chiefly of the *Holcus mollis*, or Yorkshire fog; none of which

could be observed in any other parts of the field. Hoping that the scourings of ditches, &c. would produce the same effects, if laid in abundance on the rest of the field as this sand, &c. had done on the sides, compost-dunghils were prepared during the summer, and the rate to each acre was made 100 single horse carts of earth, 6 chalders of lime, and from 15 to 30 tons of dung. The lime and earth were laid in heap, and pretty regularly mixed in summer. In the end of autumn, or through the winter, the heaps were turned, and the dung added. By spring the change was great; the whole could be spread with great regularity. The effect of this has been very great, some of the crops selling for L. 15 per acre on the foot, and the produce turning out to be 12 bolls yielding 14 pecks. And now our mode of management is greatly changed, and reduced by habit into somewhat like a system. The field being laid dry by the usual ring-drains, the ridges are laid off by the line with great exactness. Each ridge is made thirty feet wide, so that they can afterwards, if thought proper, be split into two fifteen-feet ridges. They are gently raised in the middle; they are levelled, and made uniform throughout. The spadefuls in delving are not turned over,

and left resting on their sides, with the grass and heath sticking up through the seams, but lifted, and the grassy side, after burning, laid down with as much care as in garden delving; by which means I find that the whole rots sooner,—the field is reduced into form at once,—and, in the end, the expence is diminished, though the first outlay be nearly double.

The compost is wheeled on, and every barrowful is thrown down on an old door or wooden platform, and from thence regularly spread, especially towards the sides, by people who do not wheel, but attend to spreading only; so that no tufts are seen in the field, and in general very few blank spaces. The crop is, in general, oats, though this year I tried rye, which did well; but, like other grain of the kind this year, it did not fill well.

If care has been taken to level well, and to make the furrow-drains sufficiently deep, I get the moss ploughed for the next crop, by taking the following precautions. The horses must be yoked on end. There must be no offset on the left side of the plough; so that the horses shall be able to go always on the right. As the middle of each ridge had been raised by leaving about two feet of it un-

touched from end to end, and as this would still remain solid, and be, if gathered, three sod deep, where there should be but two at the most, we lay sheaves of straw in the furrow-drains between the two contiguous ridges at either end, and cast these two ridges towards one another. Next year we reverse that; and as, by the harrowing, &c. the middle gets rather flat, we gather each ridge at the third ploughing: by which time, if care has been taken to mark any bare spots, and to give them annually a little more compost, the whole will be ready to be laid down in grass. Indeed it will be difficult to keep it from running to grass, in which, as may be expected, there will be many of those weeds that delight in putrefying soil, but the bulk will be great, and the pasture thereafter very luxuriant. I need not say, that, though the Yorkshire fog tufts well, and bears up beasts surprisingly; yet, till the sward be close, ewes and lambs in spring, and lean sheep, that, in a few weeks of dry weather, will eat a field bare, are better than heavy stock, kept on throughout the season.

Besides the above precautions in ploughing, it is necessary to add, that we choose either dry weather or frost, if not too hard, and that we always mount

our horses on pattens. Young horses do not like them on hard ground, but all horses seem to confide in them on moss. We get the crop off by means of the pattens and broad wheels; and, after the first crop, we can, in general, cart on earth where needed. To harrow for the first crop is the most difficult part of the business. Where it can be done by putting the horses on pattens; keeping them on the middle of the ridge; lengthening the traces, so as to allow a man on the other ridge to draw the harrow towards the side, &c. we do it. If the ground be too soft we harrow by men; for, on trial, we have found harrowing to be better than hoeing in the manure and seed. Hoeing raises, indeed, a shallow mould, if carefully and effectually done over the whole; but, while the tissue of the sods is as yet unbroken down by putrefaction, the work is hard, and the people get careless; while, at the best, the seed is left above; and, when it springs, its roots can neither penetrate the tough sod, nor, if they did, could they find nourishment there: whereas, harrowing turns the manure and seed both, in a great measure, into the crevices, leaving, comparatively speaking, few grains above. What are left are either picked up by the crows, or they vegetate so feebly that they

are killed by the luxuriant and tillering stems that rise from the seeds that have followed the manure: and we have always observed, that excess of manure not only has been followed by a corresponding luxuriance of crop, but that, in proportion to the luxuriance of the crop, did the putrefaction of the sods, or the making of the soil, go on. I do not know how far cropping on well dressed moss may be carried; but, from one field, I have taken three crops of oats, and one of beans, with pease, which last I ploughed in. One of my friends tried beans at the same time, but he dibbled them in. My crop was a very surprising one, and many came to see it. It was thought there would be nothing but straw; for the stems, especially of the pease, were exceedingly rank, but in this we were mistaken. The dibbled field had no crop; few of the stalks were above a foot high. I can give no reason for it, except that mine were, by the ploughing, turned in among the best soil, and got a good root, while the others were stuck into the unputrefied sods. The first crop is worse than the second, probably because the putrefaction has but begun. In so far as I can see, a second manuring, after delving or ploughing, or on the red, as it is called, if it is given liberally, would pay

well. Last year, having rather too much in hand, I laid down one field on the first crop with white clover; a little red, which, on earthed moss, I find does grow, and Yorkshire fog, which you need not buy after your first hay crop, as it comes up of itself, though, to make sure of grass soon, I generally now sow it.

If there be any thing else on which you wish farther information, I will, if I can, give it. I am, &c.

P. S.—On every acre of my upland, which is stiff clay, I lay a compost of 100 carts moss, 6 chalders lime, and from 20 to 30 tons dung, with success.

Two Letters on the Improvement and Planting of Hops on that kind of Peat-Moss called in Scotland White Flow Moss, and in Ireland named Red Bog, being that sort which is wet and soft, and composed on the surface generally of Plants of the Trichostomum lanuginosum, a variety of the Bryum hypnoides, and others of the Cryptogamic Tribe, as published in the Dublin Agricultural Essays in 1757.

GENTLEMEN,

IT must be matter of concern to all to see great tracts of land lying entirely useless in a coun-

try which has the utmost reason to husband all advantages with care. Such are the many and extensive bogs to be met with every where in Ireland, which, except a poor coarse pasture on the better kinds, afford no other profit to the owner than what can be made by burning the soil of them in turf. I hope, therefore, it will be an attempt agreeable to gentlemen of your public spirit, to introduce a culture of them, which, at a small expence, will turn to great account, and to make those unprofitable lands, without much labour in reclaiming them, bear a good and valuable crop. The crop I mean is hops: and the bogs in which I have reared them with most success, the worst and most useless of all others the red bogs. The profit has for many years fully answered my expence, and what has turned to my advantage, will do so with every body else in the same method of improvement.

Few are so far strangers in this matter as not to know, that, among the several kinds of bogs, the red are deservedly esteemed the worst. Black bogs yield some kind of pasture of a finer or coarser grass, according to the nature of the bog. They are, besides, more easily reclaimable, and if the upper surface be skimmed off, and the sods burnt, they

afford their own manure, a large quantity of red heavy ashes strongly impregnated with salts: whereas the red bog has none of these good qualities; it has a spungy, light, fungous, variegated surface, bears no grass, and when you come to burn it, yields but very little ashes, and even those, white, fleaky, light, and insipid. This is so well known, that these bogs are never charged with rent, but thrown into the survey of farms as unprofitable lands: I have indeed reclaimed some of this kind of bog in a different manner, and for other purposes than for hops, and, therefore, cannot join in calling them unprofitable; but since they are generally so esteemed, and accordingly so neglected, it will be of equal service to my country to promote the culture of them under hops, as if they were really so.

As one letter cannot contain all I have to say on this subject, you will give me leave, gentlemen, to confine myself in this to the manner of laying out the ground, and to reserve the planting of the hops for the subject of a second. Should I crowd the whole into the compass of one paper, my directions could not be particular, as they must be in Essays of this kind, to be useful to the farmer. There are in the execution of any new improvement, many

little circumstances which alleviate the labour and lessen the expence, and though they may appear trifling upon paper, they are, however, of considerable importance in practice: These I shall take leave to observe as I go on, being less concerned for elegance and neatness in a performance of this kind, than for the ease and advantage of the husbandman.

Round the spot intended for your hop-yard, dig a trench seven or eight feet wide, to drain off the water:—give it all the depth the fall of the bog will bear; and if you cut it into the gravel it is the better; make your trenches straight, and every where of an equal breadth: to that end lay them out, and mark them by the line. The score or mark is made in uplands with the spade, but in bogs a hay-knife is much better. One man will cut faster with this instrument than five men in the common way.

When that is done, take off the first or upper sods of your intended trench with the spade, but beware of cutting your sods too large; they are then inconvenient for carriage, and increase the labour of removing them. Make them of that size that they may be easily turned up, and thrown with

pitch-forks on a wheel-barrow: You may then, at a small expence, convey them where they may be useful. The proper use of them is to fill the adjacent bog-holes, and level the uneven places of your bog. However, it will be necessary to reserve a few of them for facing your ditch, in the same way as you do upland ditches.

When the first sod is pared off, proceed to dig your trench with slanes. The soil thrown up will be as good turf (for fuel) as any other, and defray the expence of trenching; and this I desire may be understood as a general direction, and applied wherever a trench or hole of any size is to be cut out in a bog. By this means the charge of digging is made up to the farmer in good turf, and the labour pays itself.

In cutting your trench, be careful to leave a gun (or bridge) on each side of your plot: This is a piece of bog uncut, designed as a passage in and out, with a channel for the water bored in it; it must be nine or ten feet wide, and the arched channel under it of sufficient height and breadth to let the water through. In short, a gun is a natural bridge, and must have the same qualities; strength in the arch to afford a safe passage over, and wide-

ness equal to the discharge of water. Two men with spades or shovels, thrusting from each side till their tools meet, will make one in a little time.

There is another circumstance to be observed in the making of your trench: At the lowest part of it, where the water is discharged, leave a bank of two feet high uncut, to keep it to that height in the whole surrounding drain. By this means you have a reservoir at hand for the use of your hop-yard; which, whenever a dry summer happens, will require to be well watered; and, besides a ready and cheap manure, from the sludge or mud which will lodge at the bottom of your trench when the current is checked by this little bank. Some, indeed, may fear, that the inclosed ground may suffer by this method, and be kept too moist by the water above it; but this I am, by long experience, satisfied is a groundless apprehension. The flowing water, with a fair vent before it, has little lateral pressure, but directs its way where it has the freest passage. I have made large drains in a bog, and kept them full of water within a foot of the brim, and found no inconveniences attending it.

The Second Letter.

GENTLEMEN,

YOU will give me leave to proceed in my instructions on bog-hops, without introduction or apology, and to address myself directly to the farmer.

When you have prepared and inclosed your bog in the manner described in my former letter, stretch a line parallel to any one side of your inclosure. To this line tie rags or feathers, nine feet asunder from each other; and, when your line is stretched upon the ground, at every mark or feather drive a sharp stick into the bog to determine the centre of your hop-hills. Having finished your first row, remove your line to nine feet distance, and mark out a second. From that proceed to a third row, and so on, until you have finished the whole plot. The ground being thus set out, and the centres of your hop-hills regularly disposed at nine feet distance from each other, your first work will be to dig a hole at every centre three feet wide and three feet

deep; to lay the upper sods of it in the hollows of your bogs, and to make turf of the remaining soil. If you proceed in your work that summer, your turf must be wheeled off immediately, spread, and laid upon other ground, otherwise it would prevent the passage of the tumbrils, which you have occasion for in your next business. This is to fill your holes with proper earths or composts, in order to receive the hop sets which are to be planted here, and afterwards managed in the same method as in other places. To do this it is obvious that much earth will be wanted in a plantation of any considerable size; and how to provide himself with a sufficient quantity, at a cheap rate, is of great importance to the farmer. My method is as follows: In the upland nearest to the bog, I take off a sward of a small plot with the hoe or winged plough. I burn it; and, by thorough ploughing, mix the ashes with the mould. To these I add a little lime, rotten dung, or rich garden mould, and throw the whole together into heaps, where it heats and rots, and in a little time affords the richest compost, and the best soil for hops. I have made artificial earths in this manner, not only for the present purpose, but in other improvements also, and found it, upon trial, a

great deal less expensive than it appears at the first view. The carriage of them to the bog is the heaviest article in the expence, and this also is much alleviated by the breadth of the alleys, and the method of planting the hops in holes. As the tough surface of your bog is nowhere broken, but in the very spots where the hops are planted, it affords a safe passage for your cattle; and, as your walks are six feet wide, the hills being but three feet over, and the centres nine feet distant, you may make use of cars and tumbrils, a cheap and commodious carriage.

I own that, notwithstanding these precautions, this improvement is expensive; but raising hops in any ground is so, and I am sure greater in the most favourable upland situation than in bog. A very little arithmetic will shew that ditching and inclosing, which in bog is no expence (the turf made at the same time being equal to the charge that ploughing, harrowing, fallowing, and digging, which, in my method, are entirely saved), with the additional articles of dunging, hoeing, and paring the alleys in uplands, are more than equivalent for all the labour and expence attendant on bog-hops; and, from fifteen years' experience, I can venture to affirm, that

the produce from the latter is as great in quantity, and in quality as good. Many reasons might be given why it should be so; some of them I beg leave to lay before your readers. They may be necessary to remove the prejudices which generally attend new projects, and to make this improvement as common in this kingdom as I am sure it will be beneficial wherever it becomes so.

Were it peculiar to my method, I should reckon it the first advantage of it that the hills stand at nine feet distance; but, as this may be imitated in uplands, I shall only say, in general, that nothing is more prejudicial to hops than close planting.

The care taken, in uplands, to hoe and pare the alleys, sufficiently shews that it is esteemed a disadvantage to have any quantity of grass growing among hops. Red bogs are, by their nature, free from this inconvenience, and, at least for many years till the surface is entirely altered, throw up none or very little. How far planters are right in their opinion that a coat of grass impairs the action of the sun upon the fruit, I shall not here examine; but, while that opinion holds, it will ever be a reason in favour of red bogs.

Watering hop grounds, in dry seasons, though,

from the great expence attending it, too frequently neglected, is certainly of great benefit to the crop. This may be done in bogs with great conveniency and little charge. The surrounding drain is a constant reservoir, where the planter may be readily supplied; and whoever understands the culture and the growth of hops will reckon this no small encouragement.

It is agreed among hop planters, that low grounds have great advantages; they are little exposed to droughts, and sheltered, by their situation, from destructive storms. Bogs enjoy those in common with the rest; besides, as long experience has informed me, some peculiar to themselves. They do not suffer so much as other flats by the rains of a wet season, or the mildews of a dry one. Whether their sponginess affords a passage to the waters which lodge in other grounds, and their constant moisture prevents the bad effects of too much heat, I shall not now examine; but the fact itself is certain, they are free from the inconveniences above mentioned; and, what is more remarkable, from those swarms of insects which too often infest our upland hops.

I must add, that, in this kind of planting, the top-roots have liberty to shoot as far as nature de-

signed they should: they have three feet of the richest soil to go through, before they run into the bog; and even there, when once it is well drained, they will meet with better juices than in a cold stiff clay, or a sharp sour gravel, which are the common upland bottoms.

I shall conclude, by obviating a doubt, which might perhaps occur to some of your readers: poles will stand in these bogs as firm as in upland ground. The earth laid into the holes, pressed together and confined by the tough stringy substance of the bog, will sufficiently support them; and they need be sunk no deeper than improvers direct in other hop-yards.

On the Mode of Application of Peat-ashes to Crops. Transcript of a Letter to the Editors of the 'Museum Rusticum,' in November 1763; from an English West-country Farmer.

THE more general a manure is in its uses, of so much the more value it is to the farmer; and of all sorts of manures, perhaps, ashes agree with the greatest variety of soils and crops. All kinds of

ashes have their several degrees of excellence; yet some are much to be preferred to others; and, perhaps, peat-ashes are at least as good as any. Ashes, therefore, in general, one should imagine, should be had in universal request: but, the misfortune is, no great quantity can be procured; and the few that are to be got fetch a large price. This deters the farmer from making use of them often as manure. I must, however, except peat-ashes, which are on all accounts valuable. These are, in most places, easy to be procured; cost no great matter, and have a wonderful effect on almost every soil and crop. You may believe what I say, as I had many years' experience of their good qualities.

The ordinary peat is dug from wet bogs and morasses; but that which is of a much superior quality and virtue in its ashes, is dug from moory wettish lands, which will bear cattle. As to the peat that is pared from the surface of heaths and commons, for firing for the poor cottagers, the ashes of it are of little value, when compared with those above mentioned.

Peat is found in most low grounds that lie between hills, especially if timber has formerly stood on the spot.

Peat may be burnt for the sake of procuring its ashes for manure all the summer season. As soon as it is dug, some of it is mixed in a heap regularly disposed with faggot-wood, or other ready burning fuel; after a layer or two of it regularly mixed in this manner, peat alone is piled up to complete the heap. A heap will consist of from 100 to 1000 loads.

After setting fire to it, at a proper place, before on purpose prepared, it is watched in the burning, and the great art is to keep in as much of the smoke as possible, provided that as much vent is left as will nourish and feed the fire. Whenever a crack appears out of which the smoke escapes, the labourer in that place lays on more peat; and if the fire slackens too much within, which may easily be known by the heat of the outside, the workmen must run a strong pole into the heap in as many places as is necessary, to supply it with a quantity of fresh air. When managed in this manner, the work goes on as it should do. It is to be noticed, that, when once the fire is well kindled, the heaviest rain does it no harm whilst it is burning.

Having procured a sufficient quantity of ashes, the farmer's next care should be to apply them pro-

perly to use; and, to do this, he must be well acquainted with the nature of the manure he is to lay on his land.

All ashes are of a hot, fiery, caustic nature; they must, therefore, be used with caution. With respect to peat-ashes, almost the only danger proceeds from laying them on in too great quantities at improper seasons.

Nothing can be better than peat-ashes for dressing low damp meadows, laying from the quantity of from fifteen to twenty Winchester bushels on an acre. It is best to sow them by hand, as they will then be more regularly spread. This work should be done in January, or February at latest, that the ashes may be washed in towards the roots of the grass by the first rains that fall in the spring.

If they were spread more forward in the year, and a speedy rain should not succeed, being hot in their nature, they would be apt to burn up the grass, instead of doing it any service.

It is to be remembered, that the damper and stiffer the soil, the more peat-ashes should be laid on it; but, in grass-lands, the quantity should never exceed thirty Winchester bushels; and on light,

warm land, less than half that quantity is sufficient.

On wheat-crops these ashes are of the greatest service; but they must be laid on with the utmost discretion. Were they to be spread in any quantity before the winter, after sowing the corn, they would make the corn too rank, and do more harm than good: were the spreading of this manure, on the contrary, deferred till spring, the corn could not possibly during the winter season be benefitted by it. After due reflection, and repeated experience, my method of management in this case is as follows. About the beginning of November, before the hard frosts set in, I sow on every acre of my heavy clayey wheat-land about eight Winchester bushels of these ashes; on my lighter lands in wheat, I sow only four bushels at this season.

About the latter end of February, on heavy lands in wheat, I bestow another dressing of ashes, by sowing on every acre eight bushels more. On my light lands, in this second dressing I allow only six bushels.

This method has succeeded well with me, and I have no reason to think it can fail with any one else.

This excellent manure I find is of great use in the turnip-husbandry on many accounts, particularly as it much contributes to preserve the young crop from being devoured by the fly.

When I sow my turnips before I harrow in the seed, I have eight bushels of these ashes strewed by hand on every acre, and when the plants show their first leaves above ground, I sow on every acre four bushels more. By this management my crops seldom fail, when, at the same time, some of my neighbours sow their turnip-land three or four times over.

But one of the principal advantages derived from these ashes, I have not yet mentioned, which is the very great service they are of to every kind of artificial pasture.

Saintfoin receives great benefit from this manure, and so does clover, rye-grass, and trefoil, provided it is laid on with discretion. The proper season is about the month of February; the quantity must be regulated by the nature of the crop and soil, but, in my opinion, it ought scarcely, in any instance, to exceed thirty Winchester bushels.

But the effect of it is most seen on tares and vetches, and on them it is I bestow most of this

manure, as they will bear it, being a very succulent plant.

The effects of this manure will be visible at least three years, and it does not, like some others, leave the land in an impoverished state, when its virtues are exhausted and spent.

Peat-ashes are not so certain a manure for barley and oats as for the winter corn: for as these are quick growers, and occupy the lands but a few months, this warm manure is often apt to push them forward too fast, and make them run too much to coarse straw, yielding only a lean immature grain. Oats, however, are not so apt to be damaged by it as barley. To get a good crop of barley, I often sow it after turnips, which have been dressed with ashes.

Peat-ashes approach in their effects on the several crops on which they are laid, to coal-soot; but two-thirds of the quantity that is used of soot, will be sufficient of the ashes, as they are in a much stronger degree impregnated with a vegetative power; and they are besides, in most places, easier procured in quantities, and at a cheaper rate.

It may possibly be objected, that this manure requires great nicety in the application. I allow it

does, yet every intelligent farmer that knows the nature and qualities of the soils of his several fields, will soon be able, with great precision, to judge how much he ought to lay on each acre. His chief care at first should be not to overdo it, for therein consists the principal danger; though, after all, these ashes will, at the worst, unless laid on in very great excess indeed, only occasion the inexperienced farmer the perhaps partial loss of a single crop: for the succeeding year they will, in all probability, have a very salutary effect upon the land, and sometimes even repay the preceding loss.

When peat is burnt for the sake of its ashes in summer time, it is necessary that some care should be taken to defend them from the influence of the rain, dews, sun, and air, or great part of their virtue will be exhausted. If the quantity of ashes procured is not very great, they may easily be put under cover in a barn, cart-lodge, or hovel, but large quantities must necessarily, to avoid expence, be kept abroad; and when this is the case, they should be ordered as follows:

A dry spot of ground must be chosen; and on this the ashes are to be laid in a large heap, as near as possible, in the form of a cone standing on its

base, the top as sharp-pointed as possible: When this is done, let the whole be covered thinly over with a coat of soil (or straw) to defend the heap from the weather.

When thus guarded, the heap may be very safely left till January or February, when it is in general the season for spreading it; but before it is used, it is always best to sift the ashes, that the cinders, stones, and half burnt turf, may be separated from them.

This may, perchance, by many, be esteemed an unnecessary trouble; but experience, which is the best guide, has convinced me, that, by this means, I can better ascertain the quantity that ought to be sown on the several sorts of land.

These peat-ashes are almost, as I have already observed, a general manure suited to every soil. On cold clay they warm the too compact particles, dispose it to ferment, crumble, and of course fertilize, and, in fine, not only assist it in disclosing and dispensing its great vegetative powers, but also bring to its aid a considerable proportion of ready prepared aliment for plants.

On light lands these ashes have a different effect. Here the pores are too large to be affected or fur-

ther separated by the salts or sulphur contained in them: but being closely attached to the surfaces of the large particles, of which this earth is generally composed, this manure disposes them, by means of its salts, to attract the moisture contained in the air. By this operation, the plants that grow on these porous soils are prevented from being scorched and burnt: and if they want, which they generally do, more nourishment than the land is of itself capable of affording, this is readily and abundantly supplied by this useful manure.

In large farms, it is very usual to see all the home-fields rich and well mended by the yard-dung, &c., whereas the more distant lands are more generally poor, impoverished, and out of heart, for want of proper manure being applied in time. Whilst the farmers depend almost entirely on their yard-dung, this cannot fail to be the case; for dung is of very heavy carriage. They are willing, therefore, to drop it as near home as possible, being in this way able to do a great deal more work in the same space of time, but would they once try the virtue of peat-ashes, all their lands would be alike improved, though at a very considerable distance from the home-stall: for so few of them are required,

and they are so light of carriage, that a single tumbril will hold as many as ought, in most cases, to be laid on two acres of land; by which means, when these ashes are used as a dressing for the distant fields, it costs the farmer less in carriage than does that of the stable-dung for his home-fields.

You may perhaps imagine I have said too much in commendation of peat-ashes as a manure, but be assured it is all warranted by experience. If, however, you think it too much, ascribe it to the prolixity of old age. I am sure you will pardon me when I inform you, that it is chiefly to the fertilizing quality of these ashes I owe the ease I now enjoy.

On Peat Ashes as a Manure, and the use of Peat for Burning Limestone. From the Edinburgh Farmers' Magazine for May 1802.

As peats are, in several districts, used for burning limestone, I have sent you the following account of experiments leading to a more economical method of conducting that process. They are ex-

tracted from the agricultural memorandums of Robert Ainslie, land-steward to the Earl of Stair, upon his Lordship's estate at Kilhorn, in Wigtonshire, in the years 1728, 1729, and 1730.

March 1728. My Lord sent from London several barrels of a kind of earthy ashes, said to be much used, and bought up at a high price by farmers in the south of England for a surface dressing to their grass and tillage grounds; and directed a third part of them to be thinly sown on a piece of ground intended for hay: another third part to be sown on oats and bear, when springing, and the remainder to be kept, and experiments made on them, to see what substances they contained.

The grass and bear were much mended by the ashes applied, which were found to contain a great proportion of earthy substance; many particles of a limy or shelly nature appeared in the refuse, when washed; the ley also was very strong; and both it and the limy or shelly particles answered experiments with vinegar like shell marl or lime. Hence I conclude that these ashes were either made by carefully burning moss that was strongly incorporated with shell marl, or that lime had been mixed among them, by means of which, and the salts na-

tural to all ashes, their great fertilizing quality is produced.

The ashes were accompanied by the following directions for burning moss, viz.—" Begin the fire with dry faggots, furze, or straw ; then put on dried moss, finely minced, and well beat with a clapper ; when that begins to burn out, put on moss less dry, but well minced and clapped, making holes with a prong, to carry on the fire where wanted to burn most ; and, whenever it begins to burn out, still add more clapping and pronging till your hill of ashes be a waggon load, which, when cold, carry to the bins before it gets wet. Bottom earth makes the strongest ashes, and yields well, when burnt wet and slow.

October 1728. The ashes, in some places, turn out poor white light stuff; in others very clean and good ; but several of the kilns are mixed with unburnt earth, and all of them wet in the bottom ; for which reason, I propose making the kilns larger next year ; so that there may be less refuse, and on dry ground that the damp may not be sucked up by the ashes before they are removed.

May 1729. Agreed with Ephraim Ross, ditcher, to burn the moss this year at *six pennies*

the cart load of ashes; he to wheel the moss from the bog, and to furnish himself with dry peats and heather, and to begin the kilns upon dry ground at the bog side.

Ephraim Ross's ashes are much better than those of last year. He began his kilns as before, and carried them on till he got a great body of heat, when he ventured to lay on the moss perfectly wet, but always chopped small with a spade, and clapped smooth with the back of a shovel, taking care to bore holes with a stick to conduct the fire and carry out the smoke. He found, by practice, that covering up the kilns in this manner twice a-day was sufficient. This he and his men did morning and evening, which did not materially interrupt their other work; so that they made good wages thereby.

Some of these kilns were as large as a cottage-house, sloping on all sides. They could not be made larger without walls of stone, as they often burned through in the sides, when the fire burst out, by which means the heat was lost; and if more earth was put to the sides, it made them so broad at top that no man could throw materials to the middle of them, or get them properly clapped; so they became open in the middle, and lost the heat.

These were such great inconveniences, that I began seriously to consider how they might be obviated, as I plainly saw that, if such a body of heat could be preserved, ashes might be made in winter as well as summer, even with wet moss. I therefore resolved upon trying to burn moss, like lime, in stone walls; and, having a draw-kiln, in which we burnt the Irish limestone, either with coals or peats, I made use of it for the experiment.

The method I followed was this: when we run out of both coals and peats, and had to give up the lime-burning, I ordered a quantity of moss earth to be collected, which, being chopped small, was thrown over the hot lime in the kiln, clapped close, and bored full of holes, as in the common ash heaps. This was repeated for several days, till the top of the draw-kiln was fully heaped. I then ordered part of the burnt lime to be drawn out at the kiln-eyes, which depressed the top, and made room for more of the moss earth, and so went on heaping and drawing till all the lime was out. I was now afraid that the fire would be smothered for want of air, thinking it could not come up through the ashes as it did through the limestones; but in this I was mistaken, as the kiln continued burning moss for

several weeks, and the ashes were more perfectly made than in the common kilns.

By this means the walls never failed: the burning (as it ought) went on slowly, and the body of heat, when properly managed, was preserved with certainty. It never failed but once, through the negligence of the attendant, who had omitted to cover it up with new moss regularly; so that it burnt through at the top, and became too cold to recover it again. It was also in danger of being smothered out by neglecting to make air-holes through the new layer of moss.

One time the bog-moss that had been collected was all burnt before a supply could be procured, and the fire was like to burn out for want of covering: it was therefore covered up with the half burnt limestone, and other rubbish about the kiln. This accident induced me to try if the moss earth, when in full heat, would burn clean limestone. For that purpose, I ordered a small quantity of well broke limestone to be thrown upon the kiln, when in full heat, and covered with a good thick layer of moss earth, and so continued to do for several days, during which time I waited impatiently to see if the stones were properly burnt. When they came to

be drawn at the kiln-eye, along with the ashes, I found them well burnt; therefore I ordered the layers of limestone to be increased gradually, always laying above them a thick coat of moss earth, chopped small, well clapped down, and bored full of holes.

In a few weeks the workmen became so expert at the work, that they burnt the limestone with moss as easily as they used to burn the moss for the making of ashes alone, and even kept burning lime, late in the season, with moss newly taken from the bog. This proved an agreeable discovery, as getting coals from Ayr was very precarious; and making many peats often prevented by bad weather and want of hands.

When lime, burnt with moss, is intended for building, the shells must be picked out from amongst the ashes before slaking, as the mixture of ashes prevents the cement from taking effect; and, when manure is the object in view, care should be taken not to throw too much water on the composition in slaking the lime-shells, as the ashes are thereby rendered useless. Ashes and lime, compounded in this manner, are preferable to either ashes or lime alone;

and, when slaked together, are much of the same nature as those sent by my Lord.

This confirms me in the opinion already given, that the English ashes either have lime mixed with them, or are made with moss earth containing a mixture of shell marl; which might be worth trying by those who have shell marl, if they would be at the trouble to burn it: perhaps this would not be worth their pains, except for the ease of carriage to a great distance, which is said to be the case in those parts of England where these ashes are used.

On Burning Limestone with Peat. From the Edinburgh Farmers' Magazine for November 1802.

I AM convinced, from experience, that limestone can be burnt to better purpose, and at less expence, with peat than with coal.

When coal is used, the limestones are apt, from excessive heat, to run into a solid lump, which never happens with peat, as it keeps them in an open state, and admits the air freely. The process of burning also goes on more slowly with coal. No lime can be drawn for two or three days; whereas

with peat, it may be drawn within twelve hours after fire is put to the kiln; and, in every succeeding day, nearly double the quantity of what can be produced by the use of coal. The expence is comparatively small. A man and a boy will dig as many peats in one day as will burn sixty Carlisle bushels of lime (the Carlisle bushel is equal to three Winchester ones), and the expence, including drying, will not exceed four, or at the most five shillings; while the coal necessary for burning the same quantity of lime would have cost twelve shillings at the pit. The wetness of seasons is no argument against the use of peats, as they can be stalked near the kiln, when half dry, at any time of summer. The moisture will be exhaled from them during winter, and they will be in a fit state for burning in the months of April or May. I live in the north-east district of Cumberland, where the farmers, in general, burn their own lime; and though there is coal in the immediate neighbourhood, I give a decided preference to peat, for the reasons above mentioned.

Account of the Method used by the Honourable Sir GEORGE BUCHAN HEPBURN, *Bart. in making compost Dunghills of Peat and Lime.* Taken from his Agricultural Survey of East Lothian.

As many parts of Scotland abound with moss, and especially the high lands, where other artificial manures cannot be so easily commanded, it seems of national importance that the mode of applying moss to land as a manure should be distinctly understood. I shall therefore state my own practice for upwards of twenty years.

The first process is to mix moss and quicklime together in the ratio of five or six cart loads of moss to one of lime; and, in this proportion, a cart load of shells will give nearly two cart loads of lime sufficiently quick for this mixture, which is allowed to lie from eight to twelve months, and is turned at least twice in that period.

Dung is then added, in the ratio of about one-fourth of the original compound; and, after lying from two to three months, and being once turned after being mixed, about thirty cubic yards of it per

acre is a full dressing for turnip, and ten cubic yards more is sufficient for a crop of wheat.

The husbandman who compounds his dung in this manner, will dress three acres for one that he can manure in the ordinary way with pure dung; and my experience authorizes me to say, that this dressing is longer marked in the productiveness of the subsequent crops, than an ordinary dressing of dung at the rate of twenty cubic yards per acre.

NOTE.—In Devonshire, black peat-earth, when mixed with lime or dung, produces good crops of excellent potatoes.—*Devonshire Report.*

Remark by Mr STEELE *on this Compost.*

That eminent chemist Sir HUMPHRY DAVY, whose opinion on the subject of composts must be of the greatest weight, observes, that lime destroys, to a certain extent, the efficacy of animal manures. It tends to render the extractive matter of common dung insoluble. But it is incumbent on me, at the same time, to state here the opinion of a respectable farmer in Roxburghshire, Mr DAWSON of Frogden, which is, that, till lands are limed, they are incapable of receiving the full benefit of animal manures.

Abstract of Directions for making Compost Dunghills from Peat-moss Earth, which have been used at Meadowbank, in Mid-Lothian, for six years, and been found to stand Cropping, whether by Corn of all sorts, Hay, Pasture, Tares, and Potatoes; and whether on Loams, thin Clays or Gravels, at least equally well with Farm-yard Dung. By Lord MEADOWBANK.

LET the peat-moss earth, of which compost is to be formed, be thrown out of the pit for some weeks or months, in order to lose its redundant moisture. By this means, it is rendered the lighter to carry, and less compact and weighty when made up with fresh dung for fermentation; and, accordingly, less dung is required for the purpose, than if the preparation is made with peat taken recently from the pit. The peat taken from near the surface, or at a considerable depth, answers equally well.

Take the peat-earth to a dry spot, convenient for constructing a dunghill, to serve the field to be manured. Lay the cart-loads of it in two rows, and of the dung in a row betwixt them. The dung thus lies nearly on an area of the future compost-dung-

hill; and the rows of peat should be near enough each other, that workmen, in making up the compost, may be able to throw them together by the spade. In making up, let the workmen begin at one end; and at the extremity of the row of dung (which should not extend quite so far at that end as the rows of peat on each side of it do), let them lay a bottom of peat, six inches deep and fifteen feet wide, if the ground admits of it; then throw forward, and lay on about ten inches of dung above the bottom of peat; then add, from the side-rows, about six inches of peat; then four or five of dung, and then six more of peat; then another thin layer of dung; and then cover it over with peat, at the end where it was begun, at the two sides, and above. The compost should not be raised above four feet, or four feet and a half high, otherwise it is apt to press too heavily on the under parts, and check the fermentation. When a beginning is thus made, the workmen will proceed working backwards, and adding to the column of compost, as they are furnished with the three rows of materials directed to be laid down for them. They must take care not to tread on the compost, or render it too compact; and of consequence, in proportion as the peat is wet, it

should be made up in lumps, and not much broken.

In mild weather, seven cart-loads of common farm-dung, tolerably fresh-made, is sufficient for twenty-one cart-loads of peat; but, in cold weather, a larger proportion of dung is desirable. To every twenty-eight carts of the compost, when made up, it is of use to throw on above it a cart-load of ashes, either made from coal, peat, or wood; or if these cannot be had, half the quantity of slaked lime may be used, the more finely powdered the better. But these additions are nowise essential to the general success of the compost.

The dung to be used, should either have been recently made, or kept fresh by compression, as by the treading of cattle or swine, or by carts passing over it. And if there is little or no litter in it, a smaller quantity will serve, provided any spongy vegetable matter is added at making up the compost, as fresh weeds, the rubbish of a stackyard, potato-shaws, sawings of timber, &c. And as some sorts of dung, even when fresh, are much more advanced in decomposition than others, it is material to attend to this; for a much less proportion of such dung, as is less advanced, will serve for the compost, provided care

is taken to keep the mass sufficiently open, either by a mixture of the above mentioned substances, or, if these are wanting, by adding the peat piece-meal, that is, first mixing it up in the usual proportion of three to one of dung, and then, after a time, adding an equal quantity, more or less, of moss. The dung of this character, of greatest quantity, is shamble-dung, with which, under the above precautions, six times the quantity of peat, or more, may be prepared. The same holds as to pigeon-dung and other fowl-dung; and to a certain extent, also, as to that which is collected from towns, and made by animals that feed on grains, refuse of distilleries, &c.

The compost, after it is made up, 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 many weeks, if the cold is severe. It always, however, has been found to come on at last. In order to bring on the heat more expeditiously, in a compost made up in frost, a narrow addition of dung and peat has sometimes, after the frost had gone off, been laid along the sides of the compost, scraping down a little of the coating of peat upon it; and, in summer, it sometimes rises so high as to be mischievous,

by consuming the materials (fire-fanging). In that season a stick should be kept in it, in different parts, to pull out and feel now and then; for, if it approaches to blood-heat, it should be either watered or turned over; and, on such an occasion, advantage may be taken to mix it with a little fresh moss. In June 1796, a compost was formed, only two and a quarter of peat to one of dung: it heated, in July, beyond the measure of a thermometer graduated to 110°. Part was allowed to stand, part turned with a half more of moss. Three weeks after (18th August), the heat of the former had descended to 84°, while that of the latter had got up again to above 110°. The heat subsides after a time, and with great variety, according to the weather, the dung, and the perfection of the making up of the compost, which then should be allowed to remain untouched till within three weeks of using, when it should be turned over upside down, and outside in, and all lumps broken; then it comes into a second heat, but soon cools, and should be taken out for use. In this state, the whole, except bits of the old decayed wood, appears a black, free mass, and spreads like garden-mould. Use it, weight for weight, as farm-

yard dung, and it will be found, in a course of cropping, fully to stand the comparison.

Let it be observed, that the object, in making up the compost, is to form as large a hot-bed as the quantity of dung employed admits of, and then to surround it on all sides, so as to have the whole benefit of the heat and effluvia. Peat, nearly as dry as garden-mould in seed-time, may be mixed with the dung, so as to double the volume, and more, and nearly triple the weight, and, instead of hurting the heat, prolong it. Workmen must begin with using layers; but when accustomed to the just proportions, if they are furnished with peat moderately dry, and dung not lost in litter, they throw it up together as a mixed mass; and they improve in the art, so as to make a less proportion of dung serve for the preparation.

The addition recommended of ashes or lime to the compost, is thought to favour the general perfection of the preparation, and to hasten the second heat. The lime, laid on above the dunghill as directed, is rendered mild by the vapours that escape during the first heat.

Compost, made up before January, has hitherto been in good order for the spring crops; but this

may not happen in a long frost. In summer it is ready in eight or ten weeks; and if there is an anxiety to have it soon prepared, the addition of ashes, or of a little lime rubbish of old buildings, or of lime slaked with foul water, applied to the dung used in making up, will quicken the process considerably.

Lime has been mixed previously with the peat, but the compost prepared with that mixture, or with the simple peat, seemed to produce equally good crops. All the land, however, that it has been tried on, has been limed more or less within these twenty-five years.

The rich coarse earth which is frequently found on the surface of peat, is too heavy to be admitted into this compost; but it makes an excellent top-dressing, if previously mixed and turned over with lime.

Peat prepared with lime alone has not been found to answer as a good manure. In one instance, viz. on a bit of fallow sown with wheat, it was manifestly pernicious.

Letter from the Author to JAMES STEDMAN, Esq. *of Whinfield, Kinross-shire, concerning Compost Dunghills of Peat.*

16*th October* 1802.

DEAR SIR,

I SHALL be much obliged to you, by your informing me how your compost peat-dunghills, that were made in the Meadowbank-mode, have answered. I think you mix with two-thirds of peat-turf about one-third of dung, to ferment it. If it is fresh horse, or pigeons' or fowls' dung, this quantity of it is perhaps more than sufficient to ferment the peat; but if it is cow-dung, or a mixture such as is common in farm-yards, do you not think a larger proportion would answer better?

Could you suggest any improvement on the Meadowbank directions? Would it not be easier, if it could otherwise answer the purpose, to mix the peat-turf with the dung in the ordinary dunghill place, just as it is thrown from stables?

In the Irish Agricultural Reports (I think it was from that of Down I took the notes), and in

some of those for England, the following easy way of making peat-composts is mentioned to have been long in use, and recommended. A quantity of peat-turf somewhat dried, to the thickness of three or four feet, is placed in the bottom of an intended dunghill. Before the dung is used, it is turned over, and mixed well with the peat. It should be turned over two or three times, at intervals of two or three weeks. Some say that potash-water put upon a gathered heap of moss, will rot it.

Dr ROBERTSON, in his Agricultural Report for Perthshire, observes, that he formed a compost dunghill of peat and dung, which made the turf finely pulverized, and was used by him with success, in the following simple manner: He laid down 150 cart-loads of peat-turf near his stables, and mixed it without any regard to stratums, with about fifty cart-loads of dung; that is, he added to the peat a fourth part of dung as a ferment, and let it lie in this state from autumn till spring, when it was needed, and the peat was then found well rotted.

Mr DUNDAS of Blair catches and carries off the peat that is floated on the river Forth from Kincardine Moss, and lays it in his straw-yard, where

it is broken down by the feet of his cattle, and forms an excellent compost with their dung.

I must remark, that a small degree of heat, not at any rate exceeding 55 degrees of FAHRENHEIT'S thermometer, is fully sufficient for decomposing any animal or vegetable substance. Hence it is possible to hurt manure by overheating it, which brings on too rapid a decomposition, and dries and wastes its substance.

We yet know little of the qualities of peat as a manure. We are accustomed to see it in a very unproductive state, when impregnated with the moisture of the bog, and we naturally conceive that it must, in whatever situation, remain unproductive: yet, in some places, the value of peat-earth as a manure without previous fermentation, is begun to be known and acknowledged. Thus, in the Agricultural Survey of the county of Nottingham by Mr LOWE, he informs us, that Mr BIRKET of Clumber Park, uses sixty loads an acre of black bog-earth as a manure for seeds, with good success: and Mr FINDLATTER, in his Survey of Tweeddale, says, that moss is sometimes applied in a raw state, fresh dug, as a manure for light soils, and apparently with good effect. He has seen it so used at

Blyth, in Linton parish. He adds, that, in some places, moss-soil is considered as a most powerful manure, even when merely dried, pulverized, and sown on the field by the hand. My opinion is, that moss used as a manure, may be the better of being deprived first of its water; for I cannot help thinking that the moisture of peat-bogs is antiseptic and hurtful to vegetation, for this plain reason: The *Salix alba, fragilis*, and *viminalis*, and, in general, all our largest and best willows, will grow in pure water, but I have tried them in every possible way in moss-grounds, and I am satisfied they will not grow there, even on the sides of moss ditches. I am, &c.

Answer by Mr STEDMAN.

WHINFIELD, 13*th December* 1802.

DEAR SIR,

IN answer to your inquiries as to how my compost dunghills have answered, that were made agreeable to the directions contained in Lord MEADOWBANK'S pamphlet, with about two-thirds of peat-

turf, and one-third of dung, I shall give you the following detail:

It was towards the end of the month of March last that I had first the opportunity of seeing the pamphlet, and I lost no time in following the directions. On the 7th of April, I made a small compost dunghill, of the extent of about thirty square yards. Every thing mentioned in the pamphlet of Lord MEADOWBANK took place with regard to the fermentation, &c., and in five or six weeks the decomposition or mellowing of the peat-turf far exceeded my expectations.

As I needed this dunghill for a field of barley, I was obliged to have it carted to it in the middle of May, without following out the directions in having it turned over. Not having a sufficiency of manure in this compost dunghill to spread on the whole field, I paid particular attention to what part was manured with this compost, that I might distinguish it from that part which was manured with ordinary farm-yard dung. The field was, as soon as manured, sown with barley, and also with rye-grass and clover seeds.

The crop of barley turned out good. Indeed it is the best I have. Nor was there any perceptible

difference in the appearance of the crop of barley on that part of the field that was manured with peat-compost from that which was manured with a proportional quantity of farm-yard dung: neither does any difference at present appear on the crop of young rye-grass and clover.

In the month of May last, I also made another compost dunghill in the same manner, which I was obliged to use as early as the month of June thereafter, being needed for a field to be sown with turnips. My drilled turnips are not so large this year as usual, which I impute to the wetness of the season. Probably also, some part of the cause may arise from this peat dunghill being made use of before it was matured or turned.

On the 12th of September last, I made a third and much larger compost dunghill, with nearly the same proportions of peat and farm-yard dung as before, only the quantity of dung was rather increased. The heat has been greater in this than in the former dunghill, and it has sunk in height nearly one-third part. It shall be managed according to the directions, and I doubt not will turn out a valuable manure. On the 18th of November last, I turned over this compost, and found the dung and peat

intimately combined beyond my expectation. I am satisfied that the heat which takes place in such a compost, will decompose quickly every vegetable refuse from the field or garden. I think such refuse of vegetables should be laid above the first or second layers of dung, keeping it about a foot from the end of the layer. This will even assist in carrying the whole mass into the putrid state. I think stable-dung is to be preferred to cow-dung for a compost with peat-earth.

You ask me, if I think, in such a compost, the proportion of farm-yard dung would be better to be increased? I answer, for the good of the public, I would advise, at the first beginning of the business, to make use of a larger proportion of dung than is recommended in the directions, till farmers become convinced of the matter of fact, that peat is thus altered in its quality; and also perceive that they may, in the same manner, decompose and reduce to dung very quickly every other fresh vegetable matter, such as branches of trees, weeds, sawings of timber, clippings of hedges, cabbage-roots, &c. In time, when they become better acquainted with the process, they may use less dung in the compost.

You next ask, what improvements I could sug-

gest on Lord MEADOWBANK's directions? I answer, I have none. His experience in the practice and knowledge in the theory are far beyond what I can pretend to. I consider this, in a country where peat is to be had in plenty, and but little dung, to be one of the greatest discoveries that ever has been made for the benefit of agriculture, and I am resolved, while a farmer, to stick by the practice.

You say, would it not be easier to fall on some way of mixing the peat with the dung in the ordinary dunghill, just as the fresh dung is thrown out from the stable.

In small farms, not exceeding perhaps fifty acres, and where peat is to be had upon or near the possession, this might answer, provided a dung-yard was conveniently fenced, so that there was plenty of room to secure the compost from being trampled upon. Till this can take place, and the value of peat as a manure is more generally known, I am inclined to think, that the most convenient plan is to lay down the peat-turf and dung for the compost, upon the land to be dunged. Thus, the compost is formed with some degree of certainty as to the quantity of each material.

As to what you state about mixing the peat and

dung promiscuously without layers, I think it would require a larger proportion of dung, but have hitherto had no experience on the subject.

History of the Mosses of Kincardine in Perthshire, Hatfield in Yorkshire, Solway in Dumfriesshire, and others, with general Remarks.

THERE is probably no tract of ground of the same extent, in any part of the British dominions, that was more unprofitable and useless, which has been rendered so productive and populous as the moss of Kincardine or Blair-Drummond, in Perthshire: and as there are also extensive tracts of waste land similar to it, both in Britain and Ireland, the means used for the reclaiming of this moss-ground deserves to be generally known.

A large number of the settlers on the moss of Kincardine, are people of the lowest ranks of the Highlands of Scotland. Had opportunity offered they would have removed to America. Fortunately, however, they have here found not only an asylum, but a comfortable settlement, in which they are usefully employed for themselves, and probably

with great benefit to their country. Were this mode of reclaiming land adopted by the great proprietors in the Highlands, in places where the subsoil is very fertile, and peat considered as of little value; or, what is preferable, were these gentlemen to employ all hands to drain the mosses and cultivate their surface, they would not only retain their people, but, by retaining them, would augment the worth of their property, and stop emigration to America or elsewhere, which, without this, or some other effectual remedy, cannot be prevented.

This extraordinary piece of improvement has been effected, by floating off the peat of Kincardine moss-ground, by a small river artificially made to run through it; and arose from the inventive genius and patriotic views of the late Lord KAMES, and has been conducted and brought to greater perfection by his son and grandson, in a liberal and judicious manner. But though it had no precedent, it is surprising, that, from the experience of its utility, it should not, as yet, have been followed as an example by any other proprietor, except, indeed, in the case of Dunmore Moss, lying in the parish of Airth, on the opposite side of the Frith of Forth, where, when this paper was written, more

than 100 acres of excellent meadow or carse grounds had been likewise recovered by floating off, by means of a stream of water, the moss-soil, which was from five to ten feet deep, and which moss-soil being a light vegetable substance, swims almost like timber. On Dunmore Moss thirty families are settled, who are an industrious and healthy race of men.

It is urged by some landholders, who have extensive mosses upon their estates, that the subsoil in Kincardine Moss is a clay of a very rich quality, and peculiarly favourable for this method of improvement. But the very same kind of clay is to be found at the bottom of many mosses. Most of the extensive mosses are bottomed by clay, or by a mixture of clay and sand, which, with a proportion of peat-earth, forms a most improveable soil. Wherever timber is found in a moss, it must have grown on the soil at the bottom: and wherever large trees have grown on a plain or in a valley, there must remain a soil well worth cultivation. It will be observed, that the great obstacle to, and expence in, the clearing of Kincardine Moss, was the want of a sufficient command of water. But, in many mos-

ses there is no such obstacle, and consequently all such expence may be avoided.

Perhaps the most important part of this plan is the nature of the tenure by which the people who improve the moss are to hold their possessions. In whatever way the immense Highland mosses may be reduced to culture, it will be found that this sort of tenure, or something similar to it, is a most effectual means to attain the end.

The Moss of Kincardine is situated in the parish of the same name, comprehended betwixt the rivers Forth and Teith, and in that district of Perthshire called Monteith. The moss begins about a mile above the confluence of these rivers; from thence it extends in length about four miles, and from one to two in breadth: and before the commencement of the operations (an account of which is to be given), comprised near 2000 acres, of which about 1500 belonged to the estate of Blair-Drummond, then the property of Lord KAMES: But including those bogs adjacent, the whole moss-grounds there consist of about 10,000 acres.

The moss lies upon a field of clay, which is a continuation of those rich extensive flats in the neighbourhood of Falkirk and Stirling, distinguished by

the name of *Carses*. This clay, which is one uniform homogeneous mass, sinking to a great depth, consists, near the surface, of different colours, and is disposed in layers. The uppermost is grey; the next is reddish, and the lowest, which is the most fertile, is blue. Through the whole mass not a pebble is to be found. The only extraneous bodies it contains are sea-shells, which occur in all the varieties peculiar to the eastern coast of Scotland. They are disposed sometimes in beds; sometimes scattered irregularly at different depths. By attending to these circumstances, it cannot be doubted that the clay is alluvial, and that the sea has been the means of the whole accumulation, and that it was carried on in a gradual manner by the ordinary ebb and flow of the tide, and by the sediments of the adjacent rivers, when flooded by excessive falls of rain, or by the melting of snow, driven back by the sea. But to whatever cause the origin of this accumulation may be ascribed, certain it is that no soil is more favourable to vegetation, or carries more abundant crops of every kind.

The surface of the clay, which, upon the retreat of the sea, had been left in an almost level plain, was thereafter every where thickly covered with trees,

oak, birch, alder, willow, mountain-ash, hawthorn, and hazel, many of them, still extant, of a great size. These trees seem to have been the first remarkable produce of the carse; and it is probable they were propagated, by dissemination from the surrounding eminences. They are found lying in all directions beside their roots, which still continue firm in the ground, in their natural position; and from impressions still visible, it is evident they have been cut with an axe or some similar instrument. For the cutting of wood, the two common purposes are, either to apply it to its proper use, or that the ground it occupies may be cultivated. In the present case, however, neither of these ends had been proposed, since the trees, by being left just as they were cut, were not only entirely lost, but the ground was rendered totally unfit for cultivation. Hence it is evident, that the downfall of this wood must be ascribed to some more extraordinary cause, and to none more probably than to that expedient, which, as we learn from historians, the Romans put so extensively in practice, to dislodge from their forests (*sacra nemora Druidum*) the ancient inhabitants of the British Islands.

CÆSAR informs us, that, after defeating the Bri-

tons, they fled into their woods, where they could not be followed by the Roman army: and HERODIAN mentions the same custom of the Britons, of skulking in their forests, and seizing such opportunities as occurred of killing the Roman soldiers. In consequence of those vexatious and repeated disasters, orders were issued by the Roman Generals then in Britain, for destroying by fire and steel all the woods. These, however, seem to have been defended by the furious Britons with uncommon bravery, for DION CASSIUS relates, that the Roman Emperor SEVERUS lost no less than 50,000 of his men, who had been employed in this business, in the course of a few years.

GALEN likewise informs us, that the Romans, after their conquest of Britain, kept their soldiers constantly employed in cutting down woods, draining marshes, and making military ways through bogs and mosses. The conquered Britons were also obliged to assist in these works.

Hatfield Chase, in Yorkshire, once a peat-bog, of the extent of 90,000 acres, and, of course, one of the largest in England, the draining of which was accomplished upwards of a century ago, plainly appears to have been formerly one of those woods or

forests thus destroyed by the Romans. That they were in this quarter of the country, and that circumstances there happened that might occasion the destruction of this forest by them, is at any rate very obvious.

The Roman way out of the south into the north, was formerly from Lindum (Lincoln) to Segelocum (Little Burrow-upon-Trent), and thence to Danum (Doncaster), where they kept a standing garrison of Crispinian Horse. A little off, on the east and north-east of their road between the two last mentioned towns, lay the borders of the Great Forest, where the Britons had their fastnesses, from which they made continued sallies upon the Roman troops, intercepting their provisions and forage, destroying their carriages, and disturbing the neighbouring garrisons. The Romans seem to have marched an army under OSTORIUS (as appears from some probable circumstances), for attacking the Britons in this forest, and encamped on a great moor not far from Tinningly, as is demonstrable from their fortifications there yet to be seen.

Upon the defeat of the Britons, they were driven back into the forest, to which the Romans set fire, cutting down with axes the most of the trees that escaped the conflagration.

Hence it is not strange that old Roman axes, somewhat in shape like what are represented in drawings as the sacrificing axes, and other axes and knives, were found many feet deep at the bottom of the moss or fen mould, on making the drains of Hatfield peat-bog.

Trees of Scotch fir, oak, birch, beech, yew, thorn, willow, ash, &c. the roots of which standing in the hard soil, at the bottom of the moss, were also found there in vast numbers. The bodies of these trees were commonly lying by their roots, with the tops in general to the north-east. The Scotch firs found there were so firm and strong, as to be sold for masts and keels of ships; and the oaks were so hard and durable, as to be fit for any purpose, though they must have been preserved in the peat-bog more than a thousand years.

It manifestly appeared that many of these trees, of all sorts, in some places had been burnt, some quite through, and some on one side. In other places some trees were found chopped and squared, some bored through, others riven with great wooden wedges and stones; and all these were found in such places, and at such depths, as must have been inaccessible, from the period of the destruction of the

forest until the time of the drainage of the peat-bog, which seems to have been formed from it.

Near a great root were found eight or nine coins of some of the Roman emperors. Hazel-nuts, acorns, and Scotch fir-cones, have also been found in great quantities, and whole bushels of them together in the moss.

On the cutting afterwards of the great new drain of Hatfield, four or five miles long, and near 300 feet wide, there were found at the bottom of the moss-ground many great trees, some of them squared and cut; rails, bars, old links of chains, horses' heads, an old axe, something like a battle-axe, two or three coins of the Emperor VESPASIAN,—one of which was kept by Mr CORNELIUS LEE of Hatfield, and had that Emperor's head on the one side, and a spread eagle on the other. In some places, the hard ground at the bottom of the moss was found to lie in ridge and furrow.—*Phil. Trans.* vol. xxii. N° 275.

On draining Martin-Meer, in Cheshire, above 100 years ago, Dr LEIGH states, that there were found in the moss-soil multitudes of the bodies and roots of great fir-trees, in their natural postures, with their cones; also, there were found eight canoes,

such as were used by the ancient Britons. In another peat-moor, Dr LEIGH mentions there were found an ancient brass-kettle, amber-beads, a small mill-stone, the head of a hippopotamus, and human bodies entire and uncorrupted. Mr DUGDALE likewise mentions a long Roman causeway, three feet thick, sixty feet broad, and twenty-four miles long, extending across the fen-country from Denver, in Norfolk, to Peterborough, supposed to have been made by the Emperor SEVERUS.

Adjacent to the moss grounds of Hatfield Chase, are those of that tract called the Isle of Axholm, in Lincolnshire. Several human bodies have been found in the deep peat-moss grounds in that quarter, which had this general description, that their skins were tanned and tough, and the hair, teeth, and nails, quite fresh. Roman roads, pavements, and platforms, and large quantities of Roman coins, were also discovered among vast heaps of fallen trees, in a state of great preservation. But among other things less remarkable, there was found by a man digging peat for fuel, at Axholm, in June 1747, the body of a lady, with antique sandals on her feet. From the shape of the sandals, some conjectured she must have been a Roman lady; and Mr

CATESBY, author of the History of Carolina, observed, that the sandals, which were of leather, were exactly like what the Indians in Virginia wear, and call mokasin; though Mr VERTUE supposed they could not be older than EDWARD I. It is remarked by Mr STOVIN, who sent the account to the Royal Society, "that all the skin of the lower parts of the body was of the same colour with the sandals, and very soft, with fresh hair upon it, &c. which distinguished it to be a woman. The skin drew or stretched like a piece of doe-leather, and was as strong."—*Phil. Trans.* vol. xliv.

The hypothesis of the Romans having also destroyed the wood where Kincardine Moss is now situated, acquires no small degree of probability, from a circumstance that occurred in May 1768, when a large round vessel of thin brass, and curious workmanship, twenty-five inches in diameter, and sixteen inches in height, was discovered upon the surface of the clay, buried under the moss. This vessel, found upon the estate of JOHN RAMSAY, Esq. of Ochtertyre, was by that gentleman presented to the Antiquarian Society of Edinburgh, in whose Museum it remains deposited, for preservation: and, in a list of the various donations pre-

sented to that Society, published by them in 1782, it is there denominated a Roman camp-kettle.

There was likewise discovered in the Moss of Kincardine, a Roman way, twelve feet wide, and regularly formed by trees or logs of wood laid across each other: also, a bridge, over what had been once a rivulet, and some Roman axes; and that this was Roman workmanship, is confirmed, by the similar Roman wooden way over a peat-bog at Groningen, in Holland, three miles long, and twelve feet broad, which appears to have been ascertained to have been laid by the 15th cohort of GERMANICUS.

Such are the grounds on which it is believed that the forest in this part of Scotland was cut down, and perhaps soon after had a road made through it by the Romans, most probably in the expedition of SEVERUS, A. D. 207, whilst DONALD I. reigned in Caledonia. The overthrow of this forest would naturally interrupt the course of these various streams which formerly ran through the valley, and thus form a morass.

Between the clay and the moss is found a stratum nine inches thick, partly dark-brown, and partly of a colour approaching to black. This is a ve-

getable mould, accumulated probably by the plants that covered the ground previous to the growth of the wood, and by leaves from the trees thereafter. The difference of colour may be owing to a difference in the vegetable substances that compose it. The brown mould is highly fertile; the other, especially in a dry season, is very unproductive. The crop that had occupied this mould, when the trees were felled, is found still entire. It consists chiefly of heath: but several other smaller plants are also very distinguishable.

Immediately above this stratum lies the moss, to the height, upon an average, of seven feet. It is composed of different vegetables, arranged in three distinct strata. Of these, the first is three feet thick. It is black and heavy, and preferable to the others for the purpose of fuel. It consists of bent-grass, which seems to have grown among the trees after they were felled. The second stratum also is three feet thick. It is composed of various kinds of mosses, but principally of bog-moss (*Sphagnum palustre*). It is of an iron colour, and remarkably elastic. It is, as fuel, considered as much inferior to that above mentioned. The third stratum is composed of heath, and a little bent-grass, but chiefly of the deciduous

parts of the former. It is about a foot thick, and black.

An inquiry will here occur, What has occasioned this succession in the vegetables of which the moss is composed?

Every vegetable has a particular soil, more or less moist, peculiarly adapted to its nature. Let a piece of rich ground be in a moist state, rushes will introduce themselves: drain the ground sufficiently, the rushes will disappear, and finer vegetables for cattle will succeed. It seems reasonable to account for the succession of the different plants that compose the moss, on similar principles.

Let us imagine an extensive plain covered with trees lying in all directions, full of branches, and possibly loaded with leaves. This, it is evident, will produce a great stagnation of water, which, as the crops of bent-grass accumulated, would still increase; and the probability is, that at length it had so increased, as to be the cause why the bent-grass, and other congenial plants of the first stratum, ceased to grow. But it is evident that a plant was to be found that could live in such a situation. Accordingly we see that moss-plants had established themselves.

When the accumulations of bent-grass, and the mosses, had, in process of time, arisen to the height of six feet above the surrounding ground, the water that fell upon the surface had, by that means, an opportunity to discharge itself. It has, accordingly, formed many channels, which are often three feet deep; and the intermediate surface being wholly turned into protuberances, has become dry and firm. By this means, it became less fit for moss plants, and heath succeeded.

By far the greatest part of the Moss of Kincardine is, upon an average, full seven feet deep, but there are parts of it fourteen feet deep; and it has, in all probability, lain undisturbed since its formation. This is called the *High Moss*. The remainder, called the *Low Moss*, lies to a considerable breadth around the extremities of the high; and is, upon an average, not above three feet in depth, to which it has been reduced by the digging of peats for fuel. These are formed of that stratum of the moss only that lies four feet beneath the surface, and downwards; the rest is improper for the purpose of fuel, and is thrown aside.

In the year 1766, Lord KAMES entered into possession of the estate of Blair Drummond. Long

before that period, he was well acquainted with the Moss of Kincardine, and often lamented that no attempt had ever been made to turn it to some advantage. Many different plans were now proposed. At length it was resolved to attempt, by means of water, as the most powerful agent, entirely to sweep off the whole body of moss.

That moss earth might be floated in water was abundantly obvious; but to find water in sufficient quantity was difficult. The only stream at hand was employed to turn a corn mill. Convinced of the superior consequence of dedicating this stream to the purpose of floating off the moss, Lord KAMES, having made an agreement with the tenants who farmed the mill, immediately threw down the mill, and applied the water to the above purpose. But the first supply of water being insufficient, a great expence was incurred by erecting an engine for raising water to the level of the moss.

In order to determine the best manner of conducting the operation of floating, workmen were now employed, for a considerable time, upon the low moss, both by the day and by the piece, to ascertain the expence for which a given quantity of moss could be removed. It was then agreed to operate

at a certain rate per acre; and, in this manner, several acres were removed.

But this was found to be a very expensive process. The ground gained might indeed be afterwards let to tenants; but every acre would require an expenditure of from L. 12 to L. 15 before it could be ready for sowing; so that the acquisition of the whole, computing it, at a medium, to be 1350 acres, would sink a capital of nearly L. 20,000 Sterling.

One other method still remained, namely, to attempt letting portions of the moss as it lay, for a term of years sufficient to indemnify tenants for the expences incurred in removing it. For some time, both these plans were adopted, but several reasons made the latter preferable. 1*st*, The quantity of water to be had was small, and being also uncertain, it was very inconvenient for an undertaker; neither were there any houses near the spot, which occasioned a great loss of time in going and coming; but when a man lived upon the spot, then he would be ready to seize every opportunity. 2*d*, The moss was an extensive waste. To let it to tenants, would increase the population of the estate, and afford to a

number of industrious people the means of making to themselves a comfortable livelihood.

In the mean time it was determined, till as many tenants could be got as might usefully apply the whole water, to carry on the work by means of undertakers.

But, before proceeding farther, it will be necessary to describe the manner of applying water to the purpose of floating the moss.

A stream of water sufficient to turn a common corn-mill, will carry off as much moss as twenty men can throw into it, provided they be stationed at the distance of a hundred yards from each other. The first step is to make, in the clay, alongside of the moss, a drain to convey the water; and, for this operation, the carse-clay below the moss is peculiarly favourable, being perfectly free from stones and all other extraneous substances, and, at the same time, when moist, slippery as soap; so that, not only is it easily dug, but its lubricity greatly facilitates the progress of the water when loaded with moss. The dimensions proper for the drain are found to be two feet for the breadth, and the same for the depth. If smaller, it could not conveniently receive the spadefuls of moss; if larger, the water would escape, leav-

ing the moss behind. The drain has an inclination of one foot in a hundred yards: the more regularly this inclination is observed throughout, the less will the moss be liable to obstructions in its progress with the water. The drain being formed, the operator marks off to a convenient extent alongside of it, a section of moss, ten feet broad, the greatest distance from which he can heave his spadeful into the drain. This he repeatedly does, till the entire mass be removed down to the clay. He now digs a new drain at the foot of the moss-bank, turns the water into it, and proceeds as before, leaving the moss to pursue its way into the river Forth,—a receptacle equally convenient and capacious, upon the fortunate situation of which, happily forming for several miles the southern boundary of the estate of Blair-Drummond, without the interposition of any neighbouring proprietor, depended the very existence of the whole operations.

When the moss is entirely removed, the clay is found to be encumbered with the roots of different kinds of trees standing in it as they grew, often very large: their trunks, also, are frequently found lying beside them. All these the tenants remove, often with great labour. In the course of their operations

they purposely leave upon the clay a stratum of moss six inches thick. This, in spring, when the season offers, they reduce to ashes, which in a great measure insures the first crop. The ground thus cleared, is turned over, where the dryness admits, with a plough, and, where too soft, with a spade. A month's exposure to the sun, wind, and frost, reduces the clay to a powder, fitting it for the seed in March and April. A crop of oats is the first, which seldom fails of being plentiful, yielding from eight to ten bolls, after one.

In the year 1767, an agreement was made with one tenant for a portion of the low moss. This, as being the first step towards the intended plan, was then viewed as a considerable acquisition. The same terms agreed upon with this tenant have ever since been observed with all the rest. They are as follows.

The tenant holds eight acres of moss, by a lease of thirty-eight years. He is allowed a proper quantity of timber, and two bolls of oatmeal to support him while employed in rearing a house. The first seven years he pays no rent: the eighth year he pays one merk Scots (or 1s. $1\frac{1}{3}$d. sterling): the ninth year two merks, and so on, with the addition

of one merk yearly till the end of the first nineteen years; during the last five years of which he also pays a hen yearly. Upon the commencement of the second nineteen years, he begins to pay a yearly rent of 12s. for each acre of land cleared from moss, and 2s. 6d. for each acre not cleared; also two hens yearly. A low rent, indeed, for so fine a soil; but no more than a proper reward for his laborious exertions in acquiring it.—*Statist. Account of Scotl.*

Dr ROBERTSON, who writes the Agricultural Survey of Perthshire, after describing some of the circumstances of this moss (of which above 400 acres had then been cleared, and on which there were 764 inhabitants, and 102 houses, with about 250 cows and horses), concludes in the following words:—"I cannot express the gratitude I feel at the happiness of above 600 British subjects in this settlement, who otherwise must have been lost to their country. Men, women, and children were employed. Their gardens, and stacks, and patches of clover, bespoke their industry. Contentment and health appeared in every countenance; comfort and plenty in every dwelling."

Before concluding this subject, it seems necessary to remark, that, as the agricultural properties of

peat-moss are yet but little known, it would be rash to decide whether, in a future age, floating off peat into the sea, as an useless commodity, may not, in whatever circumstances, be condemned. It is not impossible that, like the inhabitants of Holland, our descendants may consider peat mosses as magazines of valuable manure, as well as of fuel, in those cold northern regions, too important to be squandered away with a lavish hand.

Meantime it is not a little amusing to observe, that, while the improvers of Kincardine Moss grounds are floating off their peats, others are exerting their best endeavours to catch them in their way from being lost in the sea, considering them as profitable manures: while the former are decrying peat-earth as an useless incumbrance to their grounds, others are exulting in the discovery of it as a treasure: while some are despising peat as a fuel, as well as a manure, others in the same island are paying some hundred pounds for the surface of an acre of bog-turf, believing that, after it has served the purposes of fuel, its very ashes are the best of all possible restoratives of the vegetative powers of the earth.

Another and very different part of this moss of

Kincardine, which may probably be floating on a lake, has been repeatedly inundated with water, and carried in immense volumes upon the adjacent villages and arable fields, where it overwhelmed every thing that stood in its way.

The similar overflowing or eruption of the Moss of Solway, in Dumfriesshire, was regarded as a curious natural phenomenon in the newspapers and magazines at that time. It happened on Saturday the 16th of November 1771, when the rivers and brooks were much swelled with rain. A large body of the moss was forced into a river in its vicinity, by a fall of rain, augmenting the water, probably, of a lake beneath. It was then carried down a narrow hollow or glen between two banks, 300 feet high, into a wide and spacious plain, which it overspread. By this, 800 acres of fine arable lands were covered with moss-soil, from three to fifteen feet deep. The houses of twenty-seven families were destroyed, but the inhabitants luckily escaped. Many occurrences of this sort have taken place in Ireland, and in every country that abounds with mosses. These eruptions sometimes happen in mosses that have acquired a firm surface, and houses and inhabitants; and such mosses, when in danger, are by

their inhabitants sometimes pinned down artificially to the subsoil.

An eruption of a peat-moss is recorded as follows, in Leland's Itinerary (vol. v. p. 79): "Syr JOHN HOLCROFTE's house, in Derbyshire, stood in jeopardi with fleting of the moss."

By the eruption of the peat-bog of Poulenard, in the county of Louth, in Ireland, which happened on 20th December 1793, the ground which it overflowed was covered in some parts with peat twenty feet deep, and many houses and bridges were destroyed. And by that of Kilmaleady, in King's County, in Ireland, which began on the 26th of June 1821, above 150 acres of corn-fields, meadows, and pastures, were covered with peat-moss.

Eruptions of mosses in this manner may probably have given rise to floating isles of peat, sometimes found in lakes: these are said to be common in Holland, and some of great extent are there secured with chains.

Where many human bodies are found at the bottom of a moss (which sometimes occurs), it seems probable that this has been occasioned by their having been suddenly overwhelmed by the eruption of some moss adjacent to their habitations. The fol-

lowing instance, also, seems to denote an accident by the eruption of a moss. RICHARD LOVEL EDGEWORTH, Esq. found at the bottom of his moss, no less than fifteen feet deep, a turner's shop, many arrows, with iron heads, bowls, and other wooden utensils, and also a man's antique coat.—*Archeologia*, vol. vii.

Many disasters are also recorded of peat-mosses catching fire, both artificially and naturally, especially in very dry summers. These fires burn in some cases for months together, consuming the herbage on the surface with part of the peat-soil, and often carrying devastation to the neighbouring fields and woods. This makes great caution necessary in approaching peat-mosses with fire in very dry weather.

1826. This being a very dry summer, in Scotland, the Scotch newspapers abound with descriptions of extensive fires on various moss-grounds, especially those in Aberdeenshire. On the moss-grounds situate among the Grampian mountains, fires raged with such fury, for the space of several weeks, as to threaten with destruction the forest of Glentanner. Not only the mosses to the depth of

five or six feet, but the whole surface of the hills, to the extent of from ten to twenty miles around, were covered with a volume of flames, which destroyed both vegetables and cattle in its progress. At the mosses of Potterton and Belhelvie, also, a dreadful fire had occurred, and extended so far as to menace every thing in its way, even the habitations of men: upon which nearly 200 people assembled, and dug a great ditch on the borders of the neighbouring woods and plantations, which succeeded in stopping the progress of the conflagration. I remark, that, in general, stone-walls are the most effectual barriers against the spreading of flames occurring in moss-grounds, as I know from experience.

An Account of the Improvement of Chat Moss, in the County of Lancaster. By W. Roscoe, Esq. Communicated by him to the Right Honourable Sir John Sinclair, Baronet, Founder of the British Board of Agriculture; and by him to the Author in 1813.

Sect. I.—former state of chat moss.

The tract of land called Chat Moss, lies between the towns of Manchester and Warrington, in the county of Lancaster, being about six miles distant from each of those places, and nearly bordering upon the north-west side of the great turnpike-road between them. On the south-east side runs the navigable river Irwell, which unites with and loses its name in that of the Mersey, at Irlam, within a short distance of the moss. The principal part of this tract lies in the township and royalty of Barton-upon-Irwell. The whole length of the moss is about six miles, and its greatest breadth about three miles.

During what length of time this tract of land has remained in an uncultivated state, it is not now

possible to ascertain; but sufficient evidence remains that it has at some former period exhibited a very different surface. It is certain that a part of the moss was at one time imparked by the name of *Barton Park*. During the present improvements, the ancient oak-palings have been found under ground in cutting the drains of the moss, in an almost regular series; besides which, the boundaries of the park are indicated by a mound, which may yet be traced, and which comprehends a tract of about 400 acres.

It may also be observed, that, in the map of the county palatine of Lancaster, by ROBERT MORDEN, in CAMBDEN'S Britannia, the impalement and inclosure of Barton Park are shewn in the same manner as those of Knowsley, Latham, and many others in the neighbourhood; and the limits sufficiently agree with the boundaries before stated.

There is, however, reason to believe, that, even at the time a part of this tract was thus inclosed, other parts of it were nearly in its present state, and had been so for many ages. It is related by LELAND, that at one period the moss had grown to such a height, that a considerable portion of it became moveable, and falling into Glazebrook, was thence

carried into the river Mersey. CAMBDEN repeats this somewhat differently: "A considerable portion of the moss (says he) was, in the memory of our fathers, washed away by a river-flood, not without great danger; causing also a corruption of the waters, which destroyed a great part of the fish in those rivers," (the Irwell and Mersey). Now, as Chat Moss lies upwards of thirty feet above the level of the river, and is separated from it by a strong clay-soil; it is scarcely credible, or indeed possible, that the river could at any time have risen to such a height, as to carry away any portion of the moss. The most probable mode of accounting for this circumstance, is, that the moss having vegetated to a considerable height, and having by long continued rains, and other causes, been saturatedwith water, dislodged some portion of its surface into Glaze-brook, a small stream which runs along the south-east side of the moss into the Mersey. Instances of this have occurred in other parts of the kingdom, particularly at Solway, where nearly the same effects have been produced, not by the river-flood, but by long continued vegetation surcharged with water, which must eventually be relieved by some operation of this kind.

The last mentioned author, in mentioning Chat Moss, has entered into a brief inquiry into the causes that have produced this and similar tracts; and as from the nature of the work in which he was engaged, he must have had great experience on the subject, I shall quote what he says upon it.

" In this place (Chat Moss) there lies a valley watered by a small river" (probably the stream called Boiling-brook, which flows into the Irwell near Foxhill), " and here trees have been discovered lying flat on the ground, so that one would think that when the earth lay unhusbanded, the ditches also unscoured in these low plains, and either by neglect or depopulation, the water-passages were stopt up; those grounds that lay lower than the rest were converted into such boggy mosses, as we call them, or else into standing pools. If this be true, there is no reason to admire that so many trees in places of this nature throughout England, but particularly in this county, should lie overwhelmed, and as it were buried in the ground: for when the roots of them were loosened by reason of the too great moisture of the earth, it was impossible but they should fall, and so sink, and be drowned in such a soil." This theory seems sufficiently

to agree with the authorities quoted by Dr RENNIE, and with his ingenious reasonings on the formation of peat-moss, which he attributes to the stagnation of water at a low temperature. The stretch of land lying between the moss and the river, is of such a nature as would effectually confine the water, if the proper channels to the river were not kept open; and doubtless the obstruction of these channels by accident or neglect, has been the proximate cause of the formation of the moss.

These, however, are not all the circumstances deserving of notice on this subject. From the situation of Chat Moss, it is peculiarly liable to an influx of water, which, if not carried off, must inevitably occasion the result we are now considering. From the adjoining high grounds in the township of Worsley, under which lie the Duke of BRIDGEWATER'S coal-mines, it is probable that considerable quantities of water are subterraneously conveyed, which meeting with a substratum of clay rise up towards their level, and have for ages overflowed Chat Moss, and contributed to the increase of its vegetation. In various parts of the moss there appeared, previous to the present drainage,

many places, called by the neighbouring inhabitants Ring-pits, from which a continual stream of water issued and diffused itself over the rest of the moss. These pits were supposed by the country people to be of an unfathomable depth, but, in fact, they only extend to the substratum of clay, and are merely vents at which the superabundant water forces up a passage. In another part of the moss, the small stream called Boiling-brook suddenly disappears, but, at the distance of about fifty yards, rises up again, having doubtless traced for itself a channel between the moss and the clay. If, in addition to this influx of water from the Worsely hills, we advert to the quantity of rain occasionally falling on so large a surface, and consider the outlets to the river as stopped, we shall be at no loss to account for the formation of the moss, upon those principles which have been so fully explained by different writers, and are now sufficiently understood.

Sect. II.—of the composition of chat-moss.

Chat-moss is entirely composed of the substance well known by the name of peat, being an

aggregate of vegetable matter, disorganized and inert; but preserved by certain causes from putrefaction. On the surface it is light and fibrous, but becomes more dense as we penetrate into it. On cutting to a considerable depth, we find it black, compact, and heavy, and in many respects resembling coal. There is not throughout the whole moss the least intermixture of sand, gravel, or other material, the entire substance being a pure vegetable. The depth of the moss may be estimated from ten to upwards of thirty feet.

That water in a state of stagnation, and a certain temperature of air, are favourable to the formation of peat, is certain: But the immediate cause of peat-moss appears to be the plant called *Sphagnum palustre*, or broad-leaved bog-moss, (*Sphagnum latifolium* of Dr SMITH, Flora Britan. iii. 1145.): without which, I am inclined to believe, that not a single instance of this kind of land would exist. The very singular nature of this plant deserves particular notice. A figure of it is given in the Flora Danica, tab. 474., and its curious fructification is figured and described by HEDWIG, in his Historia Muscorum frondosorum, Pl. I. Fig. 1.

The height to which this plant grows, varies from an inch to three or four feet, according to its situation. It is strictly an aquatic; and although it will exist in situations where it is occasionally supplied with moisture, yet it grows freely, and is produced in great quantities, only where immersed in water. It consists of a thread-like stem, set with small pointed leaves, terminated in a globular head, which contains the seeds. When found in dry situations, these leaves are dense, short, and compact, but when it grows freely in wet places, they are distant and scattered. It is only of annual growth, but as the seeds fall they vegetate again in the ruins of their predecessors, if, indeed, they require any other nutriment than the water in which they are mostly found. Hence they rise to the surface, where the small heads are seen floating, and where, having ripened their seed, they again give way to their successors, annually adding their substance, as they become disorganized, to the preceding mass. This substance may, in many parts of Chat Moss, be found in its regular *laminæ;* the deposition of each year being perfectly distinct and divisible. The thickness of these decreases with the depth of the

moss, till at length they become indistinct and inseparable, and form a homogeneous substance.

But, although the *Sphagnum palustre* be the plant to which the formation of mosses is chiefly to be attributed, it is by no means the only one found in such situations. On the contrary, mosses in general support a considerable variety of plants, which may be divided into three distinct classes, according to the state of the moss, with regard to its humidity. The wettest part is chiefly occupied by the *Sphagnum palustre*, intermixed with other *mosses*, *lichens*, and *scirpi*, and interspersed with the three English species of the *Drosera* or *Sundew*. As the moss becomes more consolidated, a different kind of plants possesses themselves of it, amongst which the principal are the various kinds of *Junci*, *Eriophorum polystachion* and *vaginatum*, *Nardus stricta*, *Narthecium ossifragum*, and many of the *Carices*. But it is not till the moss has acquired a considerable degree of solidity, that it appears capable of bearing the ligneous or fruticose plants. When this has taken place, we find the whole surface thickly covered with the *Erica vulgaris*, *tetralix* and *cinerea*, the *Ledum*

angustifolium, *Vaccinium oxycoccos*, *myrtillus*, and *uliginosum*, forming a complete cover, often of considerable extent.

It may perhaps be thought that the parts of the moss thus in some degree consolidated, are more valuable than the rest, as affording a better substance, and being more easily brought into cultivation; and undoubtedly inasmuch as they require less drainage, and may sooner be worked upon with horses, they are preferable to other parts of the moss. In other respects, however, they are only upon an equality with them: the substance is entirely the same; they must be subjected to the same process; and in the following statements, I shall consider the moss as of the same consistency throughout, and apply my remarks accordingly.

Sect. III.—Drainage.

It is now nearly twenty years since I began, in company with Mr Wakefild, the drainage of Trafford Moss, a tract of about 300 acres, lying two miles east of Chat Moss. At that time, little was known on the subject, in comparison with what

has since been discovered. We engaged in the undertaking with great ardour, and no small expence. Large drains were cut in various directions; other drains, forming the boundaries of fields, opened into the main sluices; and these fields were again intersected with smaller drains, at twelve yards distance from each other. These small drains were cut with a spit, or narrow channel, in the bottom, and covered with peat sods. It is an effectual and durable mode of drainage on moss lands, the sods being almost indestructible; and many of these drains are yet as perfect as when first made.

That this method must answer the purpose cannot be doubted, but it was liable to two great objections. It was too tedious; and, from the great number of drains, two expensive. Having therefore purchased Mr WAKEFIELD'S interest in Chat Moss, I found it necessary to adopt a more expeditious method, and such as might accomplish the object I had in view with less expence. The reasons upon which I acted, and the method I adopted, were as follow.

I had frequently observed, on the borders of the moss where peat had been gotten, which is generally done by cutting down the substance of the moss to

the depth of ten or twelve feet, leaving the moss itself, or what is commonly called the moss head, standing like a perpendicular wall; that from the part so cut down, the moss had drained to a considerable distance, and frequently opened into great chasms or chinks, which became smaller according as they receded from the margin of the moss head. These chasms, which diminish from an opening large enough to take in the human body, to the size of the hand, often extend from 50 to 100 yards upon the moss head. From this it was evident, that the moss had thus been drained to a certain extent, and that very frequent drains were not necessary. To what distance a drain might act I could not precisely ascertain; but, from what I had observed, I conceived, that, if each drain had only to draw the water twenty-five yards, they would, within a reasonable time, undoubtedly answer the intended purpose; and I therefore laid out the whole of the moss on the following plan.

I first carried a main road nearly from east to west, through the whole extent of my division of the moss. This road is three miles long and thirty-six feet wide. It is bounded on each side by a main drain, seven feet wide and six feet deep, from which

the water is conveyed by the ancient tunnels under the turnpike road, with a considerable fall to the river. From these main drains, other drains diverge at 50 yards distance from each other, and extend from each side of the main road to the utmost limits of the moss. Thus each field contains fifty yards in front to the main road, and is of an indefinite length, according as the boundary of the moss varies. These field drains are four feet wide at the top, and one foot at the bottom, and four feet and a half deep. They are kept carefully open; and, as far as my experience hitherto goes, I believe they will sufficiently drain the moss, without having recourse to underdraining, which I have never made use of at Chat Moss, except in a very few instances, where, from the lowness of the surface, the water could not readily be gotten off without open channels, which might obstruct the plough. The expence of cutting out peat moss is, in general, $1\frac{1}{2}$d. per cubic yard.

Such is the whole account of the drainage of Chat Moss. In fact, the drainage of a moss, where there is a sufficient fall for the water (without which such an undertaking is seldom or never advisable), is the least difficult part of the business. The drains need

not be nearer to each other than is frequently the case with the ditches and water-courses in other lands; and I am well convinced that, in a certain period of time, drains at 100 yards from each other, if made of a proper depth, would produce a sufficient effect. The length of time that these would require, renders it, however, not desirable to rely upon them, except in cases where there is a considerable extent to work upon, and the part so in drainage will not be required for many years.

Whilst I have been engaged in this undertaking, I have been well aware of the great advantages which have been derived from the method of draining first practised by Mr ELKINGTON, in situations where it can properly be adopted. In the commencement of our undertaking, it occurred to Mr WAKEFIELD and myself, that, as the water with which the moss was overcharged, probably flowed from the adjacent high lands of Worsley, it might be practicable to intercept it in its descent by proper trenches, so as to drain the moss by one operation. With this view, we engaged the late Mr ELKINGTON to survey and examine Chat Moss; but, on considering the subject, he gave us no hopes that such an attempt would be successful. Inde-

pendent of the difficulties that would have attended it, we were not the owners of the intermediate lands; and even if we had discovered the track by which the water flowed into the moss, and had diverted its course, the immense quantity of water with which it is saturated, added to the continual increase by rain, would have rendered it necessary to proceed with the drainage in detail. I did not, however fail, as soon as I entered on the undertaking, to bring up deep drains to the overflowing feeders of the moss called ring-pits, so as to keep the water in them several feet below the surface; and, in many instances, I have since filled them up, and find such places as dry as any other part of the moss.

It would be unjust not to mention, that, in the course of these operations, I derived considerable advantage from the judicious remarks of Mr WILLIAM AITON, of Strathaven, in his tract on the Cultivation of Peat Moss; in consequence of which I was induced to diminish the size of the drains, which was a saving of great expence.

Sect. IV.—Cultivation.

The usual mode of cultivating moss lands, in the county of Lancaster, is by what is called paring and burning. A thin furrow is pared off by the skim plough, if the moss will bear horses; or by the push-plough, or breast-plough, worked by a man, if the moss be too soft for that purpose. The sod or furrow is then burnt, and the ashes, being mingled by a subsequent ploughing, with the substance of the peat, a tolerable crop of oats is produced.

But although this may be donominated cultivating, it is by no means improving moss. On the contrary, the first crop is generally the best. A course of burning, in a few years, produces a great quantity of inert and insoluble matter, which deteriorates instead of improving the soil; and even the lowering the level of the moss, by destroying every year a part of the surface, is, in some situations, a serious injury. Hence it happens, not unfrequently, that mosses, cultivated in this manner, are abandoned in a few years, and return to a worse state than they were in before any attempt was made to reclaim them.

It appeared to me, therefore, that the real improvement of moss land could only be effected by the introduction of calcareous substances, of which lime and marl are the principal. I have used both in considerable quantities. On Trafford Moss I have a tract of sixty acres, which has been entirely reclaimed by lime, and which has now been in cultivation many years, and borne crops of potatoes, clover, oats and wheat, equal to any of the adjacent lands. This tract is advantageously situated on the south side of the Duke of Bridgewater's canal from Manchester to Worsley, about four miles from Manchester; and, in consequence of the facility of obtaining manure by water-carriage, I have laid the whole down for meadow grass, and have every reason to expect it will be productive.

By marl we mean, in Lancashire, a combination of clay with a calcareous substance, and consider it valuable in proportion to the quantity of that substance it contains. It is generally found of a brown red, but sometimes of a pale blue or grey colour, and occasionally the two kinds are intermixed, as is the case at Chat Moss.

The action of these substances upon moss land is, however, extremely different. Lime possessing a

caustic as well as calcareous quality, seems to destroy the vegetable fibre of the moss, and convert it into a black friable earth, much more dry than what is formed by the application of marl. Its operation is very durable; even at the distance of fifteen or twenty years, it is scarcely possible to take up a portion of moss soil, where lime has been used, without finding the particles of that substance intimately intermixed in small white spots through every part of it. Upon such land crops of hay, turnips, potatoes, oats, barley, and even wheat, may be produced, with a quantity of animal manure not more than is required in other cases, and at less expence in labour, than any of the other kind of land. The mixture of marl with moss is much more intimate, and is probably effected by some degree of chemical union. If a piece of marl is suffered to lie undisturbed on the moss for a few months, it will be found, on taking it up, that a considerable portion of the moss will adhere to it; and if this intermediate substance be examined, it will appear to be a mixture of marl and peat, formed into one mucilaginous mass of a dark colour, and as smooth to the touch as soap. As the marl dissolves on the moss, this union takes place throughout, and a permanent

improvement is effected by the conversion of an inert and useless substance into the best of all possible soil.

It is, however, important to observe, that, in the use of marl, much depends on the state of the moss at the time it is set on. Moss, in a recent state, contains a considerable portion of acid; and, if the marl be applied before this is exhausted, the union will be much more rapid and intimate than if the moss be dry, and the acid suffered to evaporate. For this reason, moss lands that have been exhausted by burning, or ploughed in the heat of summer, are much more difficult to reclaim than lands which have been marled immediately after their first ploughing. Even those tracts of land of which there are some on Chat Moss, where turf has been gotten by the surrounding inhabitants for firing, and which have consequently been turned over to a very considerable depth, although they were supposed to be the best for cultivation, have been found to derive advantages from marl more slowly, if not less effectually, than the other parts of the moss.

Both lime and marl are generally to be found within a reasonable distance, and the preference given to either of them will much depend upon the

facility of obtaining it. The quantity of lime requisite for the purpose is so small, in proportion to that of marl, that where the distance is great, and the carriage high, it is more advisable to make use of it; but where marl is upon the spot, or can be obtained in sufficient quantity, at a reasonable expence, it appears to me to be preferable.

It would be useless to detail the various experiments which I have made during a series of years, to bring moss lands into cultivation at as little expence as possible. I have endeavoured to obtain crops of potatoes in the lazy-bed way, by digging in the first sod covered with vegetation, as is said to be done in Ireland. I have drilled in crops of grain and turnips, by a machine which scatters the seed with the manure. I have tried, to a considerable extent, the effect of cropping with peat-ashes, burnt in close fires. I have occasionally made use of only a small portion of marl, under the idea that it might be found sufficient to answer the purpose. In all these attempts, I have been, in a greater or less degree, disappointed; and, in the result, I am thoroughly convinced that all temporizing expedients are fallacious; and that there is no method of improving moss land but *by the application of a*

calcareous substance, in a sufficient quantity to convert the moss into a soil, and by the occasional use of animal or other extraneous manures, such as the course of cultivation, and the nature of the crops, may be found to require.

Under these convictions, I have, for some time past, adopted a regular system or routine of improvement. After setting fire to the heath and herbage on the moss, and burning it down as far as practicable, I plough a thin sod or furrow with a very sharp horse plough, which I burn in small heaps, and dissipate, considering it of little use but to destroy the tough sods of the *Eriophora*, *Nardus stricta*, and other plants, whose matted roots are almost imperishable. The moss being thus brought to a tolerably dry and level surface, I then plough it in a regular furrow, six inches deep; and, as soon as possible after it is thus turned up, I set upon it the necessary quantity of marl, not less than 200 cubic yards to the acre. As the marl begins to crumble and fall with the sun or frost, it is spread over the land with considerable exactness; after which I put in a crop as early as possible, sometimes by the plough, and at others with the horse-scuffle, or scarifier, according to the nature of the crop, adding,

for the first crop, a quantity of manure, which I bring down the navigable river Irwell, to the borders of the moss, setting on about twenty tons to the acre. Moss land, thus treated, may not only be advantageously cropped the first year, with green crops, as potatoes, turnips, &c. but with any kind of grain; and, as wheat has of late paid better to the farmer than any other, I have hitherto chiefly relied upon it as my first crop for reimbursing the expence.

Expence of Improving and Cropping an Acre of Land on Chat Moss, with the amount of the produce 1812.

Ploughing and burning the first furrow, -	L.	1	5 0
Second ploughing, - - -		1	0 0
200 cubic yards of marl, at 11d. per yard per contract, for which the marl is gotten, conveyed and spread upon the land; to which add 1d. per yard for feighing or uncovering the bed of marl, 1s. per yard, - - - -		10	0 0
20 tons of Manchester manure at 2s. 6d. per ton; allow for conveyance and setting on, -		5	0 0
Third ploughing, sowing, and harrowing, - -		1	0 0
Seed wheat 2 bushels, at 21s. per bushel, - -		2	2 0
	L.	20	7 0

On one piece of land thus improved, I had 20 bushels Winchester, of mixed red and cone wheat,

which, at the time it was reaped, would have sold at L. 1, 1s. per bushel, L. 21.

On another piece I had eighteen bushels and a half of red wheat, worth L. 1, 1s. per bushel, L. 19, 8s. 6d.

On four acres of land which had been broken up before, but not having been sufficiently marled, had produced a poor crop of spring wheat, and which I had therefore marled again, I had a crop of beans of thirty-two bushels to the acre, worth 12s. per bushel, L. 19, 4s.

These crops, with the value of the straw, have returned, in the first year, the full expence, and the land is now sown again chiefly with another crop of wheat.

It is obvious, however, that this statement must not, for many reasons, be taken as the average expence and return in improving the moss. The previous drainage and proportion of general charges is omitted; the prices of produce are stated unusually high; and the crops were the best upon the moss; so that, upon the whole, I apprehend the average return for wheat ought not to be estimated at above L. 15 per acre. Oats, beans, and clover, of which the rotation of crops consists from L. 10 to L. 12

per acre; but even this, or indeed a still lower estimate, would be found to yield a very speedy return for the money expended in the improvement.

I must also observe, that it would be impracticable to effect the marling at so cheap a rate, were it not for the assistance of an iron road or railway laid upon boards or sleepers, and moveable at pleasure. Over this road the marl is conveyed in waggons, with small iron wheels, each drawn by one man. These waggons, by taking out a pin, turn their lading out on either side; they each carry about fifteen hundred weight, being as much as could heretofore be conveyed over the moss by a cart, with a driver and two horses.

I am well convinced, that a road of this kind would be of great use upon other farms as well as moss lands, in diminishing the expence of horse labour, and would be found particularly advantageous in setting on marl or manure in the winter, without cutting up the land.

In 1810, I put a flock of South Downs upon the moss, which have been remarkably healthy. The astringent and antiseptic quality of the moss seems to prevent the foot rot, to which they are liable on other lands.

I am now preparing to lay down several acres with fiorin grass, of the utility and advantages of which I am fully convinced; and with the means of which I have been supplied by the kindness of Major General DIROM, whose successful cultivation of it on his estate of Mount Annan, is already known to the public.

Progress and Present State of Improvement at Chat Moss.

IN the year 1805, I obtained from JOHN TRAFFORD, Esq. of Trafford-house, near Manchester, a lease of such part of Chat Moss as belonged to him, being upwards of 2500 acres, under the authority of an act of Parliament, enabling him to grant the same for a term of ninety-two years, under a progressive rent, the ultimate amount of which is L. 150 per annum. At that time, this tract of land was wholly unproductive, and was unsafe to pass over, except in long-continued droughts in the summer season.

In the month of November 1805, I began the drainage, by cutting out the main drains on each

side of the roads; throwing out the moss from the drains into the middle of the road, so as to raise it, and leave it sufficiently dry for passing over with carts and horses. This operation was continued through the year 1806.

In 1807, I began to cut the smaller drains, diverging from the large drains, at fifty yards distance from each other, and forming the boundaries of the fields. About 1000 acres were thus prepared, and the whole of the moss was, in that and the succeeding years, cut at the same distance, so as to be in a progressive state of improvement.

In 1808, the drainage was continued. A part of the moss was now sufficiently consolidated to be worked with horses in pattens. About fifty acres were turned over, part by the plough and part by the spade, which it was necessary to resort to on account of the inequalities in the surface, occasioned by the turf-pits made in getting peat for firing. In the same year, a farm-house, with out-buildings, cottages, smiths and wheelwrights shops, &c. were erected; and I began to set marl upon the land prepared for that purpose.

In 1809, I cropped about twenty acres with tur-

nips and oats, of the latter of which I obtained a tolerable produce.

In 1810, I cropped upwards of eighty acres, of which twenty were wheat. The crops of wheat were very various; some remarkably good, others scarcely returned the seed. The causes of this difference were, however, sufficiently obvious.

In 1811, I cropped upwards of 100 acres, chiefly with wheat, and with a considerable increase of produce, although the crops were by no means uniformly good. Until this period, it was my object to effect the improvement without any materials but such as were found or produced upon the moss. The land had been slightly marled, and the crops principally got in, with burnt peat, or with the small portion of manure obtained from the horses employed in the labour.

In 1812, I began to increase the quantity of marl, setting about 200 cubic yards upon an acre; and, in getting in the crops, made use of manure obtained from the sweeping of the streets in Manchester, setting about twenty tons to the acre, and cropping it with wheat and beans. These crops much surpassed those of any preceding year, and are superior to most crops on the old farms in the neighbourhood.

In the course of the present year, I shall have brought into cultivation about 160 acres, which will be cropped with wheat, oats, potatoes, and beans. A tract of thirty acres of clover appears to be very promising.

The marling is now regularly proceeding, at the rate of 100 acres per annum, which will be taken into rotation of crop; and, from this year, I expect the improvement will be carried on in an increasing proportion, without any farther advance of capital.

On the Improvement of Mossy Lands. By the Right Hon. Sir JOHN SINCLAIR, Bart. M. P. Founder of the British Board of Agriculture.

IT was in the year 1802, that I first attempted, in Caithness, the system of cultivating mossy lands pursued in the fenny districts of the eastern coasts of England, namely, Cambridgeshire, Lincolnshire, and Huntingdonshire. The experiments were not at first successful. They were on mossy lands on

the sides of hills; whereas the English fens were flat, had been covered for ages with water, and are only preserved from inundation by art. After bringing together a number of ploughmen from England, and various instruments of husbandry used in the fens, I found very little prospect of success. Determined, however, to persevere, I thought it advisable to try the same plan next year, but on a smaller scale.

I began the year 1803, therefore, with only three Englishmen. A considerable tract of ground was prepared by them, according to the fen system, and laid down with rape, with grain, grass seeds, and other crops; but the prospect, even the second year, was not much better than the first. The corn was stunted in its growth, and unproductive; the rape thin; and the grass unpromising. I dismissed, therefore, two of the Englishmen, and reduced the establishment to one, who was to receive the occasional assistance of the neighbouring cottagers.

The third year, however, has removed all doubts of ultimate success in this important undertaking. Several acres were laid down, in spring, with bear, oats, grass-seeds, and rape, all of which have answered, in particular the bear and grass. The rape

sown in autumn 1803, though rather thin, yet stood the winter frosts, was harvested in August last, and produces seed equal to any imported from England. It is pleasant to observe such crops on the summit of a hill at least 300 feet above the level of the sea.

The cause of this success it is next proper to explain.

Dr JAMES ANDERSON, in a work entitled "A Practical Treatise on Peat Moss," printed in 8vo, anno 1799, is the first author, with whose writings I am acquainted, who made the distinction between *quick* and *dead* moss. Whilst it is quick or growing, it cannot afford food for other vegetables, being a vegetable, or a combination of vegetables itself. It is necessary, therefore, to convert it into dead moss before it can be productive.

The fen-plough, for paring the surface merely, is the best instrument ever invented for that purpose; but it is not calculated for raising the *quick* moss under the surface, and converting it into soil. Mr ANDERSON, who rents a considerable farm, called Ausdale, in this neighbourhood, was the first who observed this defect, and who recommended it to WILLIAM CARTER, the remaining Englishman, to

plough deeper, before he attempted to crop the land. Mr ANDERSON had some experience in the cultivation of mossy lands in Strathnaver, where he had resided several years. He knew the beneficial effects of deep ploughing, and of exposing moss to the influence of frost, by which it is converted, not only into a fertile soil, but even into a manure, well adapted for light or for clayey lands. It is, however, particularly to be observed, that, exposing a mossy soil to the influence of the sun, or ploughing it during the summer season, does mischief, drying up its moisture, and changing it into peat for fuel, after which it is almost proof against the effects of frost; whereas the more it can be exposed to frost, the better, as it is thus changed from *quick* to *dead* moss, and fertilized at the same time. Hence it appears that the mosses, which are so gloomy and so unpleasant to look at in their original state, and the abundance of frost, which so many object to in the climate of Scotland, may become sources of fertility and riches.

I shall now briefly detail what appears to me the best system for converting mossy lands into a productive state, and by means of which considerable profit may accrue to those who will engage in so useful an undertaking.

Preparation.—Begin with draining the land, so as to put it in a state fit for being ploughed, without rendering it at the same time too dry. Burn the heather; then make use of the fen-ploughs, for paring the surface. What is pared off, may either be made into turf-walls, for sheltering the ground, or employed to fill up the hollows; or burnt, though the ashes of the surface are in general so light as to be of very little service as a manure. When the surface is cleared, then take a common Scots plough, and, during the months of September and October, and all the winter months whilst it is practicable, plough the moss, from six to nine inches deep, exposing it as much as possible to the frost. The frequent use of the roller (and the heavier the better) is of the greatest importance in the cultivation of moss, rendering it much more capable of producing abundant crops of grain or grass than otherwise could be expected, and effectually banishing that obnoxious weed, sorrel, with which it is otherwise apt to be overspread.

Manure.—In the following spring, the land thus prepared will be fertilized by the frost, and easily converted by harrowing into mould, or what Dr ANDERSON calls moss-earth. If any clods are to

be found in a rough state, they ought to be burnt, and, if the season is dry, fire may be spread over the surface, the ashes immediately harrowed in, and the ground sown. Dung, lime, clay, sand, or small gravel, may be employed as manures, as circumstances will admit of.

Crops.—Bear seems to thrive on land thus prepared. Oats, also, would answer well. Rye would probably succeed. Rape would certainly be productive. Red clover has not yet answered, but will most probably succeed when the lands have been longer under cultivation. Rye-grass, and the grass called Yorkshire fog, seem to answer particularly well.

Succession of Crops.—It has not yet been ascertained by experience, what is the best succession of crops in such lands, but the great object certainly is to get them laid down into grass as quickly as possible. They can then be broken up with the fen-plough, the surface burnt, and the quantity of rich ashes which the roots of the grass will produce, will insure a succession of abundant crops for at least three years, of which two may be of grain; and with

the last crop of grain the land may be again laid down to grass.

There is every reason to believe, that, by following such a system, the extensive bogs in England, Scotland, and Ireland, may be rendered fertile, and a great addition made to the wealth of the country, and the subsistence of its inhabitants.

BERRISDALE INN, CAITHNESS,
14*th September* 1804.

CORRESPONDENCE OF THE AUTHOR WITH PROFESSOR JAMESON.

Letter from the Author to ROBERT JAMESON, *Esq., Professor of Natural History in the University of Edinburgh.*

24th August 1826.

DEAR SIR,

I BEG leave to send you my Manuscript History of Peat-Moss, begging your perusal of it, and that you will have the goodness to make such remarks and corrections on the work as may occur to you in the course of reading it.

May I also request that you will be pleased to allow me to print, in the Appendix to my History, your Observations on Peat, which, from your well known character for accuracy and research, cannot fail to be acceptable to those who desire to be well informed on the subject.

Though I never could find a free acid in any of the peat-soils on which I tried chemical experiments,

yet I am satisfied from your analysis of the peat of Glen-Cloy, that there is an acid in some peats. I am, &c.

Answer by Professor JAMESON.

DEAR SIR,

YOU are at liberty to make any use you choose of my paper on Peat. In regard to the acid, I may mention, that of late years it has been frequently detected in the peat of Germany.

I return your interesting manuscript. The work will do you much credit, and cannot fail to prove useful to the public. I am, &c.

Observations on Peat, by ROBERT JAMESON, *Esq., Regius Professor of Natural History, and Keeper of the Museum, and Lecturer on Mineralogy in the University of Edinburgh.* (From Mineralogical Travels through the Hebrides, &c.)

THIS curious and useful substance, Peat, has been long known as an article of fuel to the inhabitants of Europe, and used as such in those regions where no coal has been found to defend the inhabitants from the rigors of a frozen climate. The learned TORFÆUS informs us, that its use was first made known to the inhabitants of the Orkney and Shetland Islands by one EINAR, a Norwegian, who, from that circumstance, was named Torf Einar. It soon after this came into very general use, and is now the only fuel of many parts, not only of the Islands and Highlands of Scotland, but of other nations in the north.

In describing the general appearance of a peat-moor, we may conceive an almost entire flat of several miles extent, of a brown colour, here and there marked with tufts of heather, which have taken

root, owing to the more complete decomposition of the surface peat; no tree or shrub is to be seen; not a spot of grass to relieve the eye in wandering over this dreary scene. A nearer examination discovers a wet spongy surface, passable only in the driest seasons, or when all nature is locked in frost. The surface is frequently covered with a slimy black-coloured substance, which is the peat-earth, so mixed with water as to render the moss only passable, by leaping from one tuft of heather to another. Sometimes, however, the surface of peat-mosses has a different aspect, owing to the greater abundance of heath and other vegetables, as the *schœni, scirpi, eriophora*, &c., but this is principally the case with some kinds of what are called Moorlands, which contain but little peat, being nearly composed of the interwoven fibres of the roots of living vegetables.

Quick moss (as it is called) is a substance of a more or less brown colour, forms a kneadable compound, and, when good, cuts freely and clean with the spade; but when it resists the spade by a degree of elasticity, it is found to be less compact when dried, and is of an inferior quality. The best kinds burn with a clear bright flame, leaving light coloured ashes; but the more indifferent kinds in burn-

ing often emit a disagreeable smell, and leave a heavy red-coloured kind of ashes. In digging the peat, we observe, that, when first taken from the pit, it almost immediately changes its colour, and in time becomes more or less of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable paste with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackish coloured powdery matter, capable of supporting vegetation, when calcareous earth is added. Peat-earth is very retentive of moisture, which circumstance affords us a satisfactory explanation of the floating islands observed in many places of Holland, as Frise, Breme, Groningue, Oldenburg, &c. These are caused by the peat-earth or turf retaining so great a proportion of water as to float immense masses of it, which are driven about upon the surface of lakes, or are floated upon the land itself. This is so well known in Holland, that tracts of moss of great extent are secured by means of chains, &c.

Peat is found in various situations, often in valleys or plains, where it forms very extensive deep beds, from three to forty feet deep, as those in Aber-

deenshire; it also occurs upon the sides of mountains, but even there it is generally in a horizontal situation. The tops of mountains, upwards of 2000 feet high in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany it is also found at very great heights; thus, the Blogsberg, a high mountain in Lower Saxony, and the Brohen, the highest mountain in the Hartz, are covered to their summit with peat. It is also found in situations nearly upon a level with the sea; thus, the great moss of Cree in Galloway lies close upon the sea, on a bed of clay, little higher than flood-mark at spring-tides; Locker-moss, hard by Dumfries, about ten miles in length, is only a few feet above high water-mark. In the Island of Lewis, one of the Hebrides, there is an extensive plain about thirty miles long, covered with peat moss, having its surface very little elevated above that of the sea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this species is also often taken up upon the flukes of anchors, on the coast of Holland, and is sometimes cast ashore in stormy weather, which has led some speculators to imagine that it is of marine origin.

In the harbour of Oban, in Argyleshire, one part of the bottom appears to be formed of quick moss, which affords no sure anchorage. The depth of the sea is there about twenty fathoms.

Sometimes peat is to be observed alternating in thin strata with sand or clay: of this I have observed instances in the Orkney Islands; and in the second volume of the Journal des Mines, I find similar appearances noticed in France.

It appears to be peculiar to cold climates, which is one of the innumerable instances of the wisdom of nature in providing the inhabitants of a cold country with a material so necessary for their comfort, and even their existence. Dr ANDERSON, in his Treatise upon Peat, remarks, that it is not confined to cold climates, as he had specimens of real peat sent from the Island of Sumatra. It is not improbable that a substance resembling peat in some of its properties may be found in the warmest countries, when we reflect that decayed vegetable matters, in a certain stage of their decomposition, have an appearance so like peat, that they want only compression to form a similar substance. On this account it is not surprising that something of this kind should occur in the warmer regions; but great

masses of matter like our peat can hardly exist in the tropical regions. This observation is rendered more probable from the following remarks: In Scotland, it is observed that the peat at the bottom of a mountain is more decomposed than at its top, and the wood of mosses is more fresh upon the higher part of a mountain than at its lower. It is also remarked, that the peat of the south of England is more decomposed than that of the north of Scotland; and the peat of France has more of the coaly appearance than that of England. In France also, Mr ARTHUR YOUNG remarks, that the peat is never found in the Lowlands, but under cover of vast size; and it is only in the higher regions, where the climate is more temperate, that it is to be observed upon the surface. All these facts show us in a satisfactory manner, that, as we advance towards the warmer climates, the vegetable matter is more and more decomposed, until we arrive at the tropical regions, where, in all animal and vegetable matters, putrefaction proceeds so rapidly as to prevent the formation of any body of this substance.

It will not be foreign to my present purpose, to mention, in a cursory manner, the most remarkable undecomposed vegetable matters which have been

observed in our peat-mosses or bogs; particularly as writers have endeavoured to draw conclusions with regard to the time and mode of formation of peat, from the appearances which these bodies present.

1. *Fir or Pine.*—This tree more frequently occurs than any other; it is found of various sizes, some having been dug about 100 feet long, perfectly straight, with branches growing in a circular form; as is the case with the pine tribe. It is remarkable, that, in such situations, the wood has often lost its latitudinal adhesion, which renders it soft; but that the longitudinal fibres are strong and tough, so that they are split and twisted to form halters for cattle, as in Aberdeenshire.

2. *Oak.*—In all the low mosses in Scotland, this tree is the principal one which is to be observed, and is generally found wanting the bark, which shows that the wood had been long dead before it had been enveloped in the moss. In draining Hatfield Level in Yorkshire, oak-trees were found not less than 100 feet long. They were black as ebony, in excellent preservation, and some of them sold in

the middle of last century for L. 15 a tree. One of them, which is particularly described, was about 120 feet long, twelve in diameter at one end, and six at the other, and L. 20 was offered for it. BECKMAN also informs us, that wood which has long lain under water becomes black, and looks as if charred; it, however, loses none of its toughness or compactness; and many trees dug up in Holland from the turf-earth, are employed there for shipbuilding. Dr ANDERSON remarks, that he never saw a piece of oak taken from a peat-moss, which could be used in workmanship like the stakes which were lately taken from the Thames, and said to have been placed there by JULIUS CÆSAR; from this he concludes, that moss does not preserve wood so long as water. This, however, is contradicted from the facts observed at Hatfield Level, and that mentioned by BECKMAN.

3. *Birch.*—This tree also frequently occurs in our peat-mosses, but its wood is not so resinous as that of the fir, nor has it the hardness of the oak; on these accounts it is seldom found in a state of good preservation; the bark is generally the most entire, which may depend upon the great quantity

of resin which it contains, which enables it to resist the all-powerful hand of time.

The *alder*, *yew*, *willow*, *ash*, and several other trees, have been dug out of our mosses; but any detailed account of these would lead me to a great deal of unnecessary description. I may here mention, however, that besides trunks and branches of trees, we also sometimes discover their more delicate parts in a state of preservation: thus, the leaves have been observed well preserved. Seeds, which have a remarkable power in resisting the influence of the weather, have been found in peat-mosses; thus, we have instances of fir-cones and hazel-nuts; the kernel of this last was destroyed, and the shell, which is very indestructible, was fresh.

Besides trees and herbaceous plants, another tribe deserves to be particularly noticed, which are the *musci*. These plants are fond of moisture, and with a sufficiency of room to spread upon, and a cold climate, grow very fast and luxuriantly. Of these the most remarkable is the *Sphagnum palustre* of LINNÆUS, which is found in great abundance in all peat districts, particularly in those places where the soft white peat abounds. This peat is

found several feet deep, and is nothing but a collection of the *sphagnum*, which we can observe more or less decomposed as we go downwards; at last its texture disappears, its colour changes, and it cannot be distinguished from the common brown peat.

I have in my possession specimens of a substance which was found in the peat-mosses of the Highlands of Scotland; it answers to the Bergfet of the Germans, the Mineral Tallow of Mr KIRWAN.

Description—Colour, white; has nearly the resemblance of tallow, feels greasy, and stains paper as tallow does; flames with much smoke, leaving a pretty light coaly matter. It is brittle like tallow, but its specific gravity is considerably less.

A substance similar to this was found some years ago, by peasants on the coast of Finland, afterwards in one of the Swedish lakes; and more lately, Dr Babington informs us that it is found in great quantities in New Holland. Some have imagined that it is tallow, which has been accidentally deposited along with the peat, and by long exposure to the influence of the vegetable juices, may have been altered. This cannot be the case, as we are utterly unacquainted with any such changes; and besides, the circumstance of its being found in great quan-

tity in New Holland, leads us to suppose that it is not accidental. The Editor of the *Bibliotheque Britannique* supposes, that it is a substance similar to the fatty matter into which the muscular fibre is converted, when long exposed in particular situations.

A great number of extraneous substances have also been found in peat mosses, sometimes at considerable depths; from their appearance, declaring, in certain characters, the great antiquity of such mosses. Many curious instances of this kind might be mentioned; one in particular deserves to be noticed. In digging a moss at Axholm, in Lincolnshire, the body of a woman was found pretty fresh, her hair was unaltered, her nails were rounded, and her skin was tanned, soft and pliable; she had antique sandals upon her feet, which renders it probable that she was of the Roman æra. Another curious instance occurred in Shetland; in digging a peat-moss, the body of a man was found well preserved, which, it was supposed, could not have been in the moss less than eighty years. In the Irish mosses, the horns of the moose-deer have been found; in our own, the head and horns of the urus occur. Dr WALKER had a drawing of the head and horns

of a deer found in a peat-moss, of a species now no longer found in Britain. Other substances occur in mosses; the fragments of very ancient dress, and many instruments of human industry, have, at different times, been discovered.

ANALYSIS OF THE PEAT OF GLEN-CLOY, ISLAND OF ARRAN.

Character.

It is of a blackish-brown colour, pretty much intermixed with undecomposed vegetable matter, which renders it rather loose in its texture.

Solution in Water.

1. I took 1000 grains of powdered peat, boiled it repeatedly with distilled water, until no more could be dissolved; then dried, weighed, and found 800 grains remaining.

The solution had a deep brown colour, with a slightly bitter taste; tinged litmus paper, and by exposure to the air for some time, part was precipitated in an insoluble state.

2. By passing the oxygenated muriatic acid through this solution, a precipitation of a dark brownish matter immediately takes place, similar to what we observe by passing this acid through other vegetable infusions.

3. Caustic ammonia, or carbonate of potash, did not cause any precipitation in the space of twelve hours.

4. Prussian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime-water formed a copious brown coloured precipitate.

6. Muriate of barytes, nitrat of silver, sulphat of iron, sulphat of copper, caused considerable precipitations ; but nitrat of ammonia, muriat of soda, muriat of ammonia did not produce any change.

The solution being evaporated, left a blackish-brown coloured residuum, which had no peculiar smell. It presents the following characters.

a. Not soluble in spirit of wine, except by a boiling heat.

b. Difficultly soluble in water, without the assistance of heat.

c. Soluble in caustic soda, at the common temperature, or when heated.

d. Soluble in caustic ammonia, in the same manner.

7. A quantity of the residue being put into a retort, connected with a pneumatic apparatus, a gradually increasing heat was applied, when the following appearances were observed. At first water passed over quite colourless; after some time it was tinged brown; and towards the end of the operation, when no more brown liquor came over, carbonic acid, and carbonated hydrogen, passed in considerable quantity. No oil or saline matter could be detected, and not the least traces of ammonia could be perceived. The carbonaceous residue was of a blackish-brown colour; insoluble either in hot or cold water, but easily soluble in a weak solution of caustic soda.

The ease with which this carbonaceous matter is dissolved in weak solutions of alkali, shows that it contains a considerable portion of hydrogen (at least this is the explanation given by modern chemistry), for I find it impossible to dissolve any perceptible quantity of charcoal with such solutions.

8. The residue by burning affords a grey coloured ash, which I examined, in order to ascertain the nature of the saline matters. It did not afford sulphat of potash or soda, phosphat of lime or phosphat of iron; only *sulphat of magnesia* and *oxide of iron.*

To the 800 grains which I found insoluble in water, I added a solution of caustic soda, which acquired a brown tinge at the common temperature; but when heated, a very deep brown coloured solution was formed. After repeated digestion with the alkali, I was able to dissolve 400 grains: the remainder was undecomposed vegetable matter, which was quite insoluble in the alkali I used.

I next added muriatic acid to this alkaline solution; the dissolved matter was precipitated of a brown colour, and did not appear to be altered by its combination with the alkali: for it was still soluble in caustic soda and ammonia, insoluble in water by boiling, but soluble in spirit of wine. When burnt, a brown coloured ash is left, which afforded sulphat of lime and oxid of iron; but in no instance did I find phosphat of iron or phosphat of lime.

Properties of the Acid contained in Peat.

In relating the characters of the aqueous solution, I observed that it tinged litmus paper red. This shews the presence of an acid which I found to possess the following characters:

1. It is not crystallizable, but may be obtained by evaporation, in the form of thin crusts.

2. Taste slightly acid.

3. Forms composts with lime, barytes, and soda; which I have not particularly examined. The compound of lime and this acid is difficultly soluble in water; which distinguishes it, on the one hand, from the gallic acid, as it forms a very soluble compound with lime; on the other, from the oxalic, which forms an insoluble salt with lime.

4. Decomposes the acetate and nitrate of lead.

5. With sulphat of copper, a copious brown coloured precipitate is formed, having a beautiful green supernatant liquor.

6. With sulphate of iron it forms a brown precipitate, and a nearly colourless supernatant liquor.

7. Nitrate of copper changes the solution to a beautiful green, without causing any precipitation. In this it also differs from the oxalic acid, which causes a copious precipitation.

8. Muriate and nitrate of barytes are decomposed by it.

9. With a solution of sulphate of indigo, it forms a beautiful green colour. In this it also differs from the oxalic acid, which does not produce any change of colour.

This acid appears to be the same with the suberique acid lately discovered by BUILLON LA GRANGE, and which he imagines to be a compound of carbon, hydrogen, and oxygen.

Distillation of Peat.

A QUANTITY of this peat was carefully distilled, when a deep yellowish brown-coloured liquor was obtained. It had a strong empyreumatic smell; and, by exposure to the air, it acquired a considerable consistence. I did not examine particularly this liquor. I only found that, by the addition of quicklime, much ammonia was separated. GIROUD, in the first volume of the *Journal des Mines*, men-

tions, pretty fully, the properties of this liquor. He finds that it is an ammoniacal soap; which, from the many experiments he made, he thinks may become of considerable use. Thus the ammoniacal soap, being decomposed by sea-salt, would form a cheap muriate of ammoniac; and the oily matter, by proper management, may answer for some purposes in the arts.

Carbonization of Peat.

THE late improvements in agriculture have pointed out a method of converting much of the peat, which is so abundantly spread over the Highlands, into a good and productive soil; yet still there is a great deal of it lost, not only in these operations, but also from its being situated where the labours of the farmer would be employed with little advantage. From these circumstances, it is certainly deserving of attention, to endeavour to discover some means of employing this waste vegetable matter, and thus to raise new sources of industry in parts of the country where there are now only extensive and dreary wastes, without an inhabitant. As the want of common coal and charcoal, in most parts of the

Highlands, appears to have been the cause why many promising mineral appearances have been abandoned, I think that it is not improbable that charcoal from peat may, if carefully prepared, be used with common charcoal, or even by itself, in the working of ores. This is not an opinion founded upon mere speculation; for it has been actually put in practice in different parts of Europe. Thus Baron DIETRICH informs us that it is used in the Hartz for the smelting of iron ores. As the successful prosecution of this practice would be of much consequence to the Highlands of Scotland, I think it of importance to state shortly the different methods that have been followed to obtain a good charcoal from peat.

Two methods have been followed in these trials: the one by exposing the peat to a smothering heat, as is practised in the making of charcoal from wood; the other by exposing it to heat in close vessels or furnaces, and thus subjecting it to a kind of distillation.

So long ago as 1631, LAMBERVILLE seems to have used the first process; but his attempts were not ultimately successful, as his charcoal was too friable; consequently of no use in the forge, and

other similar operations. In the Hartz, DIETRICH observed that they carbonized the peat in large cylindrical iron vessels, but this was found to be too expensive; besides, the volatile matter separated from the peat was said greatly to injure the vessels. At Villeroi, in France, peat was carbonized by burning it in a furnace, not unlike the common lime-kilns of this country. This method, like the other, was also found to be unprofitable. These different methods, as RIBACOURT remarks, are very objectionable, as they do not allow the watery, oily, volatile, and saline matters of the peat to separate, without, at the same time, consuming a portion of the carbonaceous matter, which causes a great diminution of the peat. Besides this inconvenience, the peat is always irregularly burnt, one portion being in the state of charcoal, the other with a considerable portion of the watery and other matters not separated.

The second process, which is the subjecting the peat to a kind of distillation, seems, from all the trials that have been made, to be the most promising. PFEIFFER, in a work entitled *Histoire de Charbon de terre et de la tourbe*, &c. published in 1777, describes a furnace in which he distilled peat,

and obtained a solid charcoal. THORIN, in 1791, obtained a recompence from the French government, for a method of carbonizing peat in an improved iron furnace, by which he obtained a firm and useful charcoal. This method, however, was soon found to be unprofitable, on account of the great waste of the iron vessels by the fire, and the action of the volatile matters of the peat on them. More lately, BLAVIER has published an account of a furnace which is constructed of stone, and at little expence, and is said to answer excellently for the carbonization of peat; and, besides, it has this advantage, that all the volatile, oily, and alkaline matters are easily collected.

From this short account which I have given, we have reason to suppose, that, by the adoption of a furnace somewhat similar to that of BLAVIER, peat, at little expence, may be carbonized with advantage, in the most remote corner of the Highlands.

Before leaving this subject, I will shortly mention the various trials that have been made with charcoal of peat, with a view of determining the difference between it and that obtained from wood. SAGE found that the charcoal of peat gave a stronger and longer continued heat than the charcoal of wood;

and further, that the charcoal of wood gives only a third of the heat of that of peat. Two furnaces of equal size, and in every other respect alike, were employed to melt a quantity of silver, when it was found that it required a greater quantity of charcoal of wood, than that of peat to bring it into fusion. An experiment was also made in the great way at Paris, to ascertain the utility of peat charcoal in the boiling of liquids, when it was here also found to have great advantages over that of wood.

In metallurgic operations, peat has been by some considered as very pernicious, while others find it not less useful than charcoal from wood. Dr LIND, in the *Edinburgh Physical Essays*, remarks, "that there exists in peat an inflammable substance, which produces upon metals the same effect as sulphur, rendering them brittle. Another inconvenience which I have had the misfortune to experience, is this, that a strong heat converts the charcoal of peat into a glassy substance, which collects along the sides of the furnace, obstructs it, stops up the passage by which the melted metal should run, and hinders it from collecting in the lower part of the furnace." This observation, which seems very unfavourable for the employment of the charcoal of

peat in the smelting of ores, probably deserves little credit; or, if it be true, it only shews us that it is necessary that the nature of the peat should be known before it is employed; for, by its admixture with various extraneous matters, it may possibly become pernicious. That it is innoxious and useful, DIETRICH has proved; and even LAMBERVILLE, in 1626, assures us that it was successfully used in the working of iron. More lately, experiments were made at Paris, when even the temper of steel was not in the least hurt by it.

Soap from Peat.

I endeavoured, in various ways, to make a soap from peat, but always found that it gave a brown colour to the cloth. — See *Nicholson's Journal*, vol. iii.

Theory of the Formation of Peat.

THE frequent occurrence of peat in many countries has naturally attracted the attention of philo-

sophers, who have endeavoured to discover the mode of its formation. One class of observers have contented themselves by endeavouring to shew that it is of vegetable origin, and have only differed as to the probability of wood or moss alone, or jointly, having formed it: others again, having admitted its vegetable origin, differ only in the explanation of the means which nature uses in the preservation of the vegetable remains. Lastly, it has been conjectured that it is a *live vegetable, sui generis;* and an elegant poet (Dr DARWIN), having admitted its vegetable origin, has supposed some changes it undergoes by elutriation, &c.

There can be no question of the vegetable origin of this substance: any other opinion is but vain and frivolous: and it is also inconsistent with fact to assert that either wood or moss, singly, are the only substances that form peat; for we know that, in most cases, they both contribute to its formation. In considering the peculiar state of preservation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrefy, produces an extract of the nature of tan, which preserves the moss that grows up among the trees, and converts it into peat. This opinion is founded upon

the known action of astringent substances in preserving animal substances from decay. It will therefore be necessary to examine this process, to discover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning process; and we are indebted to an excellent chemist, SEGUIN, for some interesting experiments and observations upon this subject. He informs us that oak bark, &c. contain two substances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a solution of bark is applied to skins, he supposes that the gallic acid abstract oxygen from the muscular fibre, and reduces it to the state of gluten, when it immediately combines with the tanning principle, forming a compound, which is the cause of the indestructibility of leather. We have already shewn, that peat does not contain the gallic acid; but allowing that it does, it is impossible to conceive such an action to take place with regard to vegetable matters, particularly in peat, which I have found, from experiment, to contain no tanning principle. It will therefore be necessary to investigate the influence of ve-

getable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The singularity of the appearance which peat presents, has led Dr ANDERSON to conclude that it is a *live vegetable, sui generis.* This he imagines to be very satisfactorily proved from the supposed impossibility of decaying vegetables possessing properties similar to peat. He remarks, " that in vegetables which have once fallen into a state of putrescency, their inflammability decreases in proportion as that putrescency augments; and that their chemical qualities suffer an alteration proportioned to the same circumstance. But, by the hypothesis of every person who supposes that sphagnum is the original constituent matter of moss, it is always understood that the foggy peat, by their hypothesis, is the sphagnum, still so little decayed as not yet to have become perfect moss; and that, in process of time, it gradually becomes more and more perfect moss, as it gradually becomes more thoroughly putrid, till at last it loses even the appearance of sphagnum, and becomes hard and perfect peat; that is to say, in other words, as it becomes more putrid it becomes more inflammable, which is directly the reverse of the well known progress of nature in every other

case." It is upon this, and some similar arguments, that the Doctor rejects the opinion of moss being a collection of decaying vegetable matters. But to these we may shortly answer, that decaying vegetables only lose their power of burning with the destruction of their carbonaceous matter; but this, we know, requires a very long series of years; and, when the vegetable matters are in a moist situation, as is the case with peat, such a decomposition may be prevented for hundreds of years.

Having now mentioned the principal opinions with regard to the formation of peat, I will now endeavour to ascertain, upon chemical principles, the peculiar state of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two distinct stages may be observed, the acetous and putrefactive fermentations. These processes are much modified by circumstances; depending upon the degree of heat, moisture, the presence of air, and the greater or longer continuance of the action of these agents. The putrefactive fermentation is the one which here claims our chief notice; for attention to the appearances it pre-

sents will enable us to judge better of the state of vegetable matter in peat.

In the putrefactive process, if the heat be considerable, the destruction of the vegetable matter is soon accomplished; the whole is dissipated in the form of carbonic acid, carbonated hydrogen, and sometimes ammonia, a small portion of charcoal and ashes being left behind. A more moderate degree of heat, with moisture, allows the matters to decompose more slowly, and to present the vegetable matter in several other intermediate stages, such as we observe with regard to peat, when more or less decomposed. A very great proportion of moisture has a powerful influence in retarding this process: thus the trees which are found at the bottom of mosses are fresher than those at the top, owing to the bottom containing a greater quantity of water; and the stakes lately taken out of the Thames are another remarkable instance of this.

From these circumstances, it is plain that peat is a vegetable substance which has undergone, in part, and is still undergoing, the changes which have been just mentioned; and many facts lead me to conclude that the common peat, or quick moss, is the vegetable matter deprived of a considerable portion of its

hydrogen. Not only the circumstances attending the situation and appearance of peat, but also other facts, render this opinion probable.

1. Sulphuric acid being added slowly to oils, and triturated, they gradually become brown, when the oil is rendered soluble in water and spirit of wine; but if the acid be added in too great quantity, a black insoluble matter is formed.

2. If *oleum animale* be exposed to the action of oxygenous gas, water is formed, and carbon precipitated.

In this last experiment, we perceive that the separation of hydrogen causes the precipitation of carbon: and, in the experiment with the sulphuric acid, we observe that, in proportion as the hydrogen is dissipated, the carbonaceous basis becomes more or less soluble in water; and, when the whole of the hydrogen disappears, a true carbon is left behind. In the same manner, with regard to peat, the woody or other vegetable matters are slowly deprived of a portion of their hydrogen, become brown, and somewhat soluble in water and spirit of wine: thus forming a kind of bituminous matter. By a further de-

composition, more hydrogen is separated, when the vegetable matter becomes insoluble in water, but still soluble in alkali; lastly, nearly the whole of the hydrogen is separated, when a black substance is left, what is called peat-earth. This last, by exposure to the air, combines with a portion of oxygen, forming suberique acid; and appears to be what Lord DUNDONALD calls oxygenated peat.

If this explanation be thought to have probability in its favour, we may explain some other facts in a pretty satisfactory manner. Thus the great Captain COOK remarks, that the coast of Tierra del Fuego is covered with peat-moss, and the water which runs from it has a brown turbid appearance. At one time, he was obliged to water upon this dreary spot, and could obtain no other water but that from the peat moss, which made him very suspicious of its good qualities; so that, at first, it was but sparingly used. Having soon got into the warmer regions of the Pacific Ocean, he found that this water deposited a small sediment, became pellucid, and was the most wholesome, and freest from putrefaction of any he had on board. It is probable that the infusion of peat acted, in this case, in a similar manner with charcoal (from which it differs

but little), by abstracting the putrescent matter. Another curious fact is mentioned by Dr PLOTT, that intermittent fevers never occur in the neighbourhood of peat mosses. This appears to be owing either to the slower decomposition of the organized matter in peat mosses than in fens, by which a smaller portion of noxious gas is formed; or to the absorption of these gases by the peat-matter approaching to the state of charcoal. This last explanation is rendered the more probable, from a well known fact that, in church-yards, where a great number of dead bodies are buried, no bad smell is to be perceived, evidently owing to the absorption of the noxious gases by the carbonaceous matter of the soil.

Improvement of Moss Land.

THE method of improving peat moss by means of calcareous earth is certainly one of the most useful discoveries of the present day, and will no doubt form an important era in the annals of agriculture. Not long since, peat lands were only considered as useful on account of the fuel which they afforded.

The case is now widely altered: the moss grounds are eagerly sought after; and, in the west of Scotland, this method of improvement is carried on with great spirit, and is repaying the judicious manager very amply. To give a detailed account of the methods which are followed (and that is the only one that can properly be given), would require a volume; and, after all, would be little more than a repetition of what is already known. I shall therefore content myself with endeavouring to apply the preceding experiments to explain the mode of action of the calcareous earth.

We have already observed, that peat contains the suberique acid, or one nearly allied to it, which appears to be formed in greater quantity the longer the peat is exposed to the action of the air, thus assisting in retarding the decomposition of the peat, of course preventing its being useful in vegetation. Marl, shells, and limestone are useful in a triple capacity. In the first place, by removing the acid, the vegetable matter is allowed to decompose more rapidly; secondly, the combination of this acid with the lime forms a compound which may assist in vegetation; and, lastly, this acid having a stronger attraction for lime than the carbonic will disengage it

in considerable quantity, when it will assist vegetation.

I shall conclude with remarking, that there is a considerable prejudice in favour of quicklime: if the explanation now given have any plausibility, it is plain that carbonate will answer as well, if not better, in the improvement of moss lands.

SEQUEL

OF THE

NATURAL AND AGRICULTURAL HISTORY OF PEAT-MOSS.

BY ANDREW STEELE, ESQ.

BEING AN ACCOUNT OF HIS OWN IMPROVEMENTS ON SOILS OF THAT KIND.

Written in 1826.

In 1798 (which, at the date of writing this Sequel, is twenty-eight years ago) I purchased, with the view of improving it, the farm of Crosswoodhill, situate in the parish of West Calder, and county of Mid-Lothian, about seventeen miles south-west from the city of Edinburgh, on the road to Lanark, by Carnwath. It was almost wholly of a wet, mossy soil. The springs of water in it were very many and copious. It was considered the wettest farm within

a circuit of fifty miles. No person could walk a furlong on it dry footed, at any season of the year. The situation of this farm is very high and late, the lowest part of it being about 1000 feet above the level of the sea. It consists of upwards of 1200 statute acres, of which about 400 were deep peat bog, very level; and the greater part of the remainder, rising gradually to a mountain, was covered in general with moss-soil of the depth of from four inches to two, three, or four feet, upon a subsoil of siliceous sand, or of sand with a small mixture of clay, three feet deep, having a freestone bottom. But some portions of the subsoil were of decomposed basalt, on a base of whinstone. Sheep and a few black cattle were pastured on the coarse herbage of this farm, which was let on a lease of twenty-one years to a very poor resident farmer, who had a few detached acres in grain-crops, that seldom reached complete ripeness. The sheep were subject to the rot from the excessive wetness of the grounds, and consequent unwholesome nature of the pasture.

I did not obtain possession of the lands, so as to commence generally and effectually my improvements, till I had purchased the lease for about L. 300, in 1803. The rent was then L. 69, and

the price of the lands, lease, &c. amounted to nearly L. 2000.

By my improvements, these lands, which are at present let in grass inclosures, some of which produce the generally acknowledged best pasture in the parish, now yield of yearly profit above L. 300, besides a considerable part being appropriated for wood, of which the farm was formerly destitute. I have also a pleasant enough summer retreat there for myself and family. My whole expence of improving this farm, including draining, manuring, planting trees, inclosing, building, &c. does not exceed L. 3500; so I have upwards of five per cent. of profit on my outlay; and the value of the farm is yearly increasing.

I now proceed to give an account of my improvements, mostly connected with the history of moss-soil.

My first business was to drain the whole grounds. I dug to the bottom of every spring and quaking bog. My drains, great and small, have been estimated, if drawn out in a line, to extend much more than a hundred miles in length. The deep flow mosses were intersected with large drains, some of

them eight feet wide at the top, two at the bottom, and four feet deep, which were carried through them in suitable places, according to the nature of the ground. Many other drains, of all sizes, were made in them in every direction.

That part of the farm, extending to upwards of 500 acres, that rises to a mountain, is mostly, as has been said, covered with a thin moss-soil. A great proportion of the high grounds in Scotland is of this sort. It is called Bent-moss land, and this moss is produced by the wetness of the climate, and want of drains. The predominant plants that grow on such grounds are called in Scotland Bents, being most generally the *Juncus squarrosus* of the Linnean system. These are mixed every where with the cryptogamic class of plants, and partially with heath. Surface-drains, some of them large, but most of them of the dimensions of eighteen inches wide, and ten or twelve inches deep, were drawn through this ground every where. Some of those drains were placed so near each other, where requisite, as from 50 to 100 feet. They were generally made in a slanting direction across the declivities, and fell into some rivulet or large drain. Here I may take leave to remark, that the principal im-

provement that my experience now suggests to be made on these drains is, that all open drains to be dug in pasture fields, should be much wider in proportion to their depth.

The farm was next wholly inclosed, mostly with stone-walls, without mortar, $4\frac{1}{2}$ feet high. It was also subdivided into pasture fields of different sizes, and into inclosures that are planted with trees. I made some good fences on deep moss grounds, by planting hedges of spruce firs on the banks of the ditches: such hedges are both a shelter and an ornament.

As to trees; I have found that, notwithstanding the great height of Crosswoodhill above the level of the sea, in about the 56th degree of north latitude, all the common trees and shrubs that are natives of Britain, thrive very well in the improved soils near the house; but for the more exposed and mossy grounds, spruce-fir *(Pinus abies)*, larch *(Pinus larix)*, and silver-fir *(Pinus picea)*, seem best adapted, and promise to attain the greatest size, as some of these, even on moss grounds (six feet deep of peat), have already acquired the height of twenty or thirty feet. I consider spruce and silver firs, which thrive in such a soil and climate, when

allowed sufficient space, to be the most elegant trees in nature. Along with these trees I interspersed other alpine trees, such as the birch, alder, and a few mountain-ash, which, with oaks, and some species of willows, seem to have been the original inhabitants of the soil, as their remains are found in the peat-mosses. I have also planted many Scotch firs. I must, however, remark, that the Scotch fir (*Pinus sylvestris*) appears to me not to have been at any time growing there, and it is a tree that I think is not a native of so high a climate, unless under some particular shelter. The Norway spruce is perhaps the very best tree for a drained moss soil in such a climate; for, if the surface on which it is planted is dry, it seems to delight in having very deep moist ground beneath. There is a variety of this tree, called the White Spruce, from North America, that grows very fast here. I am informed that it is a tree which rises to a great height, and is long lived. The Norway or European spruce never thrives long on hard dry ground, but in favourable situations it is long lived, and sometimes is seen more than a hundred feet high.

Although I have been successful in planting some of my moss grounds with trees, I cannot say

I have been successful in so planting my great flow moss, extending to near 300 acres, which I drained (I fear not sufficiently), and intended, after having let it in pasture for a few years, to have once more covered with trees. I propose to have this moss more completely drained, and partly planted with trees, and partly perhaps earthed on the surface, for procuring better pasture. These I consider the most suitable crops in so high a climate. Deep peat mosses require to be more drained, and with deeper ditches, for trees, than for grass. The deeper roots of trees should never be involved in stagnant water. I am quite satisfied that trees of every sort will thrive in moss soil, if it be only well drained, and if its surface be relieved of the tough and unsolid roots of moss plants, particularly of *Sphagna*, *Polytricha*, *Eriophora*, *Nardi*, &c. Here I crave leave to regret, that these and other botanical terms relative to plants growing on uncultivated grounds, have no generally known names in English.

The flow moss now noticed is a part of that great tract of bog called Cobinshaw Bog (that is, the Bog of the Herd's Wood), consisting of several thousand acres, situate in the counties of Mid-Lothian and Lanark. It must have been all once a wood, as is evi-

dent from the number of trees, principally birch, found in the moss. In its original state this bog was not worth one penny per acre, and what I have of it, in my farm, was, in the purchase I made, considered as worth nothing. It has, in many places, now, merely by its drainage, acquired a surface of pasture grass.

This bog is situate in a plain, surrounded with higher grounds, and appears to be somewhat raised in the middle, in most places with a small declivity to every side. One part of its drainage-water runs to the German Ocean, and another part to the Atlantic, which shews that this moss lies in one of the highest tracts in Great Britain. In some flat places in the middle of it, there were pools of water on the surface, which I drained, and there is now grass where these pools were situate. Probably the peat of a part of this bog rests on a lake; for there are openings into which the surface-waters descend to a great depth. From the circumstance of a small rivulet, called still the Birch Burn, running through part of the moss, deep chasms have been made in some places, by which it appears that the peat of this part of the bog is generally about twelve feet deep, becoming somewhat shallower towards the edges.

The bottom is a clayey soil. Above this is a layer of four feet of decayed branches and trunks of birch, with some alder and oak trees, mixed with mud and soft moss-soil. The remainder of the peat-turf is a mass composed of the roots and stems of *Eriophora, Carices, Ericæ,* and *Musci.*

The whole surface of the bog is uneven, cut into channels by floods in some places, and raised in others into hillocks. These hillocks, in the wettest places, are composed almost entirely of the *Trichostomum lanuginosum,* which, in summer, appear, at a short distance, like cushions of white wool.

But the more general production of this bog, like that of most others, was heath plants, mixed with *Eriophora, Carex limosa, Scirpus cæspitosus, Polytrichum commune, Sphagnum palustre, Lichen rangiferinus,* and *Hypna.* The subsoil is blackish peat, somewhat firm.

In digging a drain through this moss, my servants found, at the depth of about four feet from the surface, a number of ancient Roman silver medals, in great preservation. There is in this vicinity a small square Roman camp (Castle Graig), meant for accommodating a single legion ; and the way from this camp to the next more extensive Roman station at

Castra-Corda, now called Castledykes, near Carstairs, most probably passed through Cobinshaw Bog; and a little farther in the same track, lay Colania, a Roman fort, noticed by PTOLEMY, and supposed to be the Castlehill of Lanark, on the bank of the river Clyde. It is probable, therefore, that these coins had belonged to some one of the Roman officers stationed in this quarter, perhaps in the time of the Emperor MARCUS AURELIUS ANTONINUS, as some of the medals bear his name; and others have the names of the Empress FAUSTINA, his wife, and of his predecessors DOMITIAN, TRAJAN, HADRIAN, and PIUS. There are two different figures of FAUSTINA: One of them is said to be fine. From the circumstances in which these coins were found, it is probable they were dropped on the surface of the ground upwards of 1600 years ago, and that the ground was then covered with a growing wood, as appears from the branches of birch trees (that have still their form and bark entire), in which the coins were enveloped. Indeed almost the whole parish of Calder (Coildor, the oak-wood), has been a wood even within memory, as appears from the following verses, still rehearsed amongst the people there;

Calder Wood was fair to see
When it went to Cameltree,
Calder Wood was fairer still
When it went o'er Crosswoodhill.

My general plan of improving my other grounds, after drainage, and in which I have succeeded far beyond my expectation, has been by spreading on their surface composts of earth and lime, on the peat or moss soils; and of peat and lime on earthy and comparatively dry soils.

My first operation in improvement was on an arable field of twenty acres of generally light loam land, near the farm-house of Crosswoodhill, which I inclosed, and proposed to lay down in grass for permanent pasture, considering any ground whatever, so high situated, as unfit for corn-crops. This inclosure, now called the Sheep-Park, was mostly fallowed during the two successive summers of 1807 and 1808; and, being all well limed, was, the second autumn, manured partly with dung and partly with peat, and sown with rye-grass and white clover-seeds, (and also unsuccessfully with a mixture of seeds of lucern and sainfoin), having no other crop. The hay produced was good.

This field, having about seven acres of deep moss-ground inclosed with it, is now, for the most part,

excellent pasture, being let at from L. 40 to L. 50 per annum. It has been composted twice on the surface with lime and peat-earth, and is covered with a variety of good pasture-grasses, but the principal plants seem to be white clover (*Trifolium repens*), soft grasses (*holci*), dogstail (*Cynosurus cristatus*), &c.

My next improvement was executed on a very small field, the one-half of which was peat-moss soil, from six to eight feet deep, covered with heath the other half being bent moss-ground. The subsoil was poor and sandy. The whole being well drained, with under-drains filled with stones, was ploughed, and part of the deep peat-soil carried to the sandy ground, where it was partly incinerated, and part of the sandy soil served to manure the peat-moss. The whole was then top-dressed very thinly with lime-compost, and sown with different grass-seeds. This improvement answered very well, and the surface of the whole is now bearing very good pasture; but I found the plan too expensive.

The next field was improved as follows: It had for the most part a soil of peat, covered partly with heath and partly with coarse grasses (*carices*) and stool or wire bent, sometimes called the Moss-

rush (*Juncus squarrosus*). Being relieved from its superabundant moisture by drains, and inclosed with a stone wall, it was once ploughed, and the reversed furrow-slices laid quite flat. Then it was thinly top-dressed with lime, mixed with earth obtained from different ground. Next it was harrowed, and sown with (*Holcus lanatus*) white soft grass or Yorkshire fog, (*Trifolium repens*) white clover, and other grasses and seeds. This improvement turned out to be cheap, and the field has now good grass. I have found it expedient to follow this method of ploughing, in portions of heathy grounds of other fields, though my general practice is now to accomplish a permanent improvement of the pasture where it had been formerly coarse grasses, merely by employing top-dressings of composts. I consider it expedient to plough soil in the above mentioned manner, where the ground is covered with heath, unless where I find it convenient rather to top-dress such ground with earth, at the rate of about seventy tons per statute acre, and sometimes also afterwards with lime compost. But it is obviously advantageous likewise to burn the surface-heath, and surface-herbage of every kind, before applying these

top-dressings, when that can be done with ease and safety.

The next improvement was made on a field of fifty acres, which was drained with open ditches of different dimensions, and inclosed by a stone wall. This field contained, besides many portions of it covered with coarse grasses, such as generally grow in wet soils, a large proportion of deep flow-moss, producing nothing but heath, and another portion that had been long ago ploughed. To part of the ground in the last mentioned situation I applied quicklime in sufficient quantity, without observing much improvement arising therefrom. But, after bestowing on it likewise my ordinary top-dressing of lime and earth, the herbage became visibly altered to the better, though not for three or four years. Such ground as is worn out or exhausted by tillage and corn-crops, and allowed, in a cold and wet climate, to be over-run with moss-plants, appears to be more difficult to be brought to a fertile state than any other kind of soil. Finally, the whole of this field has been top-dressed with a compost of earth and lime, and seems in a constant state of improvement. After it was inclosed and drained, it was let at first for about L. 10 per annum; the

rent is now above L. 30, and gradually advancing. It should have been mentioned that a portion of this inclosure, had, for a trial, a quantity of burnt clay administered to it as a top-dressing, instead of the ordinary lime-compost, and which appeared to produce nearly the same effect in ameliorating the pasture; but the expence was much greater.

A small field, that consisted of two-thirds of dry loam land, and one-third of deep peat-bog, was next inclosed. The dry land was laid down to grass in the ordinary way. The mossy part was drained and then top-dressed with a compost of lime and earth, and now bears more grass than the dry part. The whole is now let for pasture at a rent of L. 3 per acre.

To some portions of my inclosures or parks that were incumbered with very long moss-plants, mostly of the tribe of *hypna*, I found no better remedy than covering them well over with long or fresh dung from the stable. This answered the purpose well, and destroyed the tall moss-plants (sometimes called by farmers Fog), while it encouraged the growth of grass.

I likewise improved a large space of ground that contained many different sorts of soil, mostly wet,

by draining and inclosing it, and then partly by irrigation, and partly by applying top-dressings of lime and moss to the dry portions of it, and of lime and earth to the peaty portions of it, some of which were deep moss soils, and were improved, so as in a few years to bear the finest grasses with much white clover, in place of the coarsest herbage of a wet soil.

The irrigation was principally performed, by taking the advantage of a rivulet of pure water that runs through the inclosure. It has occasioned a vast quantity of herbage for cattle to grow on eight or ten acres, which are annually covered with the water; but it must be confessed, that a number of rushes (*Juncus conglomeratus, articulatus* and *effusus*) do now also incumber the watered meadow. These rushes are also apt to grow on some of my improved pastures in this high climate; and the only remedy against them seems to be to cut them down with a scythe early in each summer. The watered meadows, of which I have a few more on my farm, were at first laid out by myself, but were afterwards improved by a professional irrigator, Mr STEVENS.

The mountainous part of my farm, which is at present pastured with sheep, I have entirely drain-

ed and inclosed with a stone wall, and I am gradually improving the pasturage of it, by top-dressing the surface in some parts merely with the earthy subsoil, but more generally with lime-composts, in manner already mentioned, which, in a few years, completely alter the kinds of plants growing on it, and effect a change to the better, in a degree scarcely within the bounds of credibility; so that I am at liberty to say that this is an advantageous speculation to every person possessed of such lands.

When lime composts are thinly spread on good pasture, a change is generally apparent in a few weeks after they have been laid on. The grass becomes more verdant, and cattle give it a decided preference to any other part of their pasture. Experienced graziers also remark, that cattle are sooner fattened by eating grass so manured. When such composts are put on drained grass-pastures bearing coarse herbage, several months elapse before they make much improvement; but, by degrees, the coarse grasses are supplanted by those of a better sort. Lime composts, spread on dry heathy grounds, seem to me to take some years to operate the extinction of the heath. I observed, in some cases, that, after a lime compost had been applied to

heathy ground, white clover crept over the heath plants, and flowered above them. It appears, therefore to me, that the repent stems of the common *Trifolium repens* abound in almost all grounds, but it flowers in favourite soils only. In composted heath lands, I have noticed that the heath gives way, at length, to the *Nardus stricta*, a coarse grass or bent, in some districts called Mat-grass; and, after some time, this latter also yields to grasses more adapted to the gradually improving soil. Whence the seeds of fine pasture-grasses are derived, to supply a new verdure to a portion of enriched surface in the midst of a moor, is inexplicable by me; but every one may observe a similar process in garden-grounds. On a plat of mossy ground on my farm, that had been covered with heath plants, and surrounded with moor, but which plat had been rendered bare by a compost heap of quick-lime and soil taken from the adjacent land, that had lain some time on it, but had been removed, there appeared, in the autumn of the next year, the following plants, along with others of the best pasture-grasses, viz. meadow fescue (*Festuca pratensis*), annual poa (*Poa annua*), meadow soft

grass (*Holcus lanatus*), white clover (*Trifolium repens.*)

Thus this plat will become, in the subsequent year, well covered with nutritive food for cattle. So it is evident, wherever the surface-soil of the earth is altered in its nature by fertilizing manures, or otherwise, there is provided, by the incomprehensible influence of an Almighty Power, seeds and plants, and perhaps animals, adapted for such soil, climate, and situation. Whence come the seeds of the blue mould which is generated on the cheese, when suited for this production? This mould is a forest in miniature, harbouring microscopic animals of various sorts, and propagated as other plants, that the earth may be abundantly replenished, or for some wise end that mankind have not the capacity to discern.

I make use of a great deal of peat-moss, made friable, for top-dressing and for enriching grass grounds, especially poor sandy soils. I have also discovered on my farm and make use of marl: and I often top-dress merely with earths, different from those of the field to which they are applied; and with dung, and sometimes with a compost of dung and earth. But my general composts have hot lime

in them which I obtain at about five miles distance from my farm. These composts are made up as follows: Lay down a bed of earth or peat-moss, near the place where the compost is to be used. If peat, it should be chosen of the most friable sort; and, if such cannot be got cheaply, the turf should be chopped small, and the unsolid and tough portions of it rejected, and it should be somewhat wet, otherwise it may catch fire by contact with the quicklime. On this bed or layer put unslaked lime, and instantly cover it up with earth or peat. The unslaked lime may be about a tenth part of the bulk of the compost. When the lime is just completely slaked with the moist earth, which may be, in general, in eight or ten days, let the whole materials be well chopped and mixed together, and the compost may be spread in a few days thereafter, as a surface-manure. Care should be taken that the mixture should be made as soon as the lime is fully slaked, that the powdered lime may not become clotted, and also that it may not become effete; for it appears to me, that quick-lime possesses all the qualities of its carbonate, and many more, of which advantage may be taken by spreading it on the ground in its caustic state. I suppose, however, that slaked

lime continues uneffete, and possesses in some degree its caustic quality for a very long time. PLINY, the Roman naturalist, is confirmed by VITRUVIUS and the ancient architects, in stating, that building lime-mortar was not considered by the ancient Romans as at its best till it had lain prepared for three years. PLINY adds, "Intrita quoque quo vetustior eo melior." *Mortar, the older it is, the better it is found to be for building.* This is a matter of curiosity as well as of importance, as the practice of our modern masons is so very different. The ancient Romans were jealous of the character of their buildings for durability; and PLINY remarks, that there was a public law, forbidding contractors for edifices to use lime till it had lain well mixed up as mortar for the space of three years at least; because, if used sooner, unslaked portions of the lime were apt, by their vast elastic force in slaking, to displace the largest stones of a wall, and to occasion cracks, blisters, and chinks in the plaster. Thus it appears probable, that lime slaked with water, or hydrate of lime, made into mortar with sand, continues many years somewhat caustic, without imbibing its complement of carbonic acid gas, and before it becomes as hard as a stone.

It seems to be eligible that lime, chalk, and calcareous substances in general, that are designed to be used as manure, should, in most cases, be calcined, and put on the ground in a powdery state. Quick-lime should always be spread on the surface of the ground, for it sinks very deep into the soil.

I lay lime compost very thinly on my grass-lands at first, not more than from thirty to forty tons of it being used to a statute acre; but, if I see it necessary, a second, or even a third, top-dressing is given. In general the earth or peat used by me in compost is dug out of a corner of the field, where it is to be spread on the surface. I have found that lime alone does not go so far, nor is so economical or useful for my purpose in improving pastures, as when mixed into compost with peat or earth of the farm.

To conclude this account of the improvement of Crosswoodhill, I may with truth say, that I found it a bleak, wet, and gloomy heath, about seven miles around, without shelter, and without inclosure. It now presents to the eye, in summer, fields of excellent pasture, abounding in cattle of a supe-

rior description, and diversified with thriving plantations.

Letter from the Reverend JAMES HEADRICK, *Minister of Dunnichen, Author of several Agricultural and Mineralogical Treatises, to the* AUTHOR.

13th June 1826.

I HAVE perused your Manuscript History of Peat-Moss with great satisfaction, both as it respects the principles and the practice.

With regard to your own improvements on your estate of Crosswoodhill, as I have known the property both before and after these improvements, I think you have given a very fair and moderate account of them.

I beg leave to offer one remark, that your improvements are not such as perish with the use, but must every year become more productive; and, were others to follow your example, and those unsightly wastes which now occupy so large a portion of our country's surface, made to carry nutritive herbage, I leave others, who are better qualified than I am, to estimate the great increase of animal produce

which would accrue to the community, as well as of rent to the proprietors. I am, &c.

P. S.—Doubts having been entertained, and frequently alluded to in the course of your work, concerning the operation of lime in converting moss into a soil, I beg leave to observe, that, as stated by you, if lime-water be dropt into moss-water, all the moss is quickly carried to the bottom. Rain-water also that is retained on, or flows from, moss, is commonly saturated with mossy matter, but water that is retained on, or flows from, *limed* moss-grounds, is perfectly limpid and pure. Although these facts do not prove that lime adds fertility to moss, yet I apprehend they prove that lime reduces moss to an earthy substance, that is no longer capable of solution or suspension in water.

Remark by Mr STEELE.

As lime forms with tanin, a compound insoluble in water, may not the action of lime on moss-earth, noticed by Mr HEADRICK, be accounted for, by the lime attracting the tanning matter in

the peat soil, and thus leaving the hitherto inert moss, as a vegetable substance subject to the ordinary process of decay? If so, and as lime neutralizes all free acids found in any peat-soils, then theory, in the present instance, happily combines with the practice, on this general agricultural subject, in recommending quick-lime as of importance, commonly, in improving moss and fen soils; which in Great Britain and Ireland amount to several millions of acres.

Letter from Mr Alexander Thornton, *former Proprietor of Crosswoodhill, to the* Author.

23d July 1826.

Having repeatedly seen your improvements on Crosswoodhill, which I sold to you several years ago, and having indeed twice inspected the grounds with you this year, I am satisfied your account of the improvements on them is correct in all respects. I am, &c.

Letter from JOHN JOHNSTONE, *Esq., Landsurveyor in Edinburgh, Author of the Account of* ELKINGTON'S *Mode of Draining Lands, and other Agricultural Works, to the* AUTHOR.

1*st June* 1826.

I LAST night finished the reading of your Manuscript on the Improvement of Peat-Moss Soils, with which I have been much gratified. I think it the most full, correct, and intelligible account of the subject that has hitherto been given, and will be highly useful to the landed proprietor and to the practical farmer.

Particularly, I am much pleased with the account of your own improvements at Crosswoodhill; for a short statement of practical facts will go further to convince and stimulate to a similar exertion than the most lengthened detail of theoretical speculation. If it had been published fifteen years ago, many thousands a year would have been added to the rental and product of the country.

FINIS.

GLOSSARY of the English and Scotch Provincial Names commonly given to Plants found on Peat Bogs and Wet Moors, to which are applicable the following Botanical Terms of the Linnæan System, in this and other books.

NOTE—*The Linnæan names are printed in italics, and the Provincial names in the common type.*

Agrostis stolonifera. Marsh bent grass, Black squitch, Fiorin.
Aira flexuosa. Heath hair-grass.
—— *aquatica.* Water hair-grass, Rough grass.
—— *montana.* Mountain hair-grass.
—— *coerulea.* Blue moor-grass, Flybent.
Andromeda polifolia. Marsh Rosemary, Marsh Cistus, Poley Mountain, Marsh Holyrose.
Arbutus Uva-ursi. Stoneberry, Bearberry, Whortleberry.
Anthericum ossifragum. Bastard asphodel, Lancashire asphodel, King's spear.
Bryum hypnoides, &c. Red bog-moss.
Caltha palustris. Meadow-bouts, Marsh-Marigold.
Carex pulicaris.
limosa.
vesicaria.
cæspitosa.
Bladder grass, Seg grass, Blue grass.

Conferva bullosa, &c. Crow silk.
Comarum palustre. Marsh Cinquefoil, Purple marshlocks.
Cynosurus coeruleus. Blue dog-tail grass, Blue moor-grass.
Drosera rotundifolia. { Round leaved Sundew, Youthwort, Redrot, Rosa solis.
——— *longifolia.* Long-leaved Sundew, Moor-grass.
Empetrum nigrum. { Blackberried heath, Crow-berry, Crake-berry.
Equisetum palustre. Marsh horse-tail, Paddockpipe.
Erica vulgaris. Heath, Ling, Grig, Heather.
—— *tetralix.* Cross leaved heath, Bell heather.
—— *cinerea.* Fine leaved heath.
Eriophorum polystachion. { Bog cotton, Moss crops, Moor grass.
——— *vaginatum.*
Hippuris vulgaris. Stonewort, Marestail.
Hydrocotyle vulgaris. Marsh pennywort, White-rot.
Hypnum cuspidatum, &c. Mosses, Fogs.
Juncus squarrosus. { Bogrush, Goosecorn, Stoolbent, Wire-bent.
——— *articulatus.* Jointed rush, Spret.
——— *conglomeratus.* Round-headed rush.
——— *effusus.* Seaves.
——— *campestris.* Field rush.
Lichen rangiferinus. Rein-deer moss.
Lycopodium clavatum. Wolf's claw, Clubmoss.
——— *selago.* Fir moss, Fir-leaved clubmoss
Menyanthes trifoliata. { Marsh trefoil, Water trefoil, Marsh-cleaver, Trefoil buckbean.
Mnium cuspidatum, &c. Yellow knap-moss.
Myrica Gale. Sweet scented gale, Goule, Dutch myrtle.
Nardus stricta. Mat grass, Bent grass.
Oenanthe crocata. Hemlock dropwort, Dead tongue.
Pedicularis palustris. Marsh Lousewort.

Pinguicula vulgaris. { Butterwort, Yorkshire sanicle, Sheep-rot.

Polytrichum commune. { Goldilocks, Golden maidenhair, Hair moss, Redshanks.

Potamogeton natans. Broad leaved pond-weed.

Ranunculus flammula. Spearwort.

Schoenus albus. White bogrush.

——— *nigricans.* Black bogrush.

——— *mariscus.* Prickly bogrush.

Scirpus cæspitosus. Deer's-hair.

——— *palustris.* Clubrush.

——— *lacustris.* Bulrush.

Sphagnum palustre. Bog-moss.

Tormentilla erecta. Tormentil.

Triglochin palustre. Arrow-headed grass.

Trichostomum lanuginosum. Woolly bog-moss.

Utricularia minor. Lesser bladder snout, Hooded milfoil.

Vaccinium oxycoccus. { Cranberry, Mossberry, Cornberry, Marsh whorts.

——— *myrtillus.* { Blaeberry, Bilberry, Black whortle-berry.

——— *uliginosum,* Great Bilberry, Rashberry.