BRITISH FARMING

A DESCRIPTION OF

THE MIXED HUSBANDRY OF GREAT BRITAIN

BY JOHN WILSON

FARMER AT EDINGTON MAINS, BERWICKSHIRE.

WITH NUMEROUS ILLUSTRATIONS

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PREFACE.

THE Author having contributed to the new edition of the Encyclopædia Britannica the articles AGRICULTURE, DAIRY, and DRAINING, has now, at the request of the Publishers, been induced to embody these in the following Treatise, with considerable corrections and additions.

It might have been expected that such a treatise should embrace the important branch of Agricultural Chemistry; but as Dr. Anderson, Professor of Chemistry in the University of Glasgow, and Chemist to the Highland and Agricultural Society of Scotland, who contributed the article Agricultural Chemistry to the Encyclopædia, has lately republished the substance of that valuable contribution in a separate volume, entitled, "Elements of Agricultural Chemistry," the reader is referred to that volume for information on the strictly scientific departments of Agriculture. What the Author has attempted, has been to supply such an account of the present state of British Agriculture as a practical farmer of some experience might be expected to give, embracing the more important changes in agricultural practice that have been lately introduced. His endeavour has been to do this in such a way as may be useful to those engaged in agricultural pursuits, and interesting to the general reader.

EDINGTON MAINS, BERWICKSHIRE,
April 1862.

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BRITISH AGRICULTURE.

CHAPTER I.

HISTORICAL SUMMARY.

Section 1.—*Agriculture of the Ancients.*

It would be interesting to know how the nations of antiquity tilled, and sowed, and reaped; what crops they cultivated, and by what methods they converted them into food and raiment. But it is to be regretted, that the records which have come down to us are all but silent upon these homely topics.

In Mr. Hoskyn's admirable treatise,* we have an excellent specimen of what may yet be done to recover and construct an authentic history of the Agriculture of the ancients, from the casual allusions and accidental notices of rural affairs which lie thinly scattered through the body of general literature; and, more especially, from those mysterious records of the past, which are now being rescued from their long burial under the ruins of some of the most famous cities of antiquity. Although comparatively little has been found in such records bearing directly upon the subject; we must not despair of the learned industry, and masterly skill, of an advancing and searching criticism, gathering together these

* Short Enquiry into the History of Agriculture, by Chandos Wren Hoskyn, Esq., London, 1849.

gleams of light, and making them happily converge upon the darkness which has hitherto interposed between us and a circumstantial knowledge of the methods and details of ancient husbandry.

Every reader of the Bible is familiar with its frequent references to Egypt as a land so rich in corn, that it not only produced abundance for its own dense population, but yielded supplies for exportation to neighbouring countries. Profane history corroborates these statements. Diodorus Siculus bears explicit testimony to the skill of the farmers of ancient Egypt. He informs us that they were acquainted with the benefits of a rotation of crops, and were skilful in adapting these to the soil and to the seasons. The ordinary annual supply of corn furnished to Rome has been estimated at 20,000,000 of bushels. From the same author, we also learn, that they fed their cattle with hay during the annual inundation, and at other times tethered them in the meadows on green clover. Their flocks were shorn twice annually (a practice common in several Asiatic countries), and their ewes yeaned twice a year. For religious as well as economical reasons, they were great rearers of poultry, and practised artificial hatching, as at the present day. The abundance or scarcity of the harvests in Egypt depended chiefly upon the height of the annual inundation. If too low, much of the land could not be sown, and scarcity or famine ensued. On the other hand, great calamities befell the country when the river rose much above the average level. Cattle were drowned, villages destroyed, and the crops necessarily much diminished; as in such cases, many of the fields were still under water at the proper seed-time. In 1818, a calamity of this kind took place, when the river rapidly attained a height of three and a half feet above the proper level.

It is from the paintings and inscriptions with which the ancient Egyptians decorated their tombs, that we get the fullest insight into the state of agriculture amongst this remarkable people. Many of these paintings, after the lapse of two or three thousand years, retain the distinctness of outline and brilliancy of colour of recent productions. The acquaintance which these give us with their occupations, attainments, and habits, is truly marvellous, and fills the reader of such works as "Wilkinson's Egypt" with perfect amazement. Every fresh detail seems to give confirmation to that ancient saying, "There is nothing new under the sun." Those which refer to rural affairs disclose a state of matters at that early date of the world's history, which may well remind us to speak modestly of our own attainments. An Egyptian villa comprised all the conveniences of a European one of the present day. Besides a mansion with numerous apartments, there were gardens, orchards, fish-ponds, and preserves for game. Attached to it was a farm-yard, with sheds for cattle and stables for carriage horses. A steward directed the tillage operations, superintended the labourers, and kept account of the produce and expenditure. The grain was stored in vaulted chambers furnished with an opening at the top, reached by steps, into which it was emptied from sacks, and with an aperture below for removing it when required. Hand-querns, similar to our own, were used for grinding corn; but they had also a larger kind worked by oxen. In one painting in which the sowing of the grain is represented, a plough drawn by a pair of oxen goes first; next comes the sower scattering the seed from a basket; he is followed by another plough; whilst a roller, drawn by two horses yoked abreast, completes the operation. The steward stands by superintending the whole. Nothing, however, conveys to us so full an impression of the advanced state of civilization amongst the ancient Egyptians as the value which they attached to land, and the formalities which they observed in the transfer of it. In the time of the Ptolemies, their written deeds of conveyance began with the mention of the reign in which they were executed, the name of the president of the court, and of the clerk who drew them. The name of the seller, with a description of his personal appearance, his parentage, profession, and residence, was engrossed. The nature of the land, its extent, situation, and boundaries; the name and appearance of the purchaser were also included. A clause of warrandice and an explicit acceptance by the purchaser followed; and finally the deed was attested by numerous witnesses (so many as sixteen occur to a trifling bargain), and by the president of the court.

The Nomades of the patriarchal ages, like the Tartar, and perhaps some of the Moorish tribes of our own, whilst mainly dependent upon their flocks and herds, practised also agriculture proper. The vast tracts over which they roamed were in ordinary circumstances common to all shepherds alike. During summer they frequented the mountainous districts, and retired to the valleys to winter. Vast flocks of sheep and of goats constituted the chief wealth of the Nomades, although they also possessed animals of the ox kind. When these last were possessed in abundance, it seems to be an indication that tillage was practised. We learn that Job, whose time is by the best authorities fixed as about contemporaneous with that of Abraham, besides immense possessions in flocks and herds, had 500 yoke of oxen, which he employed in ploughing, and a "very great husbandry." Isaac, too, conjoined tillage with pastoral husbandry, and that with success, for we read that he sowed in the land Gerar, and reaped an hundred fold—a return which, it would appear, in some favoured regions, occasionally rewarded the labour of the husbandman. In the Parable of the Sower, our Lord (grafting his instructions upon the habits, scenery, and productions of Palestine) mentions an increase of thirty, sixty, and an hundred fold. Such increase, although far above the average rate, was sometimes even greatly exceeded, if we take the authority of Herodotus, Strabo, and Pliny.

Along with the Babylonians, Egyptians, and Romans, the Israelites are classed as one of the great agricultural nations of antiquity. The sojourn of the Israelites in Egypt trained them for the more purely agricultural life that awaited them upon their return to Canaan, to take possession of it as their own. Nearly the whole population were virtually husbandmen, and personally engaged in agriculture. Upon their entrance into Canaan, they found the country occupied by a dense population, possessed of walled cities and innumerable villages, masters of great accumulated wealth, and subsisting on the produce of their highly cultivated soil, which abounded with vineyards and oliveyards. It was so rich in grain, that the invading army, numbering 601,730 able-bodied men, with their wives and children, and a mixed multitude of camp-followers, found "old corn" in the land sufficient to maintain them from the day that they passed Jordan. The Mosaic Institute contained an Agrarian law, based upon an equal division of the soil amongst the adult males, a census of which was taken just before their entrance into Canaan. Provision was thus made for six hundred thousand yeomen, assigning (according to different calculations) from sixteen to twenty-five acres of land to each. This land, held in direct tenure from Jehovah, their sovereign, was strictly inalienable. The accumulation of debt upon it was prevented by the prohibition of interest, the release of debts every seventh year, and the reversion of the land to the proprietor, or his heirs, at each return of the year of jubilee. The owners of these small farms cultivated them with much care, and rendered them highly productive. They were favoured with a soil extremely fertile, which their skill and diligence kept in good condition. The stones were carefully cleared from the fields, which were also watered from canals and conduits, communicating with the brooks and streams with which the country "was well watered everywhere," and enriched by the application of manures. The seventh year's fallow prevented the exhaustion of the soil, which was further enriched by the burning of the weeds and spontaneous growth of the Sabbatical year. The crops chiefly cultivated were wheat, millet, barley, beans, and lentiles; to which it is supposed, on grounds not improbable, may be added rice and cotton. The ox and the ass were used for labour. The word "oxen," which occurs in our version of the Scriptures, as well as in the Septuagint and Vulgate, denotes the species, rather than the sex. As the Hebrews did not mutilate any of their animals, bulls were in common use. The quantity of land ploughed by a yoke of oxen in one day, was called a yoke or acre. Towards the end of October, with which month the rainy season begins, seed-time commenced, and of course does so still. The seed-time, begun in October, extends, for wheat and some other white crops, through November and December; and barley continues to be sown until about the middle of February. The seed appears to have been sometimes ploughed in, and at other times to have been covered by harrowing. The cold winds which prevail in January and February, frequently injured the crops in the higher and more exposed districts. The rainy season extends from October to April, during which time refreshing showers fall, chiefly during the night, and generally at intervals of a few days. The harvest was earlier or later as the rains towards the end of the season were more or less copious. It, however, generally commenced in April, and continued through May for the different crops in succession. In the south and in the plains, the harvest, as might be expected, commenced some weeks earlier than in the northern and mountainous districts. The slopes of the hills were carefully terraced and irrigated wherever practicable; and on these slopes, the vine and olive were cultivated with great success. At the same time, the hill districts and neighbouring deserts afforded pasturage for numerous flocks and herds, and thus admitted of the benefits of a mixed husbandry. With such political and social arrangements, and under the peculiarly felicitous climate of Judæa, the country, as a whole, and at the more prosperous periods of the commonwealth, must have exhibited such an example of high cultivation, rich and varied produce, and wide-spread plenty and contentment, as the world has never yet elsewhere produced on an equally extensive scale. Not by a figure of speech but literally, every Israelite sat under the shadow of his own vine and fig-tree; whilst the country as a whole, is described (2 Kings xviii. 32) as "a land of corn and wine, a land of bread and vineyards, a land of oil-olive and of honey." An interesting illustration of the advanced state of agriculture in these ancient times is afforded by the fact, that, making allowance for climatic differences, the numerous allusions to it with which the Scriptures abound seem natural and appropriate to the British farmer of the present day.

The unrivalled literature of Greece affords us little information regarding the practical details of her husbandry. The people who, by what remains to us of their poetry, philosophy, history and fine arts, still exert such an influence in guiding our intellectual efforts, in regulating taste, and in moulding our institutions, were originally the invaders and conquerors of the territory which they have rendered so famous. Having reduced the aboriginal tribes to bondage, they imposed upon them the labour of cultivating the soil. Hence both the occupation, and those engaged in it, were regarded contemptuously by the dominant race, who addicted themselves to what they regarded as nobler pursuits. With the exception of certain districts, such as Bœotia, the country was naturally unfavourable to agriculture. When we find, however, that valleys were freed from lakes and morasses by drainage, that rocky surfaces were sometimes covered with transported soil, and that they possessed excellent breeds of the domesticated animals, which were reared in vast numbers, we infer that agriculture was better understood, and more carefully practised, than the allusions to it in their literature would seem to warrant.

Amongst the ancient Romans, agriculture was highly esteemed, and pursued with earnest love and devoted attention. "In all their foreign enterprises, even in earliest times," as Schlegel remarks, "they were exceedingly covetous of gain, or rather of land; for it was in land, and in the produce of the soil, that their principal and almost only wealth consisted. They were a thoroughly agricultural people, and it was only at a later period that commerce, trades, and arts, were introduced among them, and even then they occupied but a subordinate place."* Their passion for agriculture survived very long; and when at length their boundless conquests introduced an unheard-of luxury, and corruption of morals, the noblest minds amongst them were strongly attracted towards the ancient virtue of the purer and simpler agricultural times. Several facts in their history afford convincing proof, if it were required, of the devotion of this ancient people to agriculture, in their best and happiest times. Whilst their arts and sciences, and general literature, were borrowed from the Greeks, they created an original literature of their own, of which rural affairs formed the substance and inspiration. Schlegel and Mr. Hoskyn notice also the striking fact, that whilst among the Greeks the names of their illustrious families are borrowed from the heroes and gods of their mythology, the most famous houses amongst the ancient Romans, such as the Pisones, Fabii, Lentuli, etc., have taken their names from their favourite crops and vege-

* The Philosophy of History, by Frederick Von Schlegel. London, 1846; p. 253.

tables. Perhaps it is not too much to assert, that many of those qualities which fitted them for conquering the world, and perfecting their so celebrated jurisprudence, were acquired, or at all events nourished and matured, by the skill, foresight, and persevering industry, so needful for the intelligent and successful cultivation of the soil. The words which Cicero puts into the mouth of Cato give a fine picture of the ancient Roman enthusiasm in agriculture. "I come now to the pleasures of husbandry, in which I vastly delight. They are not interrupted by old age, and they seem to me to be pursuits in which a wise man's life should be spent. The earth does not rebel against authority; it never gives back but with usury what it receives. The gains of husbandry are not what exclusively commend it. I am charmed with the nature and productive virtues of the soil. Can those old men be called unhappy who delight in the cultivation of the soil? In my opinion, there can be no happier life, not only because the tillage of the earth is salutary to all, but from the pleasure it yields. The whole establishment of a good and assiduous husbandman is stored with wealth; it abounds in pigs, in kids, in lambs, in poultry, in milk, in cheese, in honey. Nothing can be more profitable, nothing more beautiful, than a well-cultivated farm."

In ancient Rome, each citizen received, at first, an allotment of about two English acres. After the expulsion of the kings this allotment was increased to about six acres. These small inheritances must of course have been cultivated by hand labour. On the increase of the Roman territory, the allotment was increased to fifty, and afterwards even to five hundred acres. Many glimpses into their methods of cultivation are found in those works of Roman authors which have survived the ravages of time. Cato speaks of irrigation, frequent tillage, and manuring, as means of fertilizing the soil. Mr. Hoskyn, from whose valuable contribution to the

History of Agriculture we have drawn freely in this historic summary, quotes the following interesting passage from Pliny, commenting on Virgil:*—"Our poet is of opinion that alternate fallows should be made, and that the land should rest entirely every second year. And this is, indeed, both true and profitable, provided a man have land enough to give the soil this repose. But how, if his extent be not sufficient? Let him, in that case, help himself thus. Let him sow next year's wheat-crop on the field where he has just gathered his beans, vetches, or lupines, or such other crop as enriches the ground. For, indeed, it is worth notice that some crops are sown for no other purpose but as food for others, a poor practice, in my estimation." In another place, he tells us, "Wheat, the later it is reaped, the better it casts; but the sooner it is reaped the fairer the sample. The best rule is to cut it down before the grain is got hard, when the ear begins to have a reddish-brown appearance. 'Better two days too soon than as many too late,' is a good old maxim and might pass for an oracle." The following quotation from the same author is excellent: "Cato would have this point especially to be considered, that the soil of a farm be good and fertile; also, that near it there be plenty of labourers, and that it be not far from a large town: moreover, that it have sufficient means for transporting its produce either by water or land. Also, that *the house be well built*, and the land about it as well managed. But I observe a great error and self-deception which many men commit, who hold opinion that the negligence and ill-husbandry of the former owner is good for his successor or after-purchaser. Now, I say, there is nothing more dangerous and disadvantageous to the buyer than land so left waste and out of heart; and therefore Cato councils well to purchase land of one who has managed it well, and

* Short Enquiry into the History of Agriculture, pp. 49-51, by Chandos Wren Hoskyn, Esq.

not rashly and hand-over-head to despise and make light of the skill and knowledge of another. He says, too, that as well land as men, which are of great charge and expense, how gainful soever they may seem to be, yield little profit in the end, when all reckonings are made. The same Cato being asked, what was the most assured profit rising out of land? made this answer,—'To feed stock well.' Being asked again, 'what was the next?' he answered, 'To feed *with moderation*.' By which answer he would seem to conclude that the most certain and sure revenue was a *low cost of production*. To the same point is to be referred another speech of his, 'That a good husbandman ought to be a seller rather than a buyer;' also, 'that a man should stock his ground early and well, but take long time and leisure before he be a builder; for it is the best thing in the world, according to the proverb, 'to make use, and derive profit, from other men's follies.' Still, when there is a good and convenient house on the farm, the master will be the closer occupier, and take the more pleasure in it; and truly it is a good saying, that 'the master's eye is better than his heel.'"

"It is curious," says Mr. Hoskyn, "to read such passages as these, and to find the very same subjects still handled, week after week, in fresh and eager controversy in the agricultural writings and periodicals of the present day, eighteen centuries after those opinions were written."*

In the later ages of the empire agriculture was neglected, and those engaged in it were regarded with contempt. Many fair regions, once carefully cultivated, and highly productive, were abandoned to nature, and became a scene of desolation; the supplies of overgrown Rome being drawn from Egypt, Sicily, and other provinces, which became notable as the granaries of the empire.

* See also "Lectures on Roman Husbandry," by Professor Daubeny Oxford, 1857.

Section 2.—Mediæval Agriculture.

Under the Goths, Vandals, and other barbarian conquerors, agriculture in Europe, during the middle ages, seems to have sunk into the lowest condition of neglect and contempt. We owe its revival, like that of other arts and sciences, to the Saracens of Spain, who devoted themselves to the cultivation of that conquered territory, with hereditary love for the occupation, and with the skilful application of the experience which they had gathered in other lands in which they had established their power. By them, and their successors, the Moors, agriculture was carried in Spain to a height which perhaps has not yet been surpassed in Europe. It is said, that so early as the tenth century, the revenue of Saracenic Spain alone amounted to £6,000,000 sterling—probably as much as that of all the rest of Europe at that time. The ruins of their noble works for the irrigation of the soil, still attest their skill and industry, and put to shame the ignorance and indolence of their successors. The same remark applies to the Spanish dominions in South America. In the ancient empire of Peru, agriculture seems to have reached a high degree of perfection. The ruins of basins and canals, frequently carried through tunnels, prove their industry and skill in irrigation. One of their aqueducts is said by Mr. Prescott* to have been traced by its ruins for nearly 500 miles. They cultivated the sides of mountains, by means of terraces which retained forced soil, and were skilled in the application of manure. That on which they chiefly depended was guano, and their Incas protected the penguins, by which it was deposited, by strict laws, which made it highly penal to kill one of these birds, or to set foot on the islands at breeding time. The Spaniards thus obtained possession of two good patrimonies, and have wasted them both.

* "History of the Conquest of Peru," vol. i., p. 125.

The influence of the crusades upon the agriculture of this period is not to be overlooked. The dreadful oppression of the feudal system received at that time a shock most favourable to the liberties of man, and, with increasing liberty, more enlightened ideas began to be entertained, and greater attention to be paid to the cultivation of the soil.

But, during this long interval, the population of Europe was divided into two great classes, of which by far the larger one was composed of bondmen, without property, or the power of acquiring it, and small tenants, very little superior to bondmen; and the other class, consisting chiefly of the great barons and their retainers, was more frequently employed in laying waste the fields of their rivals, than in improving their own. The superstition of the times, which destined a large portion of the country to the support of the church, and which, in some measure, secured it from predatory incursions, was the principal source of what little skill and industry were then displayed in the cultivation of the soil. "If we consider the ancient state of Europe," says Mr. Hume,* "we shall find, that the far greater part of society were everywhere bereaved of their personal liberty, and lived entirely at the will of their masters. Every one that was not noble was a slave; the peasants were not in a better condition; even the gentry themselves were subjected to a long train of subordination under the greater barons, or chief vassals of the crown, who, though seemingly placed in a high state of splendour, yet, having but a slender protection from law, were exposed to every tempest of the state, and, by the precarious condition on which they lived, paid dearly for the power of oppressing and tyrannizing over their inferiors."—"The villains were entirely occupied in the cultivation of their master's land, and paid their rents either in corn or cattle, and other produce of the farm, or in servile offices, which they performed about the

* History of England, chap. xxiii.

baron's family, and upon farms which he retained in his own possession. In proportion as agriculture improved and money increased, it was found that these services, though extremely burdensome to the villain, were of little advantage to the master; and that the produce of a large estate could be much more conveniently disposed of by the peasants themselves, who raised it, than by the landlord or his bailiff, who were formerly accustomed to receive it. A commutation was therefore made of rents for services, and of money-rents for those in kind; and as men in a subsequent age discovered that farms were better cultivated where the farmer enjoyed security in his possession, the practice of granting leases to the peasant began to prevail, which entirely broke the bonds of servitude, already much relaxed from the former practices. The latest laws which we find in England for enforcing or regulating this species of servitude were enacted in the reign of Henry VII. And though the ancient statutes on this subject remain still unrepealed by Parliament, it appears, that before the end of Elizabeth, the distinction between villain and freeman was totally, though insensibly, abolished; and that no person remained in the state to whom the former laws could be applied."

But, long before the fifteenth century, it is certain that there was a class of tenants holding on leases for lives, or for a term of years, and paying a rent in land produce, in services, or in money. Whether they gradually sprung up from the class of bondmen, according to Lord Kames,* or existed from the earliest period of the feudal constitution, according to other writers,† their number cannot be supposed to have been considerable during the middle ages. The stock which these tenants employed in cultivation commonly belonged to the proprietor, who received a proportion of the produce as rent; a system which still exists in France and in

* Kames's *Law Tracts.* † Bell's *Treatise on Leases.*

other parts of the Continent, where such tenants are called *metayers,* and some vestiges of which may yet be traced in the *steel-bow* of the law of Scotland. Leases of the thirteenth century still remain;* and both the laws and chartularies,† clearly prove the existence in Scotland of a class of cultivators distinct from the *serfs* or bondmen. Yet the condition of these tenants seems to have been very different from that of the tenants of the present day; and the lease approached nearer in its form to a feu-charter than to the mutual agreement now in use. It was of the nature of a beneficiary grant by the proprietor, under certain conditions, and for a limited period: the consent of the tenant seems never to have been doubted. In the common expression, "granting a lease," we have retained an idea of the original character of the deed, even to the present time.

The corn crops cultivated during this period seem to have been of the same species, though all of them probably much inferior in quality to what they are in the present day. Wheat, the most valuable grain, must have borne a small proportion, at least in Britain, to that of other crops; the remarkable fluctuation of price, its extreme scarcity, indicated by the extravagant rate at which it was sometimes sold, as well as the preparatory cultivation required, may convince us that its consumption was confined to the higher orders, and that its growth was by no means extensive. Rye and oats furnished the bread and drink of the great body of the people of Europe. Cultivated herbage and roots were then unknown in the agriculture of Britain. It was not till the end of the reign of Henry VIII. that any salads, carrots, or other edible roots, were produced in England. The little of these vegetables that was used, was formerly imported from Holland and Flanders. Queen Catherine, when she wanted

* Sir John Cullum's *History and Antiquities of Hawsted* (*Suffolk*).

† Chalmers's *Caledonia*, book iv. c. 6.

a salad, was obliged to despatch a messenger thither on purpose.*

The ignorance and insecurity of those ages, which necessarily confined the cultivation of corn to a comparatively small portion of country, left all the rest of it in a state of nature, to be depastured by the inferior animals, then only occasionally subjected to the care and control of man. Cultivators were crowded together in miserable hamlets; the ground contiguous was kept continually under tillage; and beyond this, wastes and woodlands of a much greater extent were appropriated to the maintenance of their flocks and herds, which pastured indiscriminately, with little attention from their owners.

The low price of butcher-meat, though it was then the food of the common people, when compared with the price of corn, has been justly noticed by several writers as a decisive proof of the small progress of civilization and industry.

Section 3.—*Foreign Agriculture.*

According to the reports of a writer who has had access to the best sources of information, in addition to his own observations, the state of the agriculture of the greater part of the Continent of Europe so recently as thirty years ago was not very different from what it was in Britain during the prevalence of the feudal system. "The greater part of France," he says, "a still much greater portion of Germany, and nearly the whole of Prussia, Austria, Poland, and Russia, present a wretched uniformity of system. It is called the three-course husbandry, consisting of—1*st*, one year's clean fallow; 2*d*, winter corn, chiefly rye, with a proportion of wheat commensurate to the manure that can be applied; 3*d*, summer corn, or barley and oats. There are occasional and small deviations from this

* Hume's *History of England*, chap. xxiii.

system. In some few cases potatoes, in others peas, are grown, in the fallow year; but they are only minute exceptions to the generally established system. It is not surprising that under such a system the produce should not be much more than four times the quantity of seed, at which rate it is calculated, as appears to be rightly, by Baron Alexander Humboldt.

"The fields are almost universally uninclosed, and exposed to the most injurious effects of a changeable and an intemperate climate. The ancient feudal system of tenure is still continued, modified indeed, and softened in some few parts, but not to a degree or an extent that deserves to be taken into account in the view now under consideration of the countries as a whole. The peasants, for the most part, are *adstricti glebæ;* and where, by recent laws, their condition has been changed, the practical effect has yet hardly had time to exhibit any observable improvement in their state. Labour, whether of men or of cattle, is usually exchanged for the occupancy of land; and hence the labour is performed in the most negligent and imperfect manner, that the vigilance of an overseer, who cannot be everywhere present, will allow.

"The lords of the soil, besides their demesnes, have the right of pasturage on the fields of their tenants from harvest to the next seed-time: hence none of those intervening crops which tend to enrich the soil can be cultivated without infringing on their rights.

"Among the cultivators of the land little or no accumulation of capital has been formed; from the lord to the lowest grade of the peasantry, all are alike destitute of disposable funds. The lords are only rich in land, and sufficiently at their ease, if that land be unencumbered with mortgages or annuities. The peasants, whether owners of the live stock and of the implements, or having the use of them with the land from its owners, are content to live on, from year to year, eating their own produce, growing their own wool and flax, and converting them into garments. They are quite satisfied if they can dispose of as much surplus produce as will pay the small share of money-rent which becomes due to their lord." (*Tracts relating to the Corn Trade and Corn Laws*, by William Jacob, Esq., 1828.)

The agriculture of nearly the whole of the continent of Europe has made very great progress since the remarks now quoted were penned. In Flanders, the Netherlands, Switzerland, and Germany, there are certain limited districts which, in general management rival, and in particular points excel, our own. In nothing is this more apparent than in their scrupulous economy of manure, both as regards its preparation and application. In Flanders, not only the contents of privies, but soap-suds, scullery-water, and slops of every kind containing fertilizing matters, are carefully preserved in suitable receptacles, by the town's folk and villagers, from whom they are purchased by regular manure dealers, who come statedly round with their tub-carts to collect this sewage, store it in tanks, and in due time retail it to the farmers. The latter invariably have tanks of their own, in which the urine of their cattle and similar matters are collected. This liquid manure is frequently enriched by the addition of night-soil and rape-dust, and is always stored for several months before being applied to the land. In South-West Germany, Switzerland, and Holland, the same attention is paid to the preparation of liquid manure, by mingling the dung and urine of the cattle with water, fermenting it in tanks, and then in distributing it over green crops by means of barrel-carts. The following might stand for a description of Myre Mill or Tiptree, but for the want of the steam-engine, force-pump, and underground pipes: "The cows often lie on smooth bricks, which are washed clean twice a-day, for which purpose a pump is an essential appendage to a cow-house. There is generally a deep gutter along the wall behind the cows, into which the water and urine drain, the ground sloping gently towards it. The tank is either immediately under the stable, well vaulted over, or it is so near that all the liquid readily runs into it through a covered drain. The heads of the cows are towards the middle of the stable, and their tails over the gutter along the wall. The width of the building admits of two rows of cows, facing each other, with a space between them sufficiently wide to admit a small cart to bring the food to them. This is universally the form of a cow-house in Holland. The liquid in the tank is allowed to go through the first stages of fermentation, during which the caustic portion of the urine is rendered mild, and the liquid is better fitted to be taken up by the fibres of the roots. In order that there may be a regular succession of liquid in a proper state for use, there are partitions in the tanks, and by means of small flood-gates in the drain which leads to it, the fresh accumulation may be directed to any one of the pits thus formed, while the ripe liquor may be pumped up into tubs or barrels set on wheels, to be conveyed to the land. There are means of accelerating or retarding the fermentation, according to the time when the liquor is wanted. Stirring and admitting the air assist the process, while the addition of earth, peat, or ashes, and keeping out the air, retard it. The efficacy of the liquid is much increased by adding rape-cake, and other vegetable substances. This is usually done a short time before it is put on the land, as it would otherwise ferment too much."*

But it is in the irrigated districts of Piedmont and Lombardy that a style of farming is to be found admirable in itself, and especially fitted to interest and instruct the British farmer. For not only do we find there the oldest, the most

* "On the Agriculture of the Netherlands;" Journal of Royal Agricultural Society of England, vol. ii., p. 57.

extensive, and the most thoroughly elaborated system of irrigation to be met with in Europe; but we find also very large farms let upon leases for terms of years—varying from nine to fifteen years—to tenant farmers possessed of ample capital, and of great intelligence and excellence of character, who conduct their business with a forethought, energy, and skill, that are worthy of all praise. These large farms are usually held at a fixed money rent. At the tenant's entry the proprietor appoints an engineer to make a most elaborate statistical survey and valuation of the farm, with all its fixtures and stock—the document in which these are engrossed being called the *consegna.* The tenant, if he thinks fit, appoints another engineer to co-operate with the one employed by the landlord in making this valuation. At the expiry of the lease the engineers are again summoned to form another survey and valuation, which is called the *reconsegna,* and to draw up a *bilancio,* or balance-sheet, shewing the differences between them. In this balance-sheet every deterioration and every amelioration is shewn, with the money-value placed upon each, by the valuators; and the tenant has either to pay to or receive from his landlord certain sums, according to the results of his own management of the farm. This system is found to work admirably, and is satisfactory to both landlords and tenants. It encourages the tenant to invest his capital in improving his farm by insuring him of a just return for his outlay; and the landlord has his property improved by the labours of an intelligent and interested occupier. As a proof of the good understanding which this arrangement produces betwixt the parties, it frequently happens that leases of farms are renewed to the same tenants, or to their representatives, for successive generations.*

* For fuller information on this subject the reader is referred to the valuable work on "Italian Irrigation," by Colonel R. Baird Smith. Edin. 1855.

The agriculture of France has been influenced in no ordinary degree by the altered tenure and distribution of the soil consequent upon the great Revolution. A large portion of its territory is now minutely subdivided amongst small proprietors, and presents the appearance of one vast cultivated open field. "As far as the eye can reach over vast plains bounded by sloping hills, you see the surface varied by every description of crop; none, perhaps, above an acre or two in size,—the larger portion not more than the fourth or eighth of an acre." These small proprietors are, for the most part, without capital, so that the government has taken the chief part in instigating and promoting improvements. For this purpose it has instituted various establishments, which are either maintained entirely at its cost, or by grants in aid of local efforts. These consist of agricultural societies, veterinary schools, model farms, sheep-farms, and haras or studs. Of the model farms, Grignon, in the vicinity of Paris, consists of nearly 1200 English acres of land of various qualities. Here numbers of young men are instructed in the theory and practice of agriculture by highly qualified teachers, and have the opportunity of witnessing the daily operations of the farm. The sheep-farms are devoted to rearing the best breeds of sheep; the rams produced upon them being distributed over the country by annual sales. The haras or studs are maintained for improving the breed of horses. Stallions are sent out from them in great numbers, and are stationed at suitable places for the accommodation of the respective neighbourhoods. These institutions, established in the reign of Louis Philippe, have aided considerably in promoting agricultural improvement in France.

Since the accession of the Emperor Napoleon III. some of these institutions have been remodelled and others abolished. The efforts of this remarkable man for the improvement of the agriculture of his empire are characterized by great sagacity, and bid fair to prove successful. That marvellous collection of the products and implements of agriculture brought together in Paris, in 1855, in connection with the famous "Exhibition of the Industry of all Nations," and still more, that gathering together there, in the following year, of the choicest specimens of nearly every breed of domesticated animals to be found in Europe, to compete for the prizes offered by order of the Emperor, must have had a considerable effect in promoting the improvement of French agriculture. Its highest attainments are to be found in connection with the numerous and rapidly increasing establishments for the manufacture of sugar, and of alcohol, from beet-root. These concerns being in the hands of wealthy individuals or copartneries, capital and science are brought to bear on the cultivation of the lands attached to them. The pulp of the beet-root, after being deprived of its saccharine matter, is used in fattening immense numbers of cattle, and thus, besides a direct profit on the animals, an abundant supply of manure is obtained for maintaining the fertility of the soil.

Spain, with its delicious climate and fertile soil, exhibits the most antiquated agriculture in Europe. For want of means of conveyance, the abundant and choice products of the interior cannot be brought to its outports at a cost that would remunerate the exporter. Its great proprietors are indolent, poor, and proud, and everything lags behind for want of energy and capital. Vast tracts of country, including much fertile soil formerly occupied, are now without an inhabitant, and bear the significant designation, "*Despoblado*" (unpeopled).

But here also tokens of reviving energy are apparent. A beginning has been made in introducing that railway system which has been quietly effecting such important changes in other countries. No mean influence for good to the agriculture of Spain has arisen from having the markets of Great Britain opened to her produce. And there is a prospect of this benefit being in so far reciprocated, as it is understood that steps are now being taken to facilitate the export of mineral phosphate (*appatite*) from the immense deposits which exist in Estremadura; from whence our manufacturers of super-phosphate of lime are beginning to obtain important supplies of their raw material.

The Society of German Landowners and Foresters was established in 1837 for purposes similar to those of our own National Agricultural Societies, and is supported by the principal landed proprietors of Germany. Mr. Handley, who was present at its Fifth Annual Meeting held at Doberan in Mecklenburg, in September 1841, thus speaks of it:—"Although its objects are the same as ours, the arrangements and proceedings of the meeting partake more of the character of the British Association. Thus, while the exhibition of stock and implements forms a secondary consideration, the main business, viz., the discussions of points connected with the science of agriculture, are carried on in sections, under the presidency of some one celebrated for his acquirements in that particular department, with an earnestness which marks the interest with which they pursue the theories of agriculture, and investigate the results of practical experiments. The president of the meeting is named annually by the sovereign or reigning prince of the state in which it is held. The sections appointed were,—on sheep and the management of flocks,—on practical agriculture,—on horned cattle,—on the breeding of horses,—on geology,—on agricultural mechanics,—on pomology,—on the management of woods. The sittings occupied eight days. The several sections met at half-past six A.M., daily, and continued in deliberation till eleven. At noon, they all assembled in the grand saloon, under the presidency of the Count Sacken, when a résumé of their several proceedings was read, and animated general discussions ensued. That this Society is on a scale to work very great improvements in the agriculture of Germany, there can be no doubt. If I were to form an opinion only from what I heard, I should say it has already materially changed the cultivation of the north."*

In the northern countries of Europe, improvement in agriculture makes steady, and in some of them, even rapid progress. In all of them institutions analogous to those of France (already referred to), and similarly supported, are in operation, at which great numbers of the rising generation, both proprietors and peasants, are made acquainted, theoretically and practically, with the most approved methods of their own and other countries. By all our continental neighbours Great Britain is looked upon as their agricultural model. Specimens of our best implements, live stock, and crops, are constantly being introduced in these countries. Young men are frequently sent hither by their governments, to acquire a knowledge of our agriculture, and numbers of their landowners are constantly to be found amongst us on the same errand. Our best agricultural treatises are also translated into the principal languages of Europe. In this respect we have, however, received payment in kind, particularly in the scientific department, the names of Liebig, Bouissingault, Sprengel, and others, being now as familiar to us as those of our native authors. The recent removal by our Legislature of import duties on farm produce has given a powerful stimulus to agricultural improvement on the continent of Europe. The quality as well as numbers, of the live stock and grain sent to us, is already observed to improve.

It would have been interesting to have directed our attention to the agriculture of those more distant parts of the world with which our all-pervading commerce now brings us into

* Account of the Meeting of German Landowners in 1841 ; Journal of the Royal Agricultural Society of England, vol. iii., pp. 218, 230.

constant intercourse. China, with whose skilful and elaborate husbandry Mr. Fortune has recently made us acquainted, modern Egypt, the United States of America, and our own vast Indian and colonial empire, all possess new interest to us in an agricultural point of view, seeing that they now send corn and wool to our markets, in addition to their peculiar products. Tempting as the subject is, we must, however, refrain, and now direct our attention to the history of our native agriculture.

CHAPTER II.

EARLY BRITISH AGRICULTURE.

Section 1.—*To the end of the Fifteenth Century.*

Of the early agriculture of England, and of the condition of its cultivators, we may form some conception by adverting to a few of the enactments, from the Conquest down to the beginning of the reign of Henry VII. in 1485, when the feudal system, which had been gradually falling into decay, was almost dissolved in that country.

One of the earliest and greatest grievances was the levying of Purveyance. This originally comprehended the necessary provisions, carriages, etc., which the nearest farmers were obliged to furnish to the king's armies at the current prices, and to his houses and castles in time of war. It was called the *great purveyance*, and the officers who collected those necessaries were called purveyors. The smaller purveyance included the necessary provisions and carriages for the king's household, when living at home, or travelling through the kingdom, which the tenants on the king's demesne lands were obliged to furnish gratis; and the practice came to be adopted by the barons and great men, in every tour which they thought proper to make in the country. These exactions were so grievous, and levied in so licentious a manner, that the farmers, when they heard of the court's approach, often deserted their houses, as if the country had been invaded by an enemy. "Purveyance," says Dirom,* "was perhaps for many centuries the chief obstruction to the agriculture and

* *Inquiry into the Corn Laws*, etc., p. 9.

improvement of Great Britain. Many laws were made for the reformation and regulation of purveyance, but without effect; and the practice continued down to so late a period as the reign of James the First."

The home trade in corn was restrained by acts against forestallers in 1360, and at several subsequent periods. For many years after the Conquest, the greater part of the trade of England was carried on in markets and fairs; and a very considerable part of the revenue of the crown arose from the duties payable to the king, upon the goods brought to them for sale. The barons had also tolls at the fairs within their respective jurisdictions. When farmers and merchants were bringing their corn and other necessaries to be sold there, they were sometimes met on the way by persons who purchased their commodities, in order to retail them at a higher price. Thus the king and the lords of the manor lost the several duties payable to them; and the price, it was thought, was at the same time raised to the inhabitants. Such were the original forestallers, who were subjected by several statutes to severe penalties. This crime of forestalling, and the kindred ones of regrating and engrossing, were carefully defined, and the different degrees of punishment specified, in a new statute in 1552, to be afterwards noticed. An early law of 1266, for regulating the assize of bread and ale, furnishes a clear proof of the little intercourse that must have subsisted at that time between town and country. "Brewers in cities," says the statute, "may well afford to sell two gallons of beer or ale for a penny, and out of cities three or four gallons for a penny."

Several laws were made in the fourteenth and fifteenth centuries, permitting the exportation of grain when the price of wheat did not exceed six shillings and eightpence a quarter; and in 1463 importation was prohibited when the price was lower. The last statute, however, was little attended to, and foreign grain was admitted as before; while the state of the country, and the restrictions on internal commerce, scarcely permitted any advantage to be derived from the acts allowing exportation.

In Mr. Chalmers' *Caledonia*, a great many valuable notices are collected regarding the husbandry of Scotland during these ages. It is evident from his elaborate researches, that the progress of cultivation in the thirteenth century had been greater than we should have expected from the turbulence of the times, and the comparatively rude and uncivilized state of society. Purveyance, and other obstructions to improvement, were nearly the same in Scotland as in England; the laws regarding the corn trade appear, in some instances, to have been copied from those of England; and in the northern, as in the southern part of the island, the clergy were by far the most skilful and industrious husbandmen.

Yet it is difficult to reconcile the idea of any considerable improvement, particularly in so far as regards the extensive cultivation of wheat (which Mr. Chalmers infers from the authorities he quotes), with an act passed in 1426, which ordained every husbandman tilling with a plough of eight oxen to sow at least a firlot (little more than a Winchester bushel) of wheat, and half a firlot of peas, with a proportion of beans; or with the state of the districts only a few years ago, where wheat is said to have been extensively grown at that early period.

By statute 1449, the tenant was for the first time secured in possession, during the term of his lease, against a purchaser of the land; and in 1469 he was protected from having his property carried off for the landlord's debts, beyond the amount of rent actually due; an enactment which proves his miserable condition before that time.

Section 2.—Writers on Agriculture.

Soon after the beginning of the sixteenth century, agriculture partook of the general improvement which followed the invention of printing, the revival of learning, and the more settled authority of government; and instead of the occasional notices of historians, we can now refer to regular treatises, written by men who engaged eagerly in this neglected and hitherto degraded occupation. We shall therefore give a short account of the principal works, as well as of the laws and general policy of Britain, in regard to agriculture, from the early part of the sixteenth century to the Revolution in 1688, when a new era commenced in the legislation of corn, and soon after in the practice of the cultivator.*

The first and by far the best of our early works is the *Book of Husbandry*, printed in 1539, commonly ascribed to 1523 Fitzherbert, a judge of the common pleas in the reign of Henry VIII. This was followed, in 1539, by the *Book of Surveying and Improvements*, by the same author. In the former treatise we have a clear and minute description of the rural practices of that period, and from the latter may be learned a good deal of the economy of the feudal system in its decline. The *Book of Husbandry* has scarcely been excelled by any later production, in as far as concerns the subjects of which it treats; for at that time cultivated herbage and edible roots were still unknown in England. The author writes from his own experience of more than forty years; and, with the exception of passages denoting his belief in the superstition of the Roman writers, there is very little of this valuable work that should be omitted, and not a great deal that need

* In the account of the early writers on British agriculture, and of the earlier stages of British husbandry, the author has freely availed himself of Mr. Cleghorn's article "Agriculture" in the *seventh* edition of the Encyclopædia Britannica.

be added, in so far as regards the culture of corn, in a manual of husbandry adapted even to the present time. Fitzherbert touches on almost every department of the art, and in about a hundred octavo pages has contrived to condense more practical information than will be found scattered through as many volumes of later times; and yet he is minute even to the extreme on points of real utility. There is no reason to say, with Mr. Harte, that he had revived the husbandry of the Romans; he merely describes the practices of the age in which he lived; and from his commentary on the old statute *extenta manerii*, in his *Book of Surveying*, in which he does not allude to any recent improvements, it is probable that the management which he details had been long established. But it may surprise some of the agriculturists of the present day to be told, that, after the lapse of almost three centuries, Fitzherbert's practice, in some material branches, has not been improved upon; and that in several districts abuses still exist, which were as clearly pointed out by him at that early period as by any writer of the present age.

The *Book of Husbandry* begins with the plough and other instruments, which are concisely and yet minutely described; and then about a third part of it is occupied with the several operations as they succeed one another throughout the year. Among other things in this part of the work, the following deserve notice:—"Somme (ploughs) wyll tourn the sheld bredith at every landsende, and plowe all one way;" the same kind of plough that is now found so useful on hilly grounds. Of wheel-ploughs he observes, that "they be good on even grounde that lyeth lyghte;" and on such lands they are still most commonly employed. Cart-wheels were sometimes bound with iron, of which he greatly approves. On the much agitated question about the employment of horses or oxen in labour, the most important arguments are distinctly stated. "In somme places," he says, "a horse plough is better," and in others an oxen plough, to which, upon the whole, he gives the preference; and to this, considering the practices of that period, they were probably entitled. Beans and peas seem to have been common crops. He mentions the different kinds of wheat, barley, and oats; and after describing the method of harrowing "all manner of cornnes," we find the roller employed. "They use to role their barley grounde after a showr of rayne, to make the grounde even to mowe." Under the article "To falowe," he observes, "the greater clottes (clods) the better wheate, for the clottes kepe the wheat warme all wynter; and at March they will melte and breake and fal in manye small peces, the whiche is a newe dongynge and refreshynge of the corne." This is agreeable to the present practice, founded on the very same reasons. "In May, the shepe folde is to be set out;" but Fitzherbert does not much approve of folding, and points out its disadvantages in a very judicious manner. "In the later end of May and the begynnynge of June, is tyme to wede the corne;" and then we have an accurate description of the different weeds, and the instruments and mode of weeding. Next comes a second ploughing of the fallow; and afterwards. in the latter end of June, the mowing of the meadows begins. Of this operation, and of the forks and rakes, and the hay-making, there is a very good account. The corn harvest naturally follows: rye and wheat were usually *shorn*, and barley and oats cut with the scythe. This intelligent writer does not approve of the practice, which still prevails in some places, of cutting wheat high, and then mowing the stubbles. "In Somersetshire," he says, "they do shere theyr wheat very lowe; and the wheate strawe that they purpose to make *thacke* of, they do not threshe it, but cut off the ears, and bynd it in sheves, and call it *rede*, and therewith they thacke theyr houses." He recommends the practice of setting up corn in shocks, with two sheaves to cover eight, instead of ten sheaves, as at present; probably owing to the straw being then shorter. The corn was commonly housed; but if there be a want of room, he advises that the ricks be built on a scaffold, and not upon the ground. Corn-stacks are now beginning to be built on pillars and frames. The fallow received a third ploughing in September, and was sown about Michaelmas. "Wheat is moost commonlye sowne under the forowe, that is to say, cast it uppon the falowe, and then plowe it under;" and this branch of his subject is concluded with directions about threshing, winnowing, and other kinds of barn-work.

Fitzherbert next proceeds to live stock. "An housebande," he says, "can not well thryue by his corne without he have other cattell, nor by his cattell without corne. And bycause that shepe, in myne opynyon, is the mooste profytablest cattell that any man can haue, therefore I pourpose to speake fyrst of shepe." His remarks on this subject are so accurate, that one might imagine they came from a storemaster of the present day; and the minutiæ which he details are exactly what the writer of this article has seen practised in the hilly parts of this country. In some places at present, "they neuer seuer their lambes from their dammes;" "and the poore of the peeke (high) countreye, and such other places, where, as they vse to milke theyr ewes, they vse to wayne theyr lambes at 12 weekes olde, and to mylke their ewes fiue or syxe weekes;" but that he observes, "is greate hurte to the ewes, and wyll cause them that they wyll not take the ramme at the tyme of the yere for pouertye, but goo barreyne." "In June is tyme to shere shepe; and ere they be shorne, they must be verye well washen, the which shall be to the owner greate profyte in the sale of his wool, and also to the clothe-maker." It appears that *hand washing* was then a common practice. His remarks on horses, cattle, etc., are not less interesting; and there is a very good account of the diseases of each species, and some just observations on the advantage of mixing different kinds on the same pasture. Swine and bees conclude this branch of the work.

The author then points out the great advantages of inclosures; recommends "quycksettynge, dychynge, and hedgeyng;" and gives particular directions about the *settes*, and the method of training a hedge, as well as concerning the planting and management of trees. We have then a short information "for a yonge gentylman that intendeth to thryue," and "a prolouge for the wives occupation," in some instances rather too homely for the present time. Among other things, she is to "make her husband and herself somme clothes;" and "she maye haue the lockes of the shepe eyther to make blankettes and courlettes or bothe." This is not so much amiss; but what follows will bring our learned judge into disrepute even with our most industrious housewives. "It is a wyues occupation," he says, "to wynowe all maner of cornes, to make malte, to washe and wrynge, to make heye, shere corne, and, in time of nede, to helpe her husbande to fyll the mucke wayne or dounge carte, dryue the ploughe, to loode heye, corne, and suche other; and to go or ride to the market to sel butter, chese, mylke, egges, chekyns, capons, hennes, pygges, gese and all maner of cornes." The rest of the book contains some useful advices about diligence and economy; and concludes, after the manner of the age, with many pious exhortations.

Such is Fitzherbert's *Book of Husbandry*, and such was the state of agriculture in England in the early part of the sixteenth century, and probably for a long time before; for he nowhere speaks of the practices which he describes or recommends as of recent introduction.

The *Book of Surveying* adds considerably to our knowledge of the rural economy of that age. "Four maner of commens" are described; several kinds of mills for corn and other purposes, and also "quernes that goo with hand;"

different orders of tenants, down to the "boundmen," who "in some places contynue as yet;" "and many tymes, by colour thereof, there be many freemen taken as boundmen, and their lands and goods is taken from them." Lime and marl are mentioned as common manures; and the former was sometimes spread on the surface to destroy heath. Both draining and irrigation are noticed, though the latter but slightly. And the work concludes with an inquiry "how to make a township that is worth XX. marke a yere, worth XX. li. a year;" from which we shall give a specimen of the author's manner, as well as of the economy of the age.

"It is undoubted, that to every townshyppe that standeth in tyllage in the playne countrey, there be errable landes to plowe and sowe, and leyse to tye or tedder theyr horses and mares upon, and common pasture to kepe and pasture their catell, beestes and shepe upon; and also they have medowe grounde to get theyr hey upon. Than to let it be known how many acres of errable lande euery man hath in tyllage, and of the same acres in euery felde to chaunge with his neyghbours, and to leye them toguyther, and to make hym one seuerall close in euery felde for his errable lands; and his leyse in euery felde to leye them togyther in one felde, and to make one seuerall close for them all. And also another seuerall close for his portion of his common pasture, and also his porcion of his medowe in a seuerall close by itselfe, and al kept in seueral both in wynter and somer; and euery cottage shall haue his portion assigned hym accordynge to his rent, and than shall nat the ryche man ouerpresse the poore man with his cattell; and euery man may eate his oun close at his pleasure. And vndoubted, that hay and strawe that will find one beest in the house wyll finde two beestes in the close and better they shall lyke. For those beestis in the house have short heare and thynne, and towards March they will pylle and be bare; and therefore they may nat abyde in the fylde before the heerdmen in winter tyme for colde. And those that lye in a close under a hedge haue long heare and thyck, and they will neuer pylle nor be bare; and by this reason the husbande maye kepe twyse so many catell as he did before.

"This is the cause of this approwment. Nowe euery husbande hath sixe seuerall closes, whereof iii. be for corne, the fourthe for his leyse, the fyfte for his commen pastures, and the sixte for his haye; and in wynter time there is but one occupied with corne, and than hath the husbande other fyue to occupy tyll lente come, and that he hath his falowe felde, his ley felde, and his pasture felde al sommer. And when he hath mowen his medowe, than he hath his medowe grounde, soo that if he hath any weyke catell that wold be amended, or dyvers maner of catell, he may put them in any close he wyll, the which is a great advantage; and if all shulde lye commen, than wolde the edyche of the corne feldes and the aftermath of all the medowes be eaten in X. or XII. dayes. And the rych men that hath moche catell wold have the advantage, and the poore man can have no helpe nor relefe in wynter when he hath moste nede; and if an acre of lande be worthe sixe pens, or it be enclosed, it will be worth VIII. pens whan it is enclosed, by reason of the compostying and dongyng of the catell that shall go and lye upon it both day and nighte; and if any of his thre closes that he hath for his corne be worne or ware bare, than he may breke and plowe up his close that he hadde for his layse, or the close that he hadde for his commen pasture, or bothe, and sowe them with corne, and let the other lye for a time, and so shall he have alway reist grounde, the which will bear moche corne with lytel donge; and also he shall have a great profyte of the wod in the hedges whan it is growen; and not only these profytes and advantages beforesaid, but he shall save moche more than al these, for by reason of these closes he shall save meate, drinke, and wages of a shepeherde, the wages of the heerdman, and the wages of the swine herde, the which may fortune to be as chargeable as all his holle rent; and also his corne shall be better saved from eatinge or destroyeng with catel. For dout ye nat but heerdemen with their catell, shepeherdes with their shepe, and tieng of horses and mares, destroyeth moch corne, the which the hedges wold save. Paraduenture some men would say, that this shuld be against the common weale, bicause the shepeherdes, heerdmen, and swyneherdes, shuld than be put out of wages. To that it may be answered, though these occupations be not used, there be as many newe occupations that were not used before; as getting of quickesettes, diching, hedging, and plashing, the which the same men may use and occupye."

The next author who writes professedly on agriculture is Tusser, whose *Five Hundred Points of Husbandry*, published in 1562, was formerly in such high repute as to be recommended by Lord Molesworth to be taught in schools.* The edition of 1604 is the one we make use of here, in which the book of husbandry consists of 118 pages; and then follows the *Points of Housewifrie*, occupying 42 pages more. It is written in verse. Amidst a vast heap of rubbish, there are some useful notices concerning the state of agriculture at the time in different parts of England. Hops, which had been introduced in the early part of the sixteenth century, and on the culture of which a treatise was published in 1574 by Reynolde Scott, are mentioned as a well-known crop. Buckwheat was sown after barley. It seems to have been the practice then, in some places, to "*geld fillies*" as well as colts. Hemp and flax are mentioned as common crops. Inclosures must have been numerous in several counties; and there is a very good comparison between "champion (open fields) country, and several," which Blythe afterwards transcribed into his

* *Some Considerations for the promoting of Agriculture and employing the Poor.* Dublin, 1723.

Improver Improved. Carrots, cabbages, turnips, and rape, are mentioned among the herbs and roots for the kitchen. There is nothing to be found in Tusser about serfs or bondmen, as in Fitzherbert's works. This author's division of the crop is rather curious, though probably quite inaccurate, if he means that the whole rent might be paid by a tenth of the corn.

> "One part cast forth for rent due out of hand.
> One other part for seed to sow thy land.
> Another part leave parson for his tith.
> Another part for harvest, sickle and sith.
> One part for ploughwrite, cartwrite, knacker, and smith.
> One part to uphold thy teemes that draw therewith.
> Another part for servant and workman's wages laie.
> One part likewise for filbellie daie by daie.
> One part thy wife for needful things doth crave.
> Thyself and thy child the last part would have."

The next writer is *Barnaby Googe*, whose *Whole Art of Husbandry* was printed in 1578, and again by Markham in 1614. The first edition is merely a translation of a German work; and very little is said of English husbandry in the second, though Markham made some trifling interpolations, in order, as it is alleged, to adapt the German husbandry to the English climate. It is for the most part made up of gleanings from the ancient writers of Greece and Rome, whose errors are faithfully retained, with here and there some description of the practices of the age, in which there is little of novelty or importance. Googe mentions a number of English writers who lived about the time of Fitzherbert, whose works have not been preserved.

For more than fifty years after this, or till near the middle of the seventeenth century, there are no systematic works on husbandry, though several treatises on particular departments of it. From these it is evident, that all the different operations of the farmer were performed with more care and correctness than formerly; that the fallows were better worked, the fields kept freer of weeds, and much more attention paid to manures of every kind. A few of the writers of this period deserve to be shortly noticed.

Sir Hugh Plat, in his *Jewel House of Art and Nature,* printed in 1594 (which Weston in his catalogue erroneously gives to Gabriel Plattes), makes some useful observations on manures, but chiefly collected from other writers. His censure of the practice of leaving farm dung lying scattered about is among the most valuable.

Sir John Norden's *Surveyor's Dialogue,* printed in 1607, and reprinted with additions in 1618, is a work of considerable merit. The first three books of it relate to the rights of the lord of the manor, and the various tenures by which landed property was then held, with the obligations which they imposed. Among others, we find the singular custom so humorously described in the Spectator, of the incontinent widow riding upon a ram. In the fifth book there are a good many judicious observations on the "different natures of grounds, how they may be employed, how they may be bettered, reformed, and amended." The famous meadows near Salisbury are mentioned; and when cattle have fed their fill, hogs, it is pretended, "are made fat with the remnant; namely, with the knots and sappe of the grasse." "Clouer grasse, or the grasse honeysuckle" (white clover), is directed to be sown with other hay seeds. "Carrot rootes" were then raised in several parts of England, and sometimes by farmers. London street and stable dung was carried to a distance by water, though it appears from later writers to have been got for the trouble of removing. And leases of twenty-one years are recommended for persons of small capital, as better than employing it in purchasing land; an opinion that prevails very generally among our present farmers.

Bees seem to have been great favourites with these early writers; and among others, there is a treatise by Butler, a gentleman of Oxford, called the *Feminine Monarchie*, or the *History of Bees*, printed in 1609, full of all manner of quaintness and pedantry.

We shall pass over Markham, Mascall, Gabriel Plattes, and several other authors of this period, the best part of their writings being preserved by Blythe and Hartlib, of whom we shall say a little immediately. In Sir Richard Weston's *Discourse on the Husbandry of Brabant and Flanders*, published by Hartlib in 1645, we may mark the dawn of the vast improvements which have since been effected in Britain. This gentleman was ambassador from England to the elector palatine and king of Bohemia in 1619, and had the merit of being the first who introduced the *great clover*, as it was then called, into English agriculture, about 1645, and probably turnips also. His directions for the cultivation of clover are better than was to be expected. It thrives best, he says, when you sow it on the worst and barrenest ground, such as our worst heath ground is in England. The ground is to be pared and burnt, and unslacked lime must be added to the ashes. It is next to be well ploughed and harrowed; and about ten pounds of clover seed must be sown on an acre in April or the end of March. If you intend to preserve seed, then the second crop must be let stand till it come to a full and dead ripeness; and you shall have at least five bushels per acre. Being once sown, it will last five years; and then being ploughed, it will yield, three or four years together, rich crops of wheat, and after that a crop of oats, with which clover seed is to be sown again. It is in itself an excellent manure, Sir Richard adds; and so it should be, to enable land to bear this treatment. In less than ten years after its introduction, that is, before 1655, the culture of clover, exactly according to the present method, seems to have been well known in England, and it had also made its way to Ireland.

A great many works on agriculture appeared during the time of the commonwealth, of which Blythe's *Improver Improved*, and Hartlib's *Legacy*, are the most valuable. The first edition of the former was published in 1649, and of the latter in 1650; and both of them were enlarged in subsequent editions. In the first edition of the *Improver Improved*, no mention is made of clover, nor in the second of turnips; but in the third, published in 1662, clover is treated of at some length, and turnips are recommended as an excellent cattle crop, the culture of which should be extended from the kitchen garden to the field. Sir Richard Weston must have cultivated turnips before this; for Blythe says, that Sir Richard affirmed to himself he did feed his swine with them. They were first given boiled, but afterwards the swine came to eat them raw, and would run after the carts, and pull them forth as they gathered them; an expression which conveys an idea of their being cultivated in the fields.

Blythe's book is the first systematic work in which there are some traces of the alternate husbandry so beneficially established since, by interposing clover and turnip between culmiferous crops. He is a great enemy to commons and common fields, and to retaining land in old pasture, unless it be of the best quality. His description of the different kinds of ploughs is interesting; and he justly recommends such as were drawn by two horses (some even by one horse), in preference to the weighty and clumsy machines which required four or more horses or oxen. Almost all the manures now used seem to have been then well known; and he brought lime himself from a distance of 20 miles. He speaks of an instrument which ploughed, sowed, and harrowed at the same time; and the *setting of corn* was then a subject of much discussion. "It was not many years," says Blythe, "since the famous city of London petitioned the Parliament of England against two anusancies or offensive commodities, which were likely to come into great use and esteem; and that was Newcastle coal, in regard of their stench, etc., and hops, in regard they would spoyle the taste of drink, and endanger the people." The permanent value of Blythe's treatise consists in his judicious and clearly expressed views on draining and irrigation.

Hartlib's *Legacy* is a very heterogeneous performance, containing, among some very judicious directions, a great deal of rash speculation. Several of the deficiencies which the writer complains of in English agriculture must be placed to the account of our climate, and never have been or can be supplied. Some of his recommendations are quite unsuitable to the state of the country, and display more of general knowledge and good intention, than of either the theory or practice of agriculture. Among the subjects deserving notice may be mentioned the practice of steeping and liming seed corn as a preventive of smut; changing every year the *species* of grain, and bringing seed corn from a distance; ploughing down green crops as manure; and feeding horses with broken oats and chaff. This writer seems to differ a good deal from Blythe about the advantage of interchanging tillage and pasture. "It were no losse to this island," he says, "if that we should not plough at all, if so be that we could certainly have corn at a reasonable rate, and likewise vent for all our manufactures of wool:" and one reason for this is, that pasture employeth more hands than tillage, instead of depopulating the country, as was commonly imagined. The *grout*, which he mentions "as coming over to us in Hollond ships," about which he desires information, was probably the same with our present shelled barley; and mills for manufacturing it were introduced into Scotland from Holland towards the beginning of the last century.

To the third edition, published in 1655, are subjoined Dr. Beatie's Annotations, with the writer of the Legacy's answers, both of them ingenious, and sometimes instructive. But this cannot be said of Gabriel Plattes's *Mercurius Lætificans*, also added to this edition, which is a most extravagant production. There are also several communications from Hartlib's different correspondents, of which the most interesting are those on the early cultivation and great value of clover. Hartlib himself does not appear much in this collection; but he seems to have been a very useful person in editing the works of others, and as a collector of miscellaneous information on rural subjects. It is strange that neither Blythe nor Hartlib, nor any of Hartlib's correspondents, seem ever to have heard of Fitzherbert's works.

Among the other writers previous to the Revolution, we shall only mention Ray the botanist and Evelyn, both men of great talents and research, whose works are still in high estimation. A new edition of Evelyn's *Silva and Terra* was published in 1777 by Dr. Hunter, with large notes and elegant engravings, and reprinted in 1812.

The preceding review commences with a period of feudal anarchy and despotism, and comes down to the time when the exertions of individual interest were protected and encouraged by the firm administration of equal laws; when the prosperity of great Britain was no longer retarded by internal commotions, nor endangered by hostile invasion.

Section 3.—*Laws of this Period.*

The laws of this period, in so far as they relate to agriculture and rural economy, display a similar progress in improvement.

From the beginning of the reign of Henry VII. to the end of Elizabeth's, a number of statutes were made for the encouragement of tillage, though probably to little purpose. The great grievance of those days was the practice of laying arable land to pasture, and suffering the farm-houses to fall to ruin. "Where in some towns," says the statute 4th Henry VII. (1488), "two hundred persons were occupied and lived of their lawful labours, now there are occupied two or three herdsmen, and the residue fall into idleness;" therefore it is ordained, that houses which within three years have been let for farms, with twenty acres of land lying in tillage or husbandry, shall be upheld, under the penalty of half the profits, to be forfeited to the king or the lord of the fee. Almost half a century afterwards, the practice had become still more alarming; and in 1534 a new act was tried, apparently with as little success. "Some have 24,000 sheep, some 20,000 sheep, some 10,000, some 6000, some 4000, and some more and some less;" and yet it is alleged the price of wool had nearly doubled, "sheep being come to a few persons' hands." A penalty was therefore imposed on all who kept above 2000 sheep; and no person was to take in farm more than two tenements of husbandry. By the 39th Elizabeth (1597), arable land made pasture since the 1st Elizabeth shall be again converted into tillage, and what is arable shall not be converted into pasture.

Many laws were enacted during this period against vagabonds, as they were called; and persons who could not find employment seem to have been sometimes confounded with those who really preferred idleness and plunder. The dissolution of the feudal system, and the suppression of the monasteries, deprived a great part of the rural population of the means of support. They could not be employed in cultivating the soil, for there was no middle class of farmers possessed of capital to be vested in improvements; and what little disposable capital was in the hands of great proprietors could not, in those rude times, be so advantageously embarked in the expensive and precarious labours of growing corn, as in pasturage which required much less skill and superintendence. Besides, there was a constant demand for wool on the Continent; while the corn market was not only confined by laws against exportation, but fettered by restrictions on the internal trade. The laws regarding the wages of labour and the price of provisions are a further proof of the ignorance of the age in regard to the proper subject of legislation.

By the statute 1552 it is declared, that any person that shall buy merchandise, victual, etc., coming to market, or make any bargain for buying the same before they shall be in the market ready to be sold, or shall make any motion for enhancing the price, or dissuade any person from coming to market, or forbear to bring any of the things to market, etc., shall be deemed a *forestaller*. Any person who buys and sells again in the same market, or within four miles thereof, shall be reputed a *regrater*. Any person buying corn growing in the fields, or any other corn, with intent to sell again, shall be reputed an unlawful *ingrosser*. It was also declared, that no person shall sell cattle within five weeks after he had bought them. Licences, indeed, were to be granted in certain cases, and particularly when the price of wheat was at or under 6s. 8d. a quarter, and other kinds of grain in that proportion.

The laws regarding the exportation and importation of corn during this period could have had little effect in encouraging agriculture, though towards the latter part of it they gradually approached that system which was finally established at and soon after the Revolution. From the time of the above-mentioned statute against forestallers, which effectually prevented exportation, as well as the freedom of the home trade, when corn was above the price therein specified, down to 1688, there are at least twelve statutes on this subject; and some of them are so nearly the same, that it is probable they were not very carefully observed. The price at which wheat was allowed to be exported was raised from 6s. 8d. a quarter, the price fixed by the 1st and 2d of Philip and Mary (1553), to 10s. in 1562; to 20s. in 1593; to 26s. 8d. in 1604; to 32s. in 1623; to 40s. in 1660; to 48s. in 1663; and at last, in 1670, exportation was virtually permitted without limitation. Certain duties, however, were payable, which in some cases seem to have amounted to a prohibition; and until 1660 importation was not restrained even in years of plenty and cheapness. In permitting exportation, the object appears to have been revenue rather than the encouragement of production.

The first statute for levying tolls at turnpikes, to make or repair roads in England, passed in 1662.

Section 4.—Agriculture of Scotland in the Sixteenth and Seventeenth Centuries.

Of the state of agriculture in Scotland in the sixteenth and the greater part of the seventeenth century, very little is known; no professed treatise on the subject appeared till after the Revolution. The south-eastern counties were the earliest improved, and yet in 1660 their condition seems to have been very wretched. Ray, who made a tour along the eastern coast in that year, says, "We observed little or *no fallow grounds* in Scotland; some ley ground we saw, which they manured with sea wreck. The men seemed to be very lazy, and may be frequently observed to plough in their cloaks. It is the fashion of them to wear cloaks when they go abroad, but especially on Sundays. They have neither good bread, cheese, nor drink. They cannot make them, nor will they learn. Their butter is very indifferent, and one would wonder how they could contrive to make it so bad. They use much pottage made of coalwort, which they call *kail*, sometimes broth of decorticated barley. The ordinary country houses are pitiful cots, built of stone and covered with turfs, having in them but one room, many of them no chimneys, the windows very small holes, and not glazed. The ground in the valleys and plains bears very good corn, but especially bears barley or bigge, and oats, but rarely wheat and rye."*

It is probable that no great change had taken place in Scotland from the end of the fifteenth century, except that tenants gradually became possessed of a little stock of their own, instead of having their farm stocked by the landlord. "The minority of James V., the reign of Mary Stuart, the infancy of her son, and the civil wars of her grandson Charles I., were all periods of lasting waste. The very laws which were made during successive reigns, for protecting the tillers of the soil from spoil, are the best proofs of the deplorable state of the husbandman."†

Yet in the seventeenth century were those laws made which paved the way for the present improved system of agriculture in Scotland. By statute 1633, landholders were enabled to have their tithes valued, and to buy them either at nine or six years' purchase, according to the nature of the property. The statute 1685, conferring on landlords a power to entail their estates, was indeed of a very different tendency in regard to its effects on agriculture. But the two acts in 1695, for the division of commons, and separation of intermixed properties, have facilitated in an eminent degree the progress of improvement.

* *Select Remains of John Ray.* Lond. 1760.
† Chalmers' *Caledonia,* vol. ii. p. 732.

CHAPTER III.

PROGRESS OF AGRICULTURE FROM 1688 TO 1760.

Section 1.—*Writers on Agriculture.*

FROM the Revolution to the accession of George III. the progress of agriculture was by no means so considerable as we should be led to imagine from the great exportation of corn. It is the opinion of well-informed writers,* that very little improvement had taken place, either in the cultivation of the soil or in the management of live stock, from the Restoration down to the middle of last century. Even clover and turnips, the great support of the present improved system of agriculture, were confined to a few districts, and at the latter period were scarcely cultivated at all by common farmers in the northern part of the island. Of the writers of this period, therefore, we shall notice only such as describe some improvement in the modes of culture, or some extension of the practices that were formerly little known.

In Houghton's *Collections on Husbandry and Trade,* a periodical work begun in 1681, we have the first notice of turnips being eaten by sheep. "Some in Essex have their fallow after turnips, which feed their sheep in winter, by which means the turnips are scooped, and so made capable to hold dews and rain water, which, by corrupting, inbibes the nitre of the air, and when the shell breaks it runs about and fertilizes. By feeding the sheep, the land is dunged as if it

* *Annals of Agriculture,* No. 270. Harte's *Essays.* Comber *on National Subsistence,* p. 161.

had been folded; and those turnips, though few or none be carried off for human use, are a very excellent improvement, nay, some reckon it so though they only plough the turnips in without feeding."* This was written in February 1694; but ten years before, Worlidge, one of his correspondents, observes, "sheep fatten very well on turnips, which prove an excellent nourishment for them in hard winters, when fodder is scarce; for they will not only eat the greens, but feed on the roots in the ground, and scoop them hollow even to the very skin. Ten acres (he adds) sown with clover, turnips, etc., will feed as many sheep as one hundred acres thereof would before have done."†

At this time potatoes were beginning to attract notice. "The potato," says Houghton, "is a *bacciferous* herb, with *esculent* roots, bearing winged leaves and a bell flower.

"This, I have been informed, was brought first out of Virginia by Sir Walter Raleigh; and he stopping at Ireland, some was planted there, where it thrived very well, and to good purpose; for in their succeeding wars, when all the corn above the ground was destroyed, this supported them; for the soldiers, unless they had dug up all the ground where they grew, and almost sifted it, could not extirpate them; from whence they were brought to Lancashire, where they are very numerous, and now they begin to spread all the kingdom over. They are a pleasant food boiled or roasted, and eaten with butter and sugar. There is a sort brought from Spain, that are of a longer form, and are more luscious than ours; they are much set by, and sold for sixpence or eightpence the pound."‡

The next writer is Mortimer, whose *Whole Art of Husbandry* was published in 1706, and has since run through

* Houghton's *Collections on Husbandry and Trade*, vol. i. p. 213, edit. 1728.

† *Ibid.* vol. iv. p. 142-144.

‡ *Ibid.* vol. ii. p. 468.

several editions. It is a regular, systematic work, of considerable merit; and it does not appear that much improvement has been made since in the practices he describes, in many parts of Britain. From the third edition of Hartlib's *Legacy*, we learn that clover was cut green, and given to cattle; and it appears that this practice of *soiling*, as it is now called, had become very common about the beginning of last century, wherever clover was cultivated. Ryegrass was now sown along with it. Turnips were hand-hoed, and extensively employed in feeding sheep and cattle, in the same manner as at present.

The first considerable improvement in the practice of that period was introduced by Jethro Tull, a gentleman of Berkshire, who began to drill wheat and other crops about the year 1701, and whose "*Horse-hoeing Husbandry*," published in 1731, exhibits the first decided step in advance upon the principles and practices of his predecessors. Not contented with a careful attention to details, Tull set himself, with admirable skill and perseverance, to investigate the growth of plants, and thus to arrive at a knowledge of the principles by which the cultivation of field-crops should be regulated. Having arrived at the conclusion that the food of plants consists of minute particles of earth taken up by their rootlets, it followed, that the more thoroughly the soil in which they grew was disintegrated, the more abundant would be the "pasture" (as he called it) to which their fibres would have access. He was thus led to adopt that system of sowing his crops in rows, or drills, so wide apart as to admit of tillage of the intervals, both by ploughing and hoeing, being continued until they had wellnigh arrived at maturity.

As the distance between his rows appeared much greater than was necessary for the range of the roots of the plants, he begins by shewing that these roots extend much farther than is commonly believed, and then proceeds to inquire into the nature of their food. After examining several hypotheses, he decides this to be fine particles of earth. The chief, and almost the only use of dung, he thinks, is to divide the earth, to dissolve "this terrestrial matter, which affords nutriment to the mouths of vegetable roots;" and this can be done more completely by tillage. It is therefore necessary not only to pulverise the soil by repeated ploughings before it be seeded, but, as it becomes gradually more and more compressed afterwards, recourse must be had to tillage while the plants are growing; and this is *hoeing*, which also destroys the weeds that would deprive the plants of their nourishment.

The leading features of Tull's husbandry are his practice of laying the land into narrow ridges of five or six feet, and upon the middle of these drilling one, two, or three rows, distant from one another about seven inches when there were three, and ten when only two. The distance of the plants on one ridge from those on the contiguous one he called an *interval;* the distance between the rows on the same ridge, a *space* or *partition:* the former was stirred repeatedly by the horse-hoe, the latter by the hand-hoe.

The extraordinary attention this ingenious person gave to his mode of culture is perhaps without a parallel:—"I formerly was at much pains," he says, "and at some charge in improving my drills for planting the rows at very near distances, and had brought them to such perfection, that one horse would draw a drill with eleven shares, making the rows at three inches and a half distance from one another; and at the same time sow in them three very different sorts of seeds, which did not mix; and these, too, at different depths. As the barley-rows were seven inches asunder, the barley lay four inches deep. A little more than three inches above that, in the same channels, was clover; betwixt every two of these rows was a row of St. Foin, covered half an inch deep.

"I had a good crop of barley the first year; the next year two crops of broad clover, where that was sown; and where hop-clover was sown, a mixed crop of that and St. Foin; but I am since, by experience, so fully convinced of the folly of these, or any other mixed crops, and more especially of narrow spaces, that I have demolished these instruments, in their full perfection, as a vain curiosity, the drift and use of them being contrary to the true principles and practice of horse-hoeing."*

In the culture of wheat, he began with ridges six feet broad, or eleven on a breadth of 66 feet; but on this he afterwards had fourteen ridges. After trying different numbers of rows on a ridge, he at last preferred two, with an intervening space of about ten inches. He allowed only three pecks of seed for an acre. The first hoeing was performed by turning a furrow from the row, as soon as the plant had put forth four or five leaves; so that it was done before or at the beginning of winter. The next hoeing was in spring, by which the earth was returned to the plants. The subsequent operations depended upon the circumstances and condition of the land and the state of the weather. The next year's crop of wheat was sown upon the intervals which had been unoccupied the former year; but this he does not seem to think was a matter of much consequence. "My field," he observes, "whereon is now the thirteenth crop of wheat, has shown that the rows may successfully stand upon any part of the ground. The ridges of this field were, for the twelfth crop, changed from six feet to four feet six inches. In order for this alteration the ridges were ploughed down, and then the next ridges were laid out the same way as the former, but one foot six inches narrower, and the double rows drilled on their tops; whereby, of consequence, there must be some rows standing on every part of the ground, both on the former

* *Horse-hoeing Husbandry*, p. 62. Lond. 1762.

partitions, and on every part of the intervals. Notwithstanding this, there was no manner of difference in the goodness of the rows; and the whole field was in every part of it equal, and the best I believe that ever grew on it. It is now the thirteenth crop, likely to be good, though the land was not ploughed crossways."*

It follows, from this singular management, that Tull thought a succession of crops of different species altogether unnecessary; and he labours hard to prove against Dr. Woodward, that the advantages of such a change under his plan of tillage were quite chimerical; though he seems to admit the benefit of a change of the seed itself.

In cultivating turnips he made the ridges of the same breadth as for wheat, but only one row was drilled on each. His management, while the crop was growing, differs very little from the present practice. When drilled on the level, it is impossible, he observes, to hoe-plough them so well as when they are planted upon ridges. But the seed was deposited at different depths, the half about four inches deep, and the other half exactly over that, at the depth of half an inch. "Thus planted, let the weather be never so dry, the deepest seed will come up; but if it raineth immediately after planting, the shallow will come up first. We also make it come up at four times, by mixing our seed half new and half old, the new coming up a day quicker than the old. These four comings up give it so many chances for escaping the fly; it being often seen that the seed sown over night will be destroyed by the fly, when that sown the next morning will escape, and *vice versa:* or you may hoe-plough them when the fly is like to devour them; this will bury the greatest part of these enemies; or else you may drill in another row without new-ploughing the land."

Drilling and horse and hand hoeing seem to have been in

* *Horse-hoeing Husbandry*, p. 424.

use before the publication of Tull's book. "Hoeing," he says, "may be divided into deep, which is our horse-hoeing; and shallow, which is the English hand-hoeing; and also the shallow horse-hoeing used in some places betwixt rows, where the intervals are very narrow, as 16 or 18 inches. This is but an imitation of the hand-hoe, or a succedaneum to it, and can neither supply the use of dung nor fallow, and may be properly called scratch-hoeing." But in his mode of forming ridges his practice seems to have been original; his implements display much ingenuity; and his claim to the title of father of the present horse-hoeing husbandry of Great Britain seems indisputable. A translation of Tull's book was undertaken at one and the same time in France, by three different persons of consideration, without the privity of each other. Two of them afterwards put their papers into the hands of the third, M. du Hamel du Monceau of the Royal Academy of Sciences at Paris, who published a treatise on husbandry, on the principles of Mr. Tull, a few years after. But Tull seems to have had very few followers in England for more than 30 years.

Tull's doctrines and practices being quite in advance of his own times, were, as is usual in such cases, vehemently opposed by his contemporaries. He was, in consequence, involved in frequent controversy, in conducting which he occasionally showed an asperity of temper which excites our regret, but which is not to be wondered at, when we consider the trials of patience which he encountered from the unreasonable opposition of the agricultural community to his improvements; the thwarting of his experiments by his own labourers, who, in their ignorant zeal against innovations, wilfully broke his machines, and disregarded his orders; and from acute and protracted bodily disease. The soundness of his views and practice, as regards turnip culture, came by and by to be acknowledged, and have ever since been generally adopted. But it is only now that his full merit begins to be understood. The Rev. Mr. Smith, in his "Word in Season," has recalled attention to his peculiar system of wheat culture, in a way that has startled the whole community; while Professor Way, in his eloquent lectures delivered before the Royal Agricultural Society, has shewn that his science is true in the main, and even more strikingly ahead of his times than his practice.

Among the English writers of this period may be mentioned Bradley, Lawrence, Hales, Miller, Ellis, Smith, Hill, Hitt, Lisle, and Home. Most of their works went through several editions in a few years; at once a proof of the estimation in which they were held, and of the direction of the public mind towards investigating the principles and practice of agriculture.

Section 2.—*Writers on Scottish Husbandry.*

Of the progress of the art in Scotland, till towards the end of the seventeenth century, we are almost entirely ignorant. The first work, written by Donaldson, was printed in 1697, under the title of *Husbandry Anatomized; or, an Inquiry into the Present Manner of Teiling and Manuring the Ground in Scotland.* It appears from this treatise, that the state of the art was not more advanced at that time in North Britain than it had been in England in the time of Fitzherbert. Farms were divided into infield and outfield; corn crops followed one another without the intervention of fallow, cultivated herbage, or turnips, though something is said about fallowing the outfield; inclosures were very rare; the tenantry had not begun to emerge from a state of great poverty and depression; and the wages of labour, compared with the price of corn, were much lower than at present; though that price, at least in ordinary years, must appear extremely moderate in our times. Leases for a term of years, however, were not uncommon; but the want of capital rendered it impossible for the tenantry to attempt any spirited improvements.

Donaldson first points out the common management of that period, which he shews to have been very unproductive; and afterwards recommends what he thinks would be a more profitable course. "Of the dale ground," he says, "that is, such lands as are partly hills and partly valleys, of which sorts may be comprehended the greatest part of arable ground in this kingdom, I shall suppose a farmer to have a lease or tack of three score acres, at three hundred merks of rent per annum (£16 : 13 : 4 sterling). Perhaps some who are not acquainted with rural affairs may think this cheap; but those who are the possessors thereof think otherwise, and find difficulty enough to get the same paid, according to their present way of manuring thereof. But that I may proceed to the comparison, I shall shew how commonly this farm-room is managed. It is commonly divided into two parts, viz., one-third croft, and two-thirds outfield, as it is termed. The croft is usually divided into three parts; to wit, one-third barley, which is always dunged that year barley is sown thereon; another third oats; and the last third peas. The outside field is divided into two parts, to wit, the one half oats, and the other half grass, two years successively. The product which may be supposed to be on each acre of croft, four bolls (three Winchester quarters), and that of the outfield, three (2¼ quarters); the quota is seven score bolls, which we shall also reckon at five pounds (8s. 4d.) per boll, cheap year and dear year one with another. This, in all, is worth £700 (£58, 6s. 8d. sterling).

"Then let us see what profit he can make of his cattle. According to the division of his lands, there is twenty acres of grass, which cannot be expected to be very good, because it gets not leave to lie above two years, and therefore cannot be well swarded. However, usually, besides four horses which are kept for ploughing the said land, ten or twelve nolt are also kept upon a farm-room of the above-mentioned bounds; but, in respect of the badness of the grass, as said is, little profit is had of them. Perhaps two or three stone of butter is the most that can be made of the milk of his kine the whole summer, and not above two heffers brought up each year. As to what profit may be made by bringing up young horses, I shall say nothing, supposing he keeps his stock good by those of his own upbringing. The whole product, then, of his cattle cannot be reckoned above fifty merks (£2 : 15 : 6). For, in respect his beasts are in a manner half-starved, they are generally small; so that scarce may a heffer be sold at above twelve pounds (£1 sterling). The whole product of this farm-room, therefore, exceeds not the value of 733 (£61 : 1 : 8 sterling), or thereabout." The labourers employed on this farm were two men and one woman, besides a herd in summer, and other servants in harvest.

Donaldson then proceeds to point out a different mode of management, which he calculates to be more profitable; but no notice is taken of either clover or turnips as crops to be raised in his new course, though they are incidentally noticed in other parts of the work.

"I also recommend potatoes as a very profitable root for husbandmen and others that have numerous families. And because there is a peculiar way of planting this root, not commonly known in this country, I shall here shew what way it is ordinarily planted or set. The ground must be dry; and so much the better it is if it have a good soard of grass. The beds or rigs are made about eight foot broad, good store of dung being laid upon your ground; horse or sheep dung is the proper manure for them. Throw each potatoe or sett (for they were sometimes cut into setts) into a knot of dung, and afterwards dig earth out of the furrows, and cover them all over, about some three or four inches deep; the furrows left between your riggs must be about two feet broad, and little less will they be in depth before your potatoes be covered. You need not plant this root in your garden; they are commonly set in the fields, and wildest of ground, for enriching of it." As to their consumption, they were sometimes "boiled and broken, and stirred with butter and new milk; also roasted, and eaten with butter; yea, some make bread of them, by mixing them with oat or barley meal; others parboil them, and bake them with apples, after the manner of tarts."

There is a good deal in this little treatise about sheep, and other branches of husbandry; and if the writer was well informed, as in most instances he appears to have been, his account of prices, of wages, and generally of the practices of that period, is very interesting.

The next work on the husbandry of Scotland is, *The Countryman's Rudiments, or an advice to the Farmers in East Lothian, how to labour and improve their grounds;* said to have been written by Lord Belhaven about the time of the Union, and reprinted in 1723. In this we have a deplorable picture of the state of agriculture in what is now the most highly improved county in Scotland. His lordship begins with a very high encomium on his own performance. "I dare be bold to say, there was never such a good easy method of husbandry as this, so succinct, extensive, and methodical in all its parts, published before." And he bespeaks the favour of those to whom he addresses himself, by adding, "neither shall I affright you with hedging, ditching, marling, chalking, paring and burning, draining, watering, and such like, which are all very good improvements indeed, and very agreeable with the soil and situation of East Lothian; but I know ye cannot bear as yet a crowd of improvements, this being only intended to initiate you in the true method and principles of husbandry." The farm-rooms in East Lothian, as in other districts, were divided into infield and outfield. "The infield (where wheat is sown) is generally divided by the tenant into four divisions, or breaks, as they call them, viz. one of wheat, one of barley, one of pease, and one of oats; so that the wheat is sowed after the pease, the barley after the wheat, and the oats after the barley. The outfield land is ordinarily made use of promiscuously for feeding of their cows, horse, sheep, and oxen; 'tis also dunged by their sheep, who lay in earthen folds; and sometimes, when they have much of it, they fauch or fallow a part of it yearly." Under this management the produce seems to have been three times the seed; and yet, says his lordship, "if in East Lothian, they did not leave a higher stubble than in other places of the kingdom, their grounds would be in a much worse condition than at present they are, though bad enough."—"A good crop of corn makes a good stubble, and a good stubble is the equalest mucking that is." Among the advantages of inclosures, he observes, "you will gain much more labour from your servants, a great part of whose time was taken up in gathering thistles and other garbage for their horses to feed upon in their stables; and thereby the great trampling and pulling up, and other destruction of the corns, while they are yet tender, will be prevented." Potatoes and turnips are recommended to be sown in the yard (kitchen-garden). Clover does not seem to have been in use. Rents were paid in corn; and, for the largest farm, which he thinks should employ no more than two ploughs, the rent was about six chalders of victual "when the ground is very good, and four in that which is not so good. But I am most fully convinced they should take long leases or tacks, that they may not be straitened with time in the improvement of their rooms; and this is profitable both for master and tenant."

Such was the state of the husbandry in Scotland in the early part of last century. The first attempts at improvement cannot be traced farther back than 1723, when a number of landholders formed themselves into a society, under the title of the *Society of Improvers in the Knowledge of Agriculture in Scotland.* The Earl of Stair, one of their most active members, is said to have been the first who cultivated turnips in that country. The *Select Transactions* of this society were collected and published in 1743 by Mr. Maxwell, who took a large part in its proceedings. It is evident from this book that the society had exerted itself in a very laudable manner, and apparently with considerable success, in introducing cultivated herbage and turnips, as well as in improving the former methods of culture. But there is reason to believe that the influence of the example of its numerous members did not extend to the common tenantry, who are always unwilling to adopt the practices of those who are placed in a higher rank, and supposed to cultivate land for pleasure rather than profit. Though this society, the earliest probably in the United Kingdom, soon counted upwards of 300 members, it existed little more than 20 years. Maxwell delivered lectures on agriculture for one or two sessions at Edinburgh, which, from the specimen he has left, ought to have been encouraged.

In the introductory paper in Maxwell's collection, we are told, that "the practice of draining, inclosing, summer fallowing, sowing flax, hemp, rape, turnip and grass seeds, planting cabbages after, and potatoes with, the plough, in fields of great extent, is introduced; and that, according to the general opinion, more corn grows now yearly where it was never known to grow before, these twenty years last past, than perhaps a sixth of all that the kingdom was in use to produce at any time before."

In this work we find the first notice of a thrashing-machine; it was invented by Mr. Michael Menzies, advocate, who obtained a patent for it. Upon a representation made to the society that it was to be seen working in several places, they appointed two of their number to inspect it; and in their report they say, that one man would be sufficient to manage a machine which would do the work of six. One of the machines was "moved by a great water-wheel and triddles," and another "by a little wheel of three feet diameter, moved by a small quantity of water." This machine the society recommended to all gentlemen and farmers.

The next work is by the same Mr. Maxwell, printed in 1757, and entitled the *Practical Husbandman; being a collection of miscellaneous papers on Husbandry, etc.* In this book the greater part of the *Select Transactions* is republished, with a number of new papers, among which, an *Essay on the Husbandry of Scotland*, with a proposal for the improvement of it, is the most valuable. In this he lays it down as a rule, that it is bad husbandry to take two crops of grain successively, which marks a considerable progress in the knowledge of modern husbandry; though he adds, that in Scotland the best husbandmen after a fallow take a crop of wheat; after the wheat, peas; then barley, and then oats; and after that they fallow again. The want of inclosures was still a matter of complaint. The ground continued to be cropped so long as it produced two seeds; the best farmers were contented with four seeds, which was more than the general produce.

Section 3.—*Laws of this period.*

The first act of parliament for collecting tolls on the highway in Scotland was passed in 1750, for repairing the road from Dunglass bridge to Haddington. In ten years after, several acts followed for the counties of Edinburgh and Lanark, and for making the roads between Edinburgh and Glasgow. The benefit which agriculture has derived from good roads, it would not be easy to estimate. The want of them was one great cause of the slow progress of the art in former times.

The Revolution in 1688 was the epoch of that system of corn laws to which very great influence has been ascribed, both on the practice of agriculture and the general prosperity of the country.

The exportation of wool was prohibited in 1647, in 1660, and in 1688; and the prohibition strictly enforced by subsequent statutes. The effect of this on its price, and the state of the wool trade, from the earliest period to the middle of last century, are distinctly exhibited by the learned and laborious author of *Memoirs on Wool*, printed in 1747.

CHAPTER IV.

PROGRESS FROM 1760 TO 1815.

Section 1.—*Progress from* 1760 *to* 1792.

THE gradual advance in the price of farm produce soon after the year 1760, occasioned by the increase of population, and of wealth derived from manufactures and commerce, gave a powerful stimulus to rural industry, augmented agricultural capital, and called forth a more skilful and enterprising race of farmers. The arable lands of the country, which, under the operation of the feudal system, had been split up into minute portions, cultivated by the tenants and their families without hired labour, began now to be consolidated into larger holdings, and let to those tenants who possessed most energy and substance. This enlargement of farms, and the letting of them under leases for a considerable term of years, continued (in Scotland) to be a marked feature in the agricultural progress of the country until the end of the century, and is to be regarded both as a cause and a consequence of that progress. The passing of more than 3000 inclosure bills during the reign of Geo. III., before which the whole number was but 244, shews how rapidly the cultivation of new land now proceeded. The disastrous American war for a time interfered with the national prosperity; but with the return of peace in 1783, the cultivation of the country made more rapid progress. The quarter of a century immediately following 1760, is memorable in our agricultural annals for the introduction of various important improvements. It was during this period that the genius of Bakewell produced such an extraordinary change in the character of our more important breeds of live stock; but especially by the perfecting of a new race of sheep—the well-known Leicesters—which have ever since proved such a boon to the country, and have added so much to its wealth. Bakewell's fame as a breeder was for a time enhanced by the improvement which he effected on the long-horned cattle, then the prevailing breed of the midland counties of England. These, however, were ere long rivalled, and have now been entirely superseded by the shorthorn or Durham breed, which the brothers Colling obtained from the useful race of cattle that had long existed in the valley of the Tees, by applying to them the principle of breeding which Bakewell had already established. A more rational system of cropping now began very generally to supersede the thriftless and barbarous practice of sowing successive crops of corn until the land was utterly exhausted, and then leaving it foul with weeds, to recover its power by an indefinite period of rest. Instead of this, green crops, such as turnips, clover, and ryegrass, began to be alternated with grain crops, and hence the name *alternate husbandry*, by which this improved system is generally known. The land was now also generally rendered clean and mellow by a summer fallow before being sown with clover or grasses.

Hitherto, the husbandry of England had been very superior in every respect to that of Scotland. Improvements now, however, made rapid progress in the latter. So early as 1764, Mr. Dawson, at Frogden, in Roxburghshire, is said to have had 100 acres of drilled turnips on that farm in one year. A few years after this, the Messrs. Culley—one of them a pupil of Bakewell—left their paternal property on the banks of the Tees, and settled on the Northumbrian side of the Tweed, bringing with them the valuable breeds of live stock and improved husbandry of their native district. The improvements introduced by these energetic and skilful farmers, spread rapidly and exerted a most beneficial influence upon the border counties. An act passed in 1770, which relaxed the rigour of strict entails, and afforded power to landlords to grant leases and otherwise improve their estates, had a beneficial effect on Scottish agriculture. From 1784 to 1795, improvements advanced with steady steps. This period was distinguished for the general adoption and industrious working out of ascertained improvements. Small's swing plough, and Meikle's thrashing-machine, although invented some years before this, were now perfected and brought into general use, to the great furtherance of agriculture. Two important additions were about this time made to the field crops, viz., the Swedish turnip and potato oat. The latter was accidently discovered in 1788, and both soon came into general cultivation. In the same year, Merino sheep were introduced by his Majesty, George III., who was a zealous farmer. For a time, this breed attracted much attention, and sanguine expectations were entertained that it would prove of national importance. Its unfitness for the production of mutton, and increasing supplies of fine clothing wool from other countries, soon led to its total rejection.

In Scotland, the opening up of the country by the construction of practicable roads, and the enclosing and subdividing of farms by hedge and ditch was now in active progress. The former admitted of the general use of wheel-carriages, of the ready conveyance of produce to markets, and in particular, of the extended use of lime; the application of which was immediately followed by a great increase of produce. The latter, besides its more obvious advantages, speedily freed large tracts of country from stagnant water, and their inhabitants from ague; and prepared the way for the under-ground draining which soon after began to be practised.

Section 2.—Remarkable progress from 1795 *to* 1815.

The agriculture of the country was thus steadily improving, when suddenly the whole of Europe became involved in the wars of the French Revolution. In 1795, under the joint operation of a deficient harvest, and the cutting off of foreign supplies of grain by the policy of Napoleon, the price of wheat, which, for the twenty preceding years, had been under 50s. a quarter, suddenly rose to 81s. 6d., and in the following year reached to 96s. In 1797 the fear of foreign invasion led to a panic and run upon the banks, in which emergency the Bank Restriction Act, suspending cash payment, was passed, and ushered in a system of unlimited credit transactions. Under the unnatural stimulus of these extraordinary events, every branch of industry extended with unexampled rapidity. But in nothing was this so apparent as in agriculture; the high prices of produce holding out a great inducement to improve lands then arable, to reclaim others that had previously lain waste, and to bring much pasture-land under the plough. Nor did this increased tillage interfere with the increase of live stock; as the green crops of the alternate husbandry more than compensated for the diminished pasturage. This extraordinary state of matters lasted from 1795 to 1814; the prices of produce even increasing towards the close of that period. The average price of wheat for the whole period was 89s. 7d. per quarter; but for the last five years it was 107s., and in 1812 it reached to 126s. 6d. The agriculture of Great Britain, as a whole, advanced with rapid strides during this period; but nowhere was the change so great as in Scotland. Indeed, its progress there, during these twenty years, is probably without parallel in the history of any other country. This is accounted for by a concurrence of circumstances. Previous to this period, the husbandry of Scotland was still in a backward state as compared with the best districts of England, where many practices, only of recent introduction in the north, had been in general use for generations. This disparity made the subsequent contrast the more striking. The land in Scotland was now, with trifling exceptions, let on leases for terms varying from twenty to thirty years, and in farms of sufficient size to employ at the least two or three ploughs. The unlimited issues of Government paper, and the security afforded by these leases, induced the Scotch banks to afford every facility to landlords and tenants to embark capital in the improvement of the land. The substantial education supplied by the parish schools, of which nearly the whole population could then avail themselves, had diffused through all ranks such a measure of intelligence as enabled them promptly to discern, and skilfully and energetically to take advantage of this spring-tide of prosperity; and to profit by the agricultural information now plentifully furnished by means of the Bath and West of England Society, established in 1777; the Highland Society, instituted in 1784; and the National Board of Agriculture in 1793; of which, however, more anon. As one proof of the astonishing progress of Scottish husbandry during this period, we may mention that the rental of land which in 1795 amounted to £2,000,000, had in 1815 risen to £5,278,685, or considerably more than doubled in twenty years.

But of the causes which have influenced the agriculture of the period under review, none have been so powerful as the extraordinary increase of our population, which, in round numbers, has twice doubled during the past seventy years. Not only are there four times as many people requiring to be fed and clad now as there was then, but from the increased wealth and altered habits of the people, the individual rate of consumption is greater now than formerly. This is particularly apparent in the case of butcher-meat, the consumption of which has increased out of all proportion with that of bread-corn. To meet this demand, there behoved to be more green crops and more live stock; and from that has resulted more wool, more manure, and more corn. While this ever-growing demand for farm-produce has stimulated agricultural improvement, it has also operated in another way. The productiveness of the soil has been greatly increased, and will no doubt be still more so in future; but the area of the country cannot be increased. Land—the raw material from which food is produced—being thus limited in amount, and in increasing demand, has necessarily risen in price. So much is this the case, that whereas the average price of wheat for the five years preceding 1852, has been £2 : 8 : $7\frac{3}{4}$ per quarter, or £2 : 13 : 10 less than during the five years preceding 1815, the rent of land is actually higher now than it was then. The raw material of the food-grower having thus risen in price, his only resource has been to fall upon plans for lowering the cost of producing his crops and for increasing their amount. To such an extent has he succeeded, that the produce-market has been kept full, and prices have decreased. The business of farming has in the main been a less prosperous one than most other branches of national industry, and yet agriculture, as an art and as a science, has made steady progress. We believe it is only in this way that the contemporaneous existence of two things apparently so incompatible as a steady rise in the rent of land, and a steady decrease in the price of its produce, can be satisfactorily accounted for.

CHAPTER V.

PROGRESS SINCE 1815.

Section 1.—Laws affecting Agriculture.

THE abundant crop of 1813, and restored communication with the continent of Europe in the same year, gave the first check to these unnaturally exorbitant prices and rents. The restoration of peace to Europe, and the re-enactment of the Corn-Laws in 1815, mark the commencement of another era in the history of our national agriculture. It was ushered in with a time of severe depression and suffering to the agricultural community. The immense fall in the price of farm-produce which then took place was aggravated, first, by the unpropitious weather and deficient harvest of the years 1816, 1817; and still more by the passing in 1819 of the Bill restoring cash payments, which coming into operation in 1821, caused serious embarrassment to all persons who had entered into engagements at a depreciated currency, which had now to be met with the lower prices of an enhanced one. The much-debated Corn-Laws, after undergoing various modifications, and proving the fruitful source of business uncertainty, social discontent, and angry partizanship, were finally abolished in 1846, although the Act was not consummated until three years later. Several other Acts of the Legislature, passed during this period, have exerted an important influence on agriculture. Of these, the first in date and importance is the Tithe Commutation Act of 1836. All writers on agriculture had long concurred in pointing out the injurious effects on agriculture, of the tithe system as it then stood. The results of the change have amply verified the anticipations of those who were instrumental in procuring it. Since the removal of this formidable hindrance, improvement has been stimulated by those acts under which the Government has been empowered to advance money on certain conditions, for the draining of estates. An important feature in these advances is, that the $6\frac{1}{2}$ per cent of interest charged upon them provides a sinking fund by which the debt is extinguished in twenty-two years. Additional facilities have also been granted, by the act passed in 1848 for disentailing estates, and for burdening such as are entailed with a share of the cost of certain specified improvements.

Section 2.—*Cattle Murrain and Potato Disease.*

Another class of outward events, which has had an important influence upon agriculture, requires our notice. We refer to those mysterious diseases affecting both the animal and vegetable kingdoms, the causes and remedies for which we have alike failed to discover. The murrain, or "vesicular epizootic" appeared first in 1841; having been introduced, as is supposed, by foreign cattle. It spread rapidly over the country, affecting all our domesticated animals, except horses, and causing everywhere great alarm and loss, although seldom attended by fatal results. It has prevailed ever since, in a greater or less degree. It was soon followed by the more terrible lung-disease, or pleuro-pneumonia, which continues to cause such mortality among our herds. But these have been as nothing in comparison with the dreaded potato-disease, which first appearing in 1845, has since pervaded the whole of Europe, and in Ireland especially proved the sad precursor of famine and pestilence. This seemingly insignificant blight for a time wellnigh with-drew from cultivation one of our most esteemed field crops; it influences the business of farming in a way that baffles the shrewdest calculators, and is producing social changes of which no man can predict the issue.

Section 3.—*Leading Improvements.*

We can here do little more than enumerate some of the more prominent improvements in practical agriculture which have taken place during the period under review. Before the close of the past century, and during the first quarter of the present one, a good deal had been done in the way of draining the land, either by open ditches, or by Elkington's system of deep covered drains. This system has now been superseded by one altogether superior to it both in principle and practice. In 1835, James Smith of Deanston (honour to his memory!) promulgated his now well-known system of thorough draining and deep ploughing. It has been carried out already to such an extent, as to have altered the very appearance and character of whole districts of our country, and has prepared the way for all other improvements. The words "Portable Manures," indicate at once another prominent feature in the agriculture of the times. Early in the present century, ground bones began to be used in the eastern counties of England as a manure for turnips; whence the practice spread, at first slowly, and then very rapidly, over the whole country. It was about 1825, when it began to be generally used in Scotland. In 1841 the still more potent guano was introduced in Great Britain; and about the same time, bones, under the new form of superphosphate of lime. By means of these invaluable fertilizers, a stimulus has been given to agriculture which can scarcely be over-rated.

The labour of agriculture has been greatly lightened and its costs curtailed, by means of improved implements and machines. The steam-engine has taken the place of the jaded horses as a thrashing power. This was first done in East Lothian, by Mr. Aitchison of Drumore, who, about 1803, had his thrashing machinery, at his distillery and farm of Clement's Wells, attached to a steam-engine, which he had got put up a few years previously, by Bolton and Watt, for the works of the distillery. About 1818-20 several steam-engines on the condensing principle were erected in East Lothian, solely for the propelling of thrashing machinery. One of these, put up by Mr. Reid of Drem, at a cost of £600, is still doing its work there, and, strange to say, after the lapse of forty years, looks as well, and is as efficient as when first erected. It would be tedious to particularise other instances in this department, as it will be treated of fully in its proper place. It is especially in this department that the influence of the ever memorable Exhibition of the Industry of all Nations in 1851, has told upon agriculture. Reaping by machinery may virtually be regarded as one of the fruits of that great gathering.

The railways, by which the country is now intersected in all directions, have proved of great service to farmers, by conveying their bulky produce to distant markets cheaply and quickly; and by making lime and other manures available to the occupiers of many inland and remote districts. In nothing has this benefit been more apparent, than in the case of fatted live stock, which is now invariably transported by this means, with manifold economy to all concerned.

During the whole of this period there has been going on great improvement in all our breeds of domesticated animals. This has been manifested, not so much in the production of individual specimens of high merit—in which respect the Leicesters of Bakewell, or the short-horns of Colling, have perhaps not yet been excelled—as in the diffusion of these and other good breeds over the country, and in the improved quality of our live stock as a whole. The fattening of animals is now conducted on more scientific principles. Increased attention has also been successfully bestowed on the improvement of our field crops. Improved varieties, obtained by cross-impregnation, either naturally or artificially brought about, have been carefully propagated, and generally adopted. Increased attention is now bestowed on the cultivation of the natural grasses. The most important additions to our list of field crops during this period, have been Italian ryegrass, winter beans, white Belgian carrot, sugar beet, and alsike clover.

Section 4.—Increase and Diffusion of Agricultural Knowledge.

Let us look now at the means by which, during this period, agricultural knowledge has at once been increased and diffused. Notice has already been taken of the institution of the Highland Society and National Board of Agriculture. These patriotic societies were the means of collecting a vast amount of statistical and general information connected with agriculture and by their publications, and premiums made known the practices of the best-farmed districts of the country and encouraged their adoption elsewhere. These national associations were soon aided in their important labours by numerous local societies which sprung up in all parts of the kingdom. After a highly useful career, under the zealous presidency of the amiable Sir John Sinclair, the Board of Agriculture was dissolved, but has left in its Statistical Account, county surveys, and other documents, much interesting and valuable information regarding the agriculture of that period. In 1800, the original Farmers' Magazine entered upon its useful career under the editorship of Robert Brown of Markle, the author of the well-known treatise on "Rural Affairs." The Highland Society having early extended its operations to the whole of Scotland, by and by made a corresponding addition to its title, and as the *Highland and Agricultural Society of Scotland* continues to occupy its important sphere with a steadily increasing membership, popularity, and usefulness. As its revenue and experience increased, it gradually extended its operations. In 1828, shortly after the discontinuance of the Farmers' Magazine, its "Prize Essays and Transactions" began to be issued statedly in connection with the "Quarterly Journal of Agriculture," a periodical which still occupies a prominent place in our professional literature. This Society early began to hold a great annual show of live stock, implements, etc., the popularity of which continues unabated. In 1842, Mr. John Finnie at Swanstone, near Edinburgh, having suggested to some of his neighbours the desirableness of obtaining the aid of chemistry to guide farmers in many departments of their business, the hint was promptly acted upon, and these Mid-Lothian tenant-farmers had the merit of originating an Agricultural Chemistry Association (the first of its kind), by which funds were raised, and an eminent chemist engaged, for the express purpose of conducting such investigations as the title of the Society imports. After a successful trial of a few years this association was dissolved, after transferring its functions to the Highland and Agricultural Society, which has ever since devoted much of its attention to this subject. The treatise on Agricultural Chemistry by its present accomplished chemist, Dr. Anderson, shews the nature and importance of the labours in which he, and his predecessor, Professor Johnston, have been engaged.* The Highland Society has of late years established itself on a broader basis, and imparted new energy to its operations by lowering its admission-fee in behalf of tenant-farmers, who

* This treatise appeared in the 8th Edition of the Encyclopædia Britannica, and has been published in a separate form—"Elements of Agricultural Chemistry." Edinburgh, 1860.

have in consequence joined it in great numbers, and now take an important part in the conduct of its business. The practice adopted by it, about the same time, of holding periodical meetings for the discussion of important practical questions, by means of essays from selected individuals, is doing good service to the cause of agricultural progress.

The adoption by Government of a proposal made by this Society to collect the agricultural statistics of Scotland, showed at once how thoroughly it enjoyed the confidence of the tenantry, and how easily, and by what simple and inexpensive machinery, this most important and interesting inquiry could be conducted. Through an unfortunate misunderstanding betwixt the Government and the Society on a mere technical point, this most useful inquiry came to an abrupt termination, after having been conducted for five years. The statistics collected during these years will ever be regarded with interest for the trustworthy information then for the first time obtained on many points of great importance.

The obvious success of this National Scottish Society has led to the formation of similar ones in England and in Ireland. The former, instituted in 1838, and shortly afterwards incorporated by Royal Charter, at once entered upon a career of usefulness, the extent of which cannot well be overrated. Its membership—comprising the most influential persons in the kingdom—and its revenues, are now so large as to enable it to conduct its proceedings on a scale befitting its position and objects. These are of a varied character, but its efforts are concentrated upon its journal and annual show. The former, published twice a-year, is chiefly composed of the essays and reports to which the liberal prizes of the society have been awarded, and undoubtedly stands at the head of our present agricultural periodicals. At its annual shows, a prominent place is assigned to implements and machines. Such as admit of it, are subjected to comparative trials, which are conducted with such skill and pains that the awards command the entire confidence of exhibitors and their customers. The extent and rapidity of the improvement in agricultural machinery which the society has been the means of effecting, is altogether extraordinary.

There are few market-towns of any importance that have not their organised club or occasional gathering of the farmers in their neighbourhood, for the discussion of professional topics. We have now also a goodly list of agricultural periodicals, both weekly and monthly, most of them ably conducted, which are extensively read, and are the means of collecting and diffusing much valuable knowledge, which, but for them, would often, as in former times, perish with its authors, or be confined to corners. The facilities now afforded by railways for cheap and expeditious travelling, induce most farmers to take an occasional peep at what is going on beyond their own neighbourhood. This, more than anything, deals deathblows to prejudices, and extends good husbandry.

The literature of agriculture has, during a comparatively brief period, been enriched by the contributions of many able writers. Of these we may enumerate the late David Low, Esq., whose volumes on "Practical Agriculture," "Landed Property and Economy of Landed Estates," and "Domesticated Animals," must ever be of standard authority on their respective subjects. Mr. Henry Stephens' "Book of the Farm," and Mr. J. C. Morton's "Cyclopædia of Agriculture," are invaluable to the agricultural student for their fulness, and for the minuteness of their details. Mr. Caird's "English Agriculture in 1850 and 1851," gives a lively picture of the state of matters in nearly every county of England at the critical period of transition from protective duties to free trade in agricultural produce, and supplies the means for a most interesting comparison with the descriptions left to us by Arthur Young. Mr. Hoskyn's "History of Agriculture," and "Chronicles of a Clay Farm," are the very gems of our professional literature. A series of essays on our "Farm Crops," by Professor John Wilson of Edinburgh, in which the scientific and the practical are most happily combined, has recently been published. Johnstone, Anderson, Way, and Voelcker, have done admirable service in expounding the chemistry of agriculture; Youatt, Spooner, and Vasey, its zoology; and Smith, Parkes, Webster, and Scott Burn, its engineering, mechanics, and architecture.

In reviewing the history of our national agriculture for the past sixty years, it is pleasing to note the growing intelligence displayed by our agriculturists in the prosecution of their calling. It is curious, also, to observe the analogy betwixt the order of that progress, and that which is usually observed in individual minds. For a length of time we see agricultural societies and writers occupying themselves chiefly about the practical details and statistics of husbandry, and attaching much importance to empirical rules. Gradually, however, we observe, along with a zealous collecting of facts, a growing disposition to investigate the *causes* of things, and to know the *reason* why one practice is preferable to another. When, therefore, the Royal Agricultural Society adopted as its motto "Practice with Science," it expressed not more the objects to be aimed at in its own proceedings, than the characteristic feature of our present stage of agricultural progress.

PART II.

CHAPTER I.

PRACTICE OF BRITISH AGRICULTURE.

WE shall now endeavour to present a picture of British Agriculture in its present state. In doing this, we shall take much the same course which we should pursue, if we were asked to conduct a visitor over our own farm, and to give him a detailed account of its cultivation and management. In the case supposed, we should, first of all, explain to him that the farm comprises a great diversity of SOILS; that its fields are very variously circumstanced as regards CLIMATE, altitude, exposure, and distance from the homestead; and that in its tillage, cropping, and general management, regard must be had to these diversities, whether natural or artificial. Having thus premised, we should then conduct him through the homestead, pointing out the position and uses of the various FARM BUILDINGS, and of the MACHINERY and IMPLEMENTS contained in them. From thence we should proceed to the fields to examine their FENCES and the TILLAGE OPERATIONS. With some observations about the SUCCESSION OF CROPS, and the MANURES applied to them, there would follow an examination of the CULTIVATED CROPS, PASTURES, and MEADOWS; of the LIVE STOCK of the farm; and of the measures adopted in reclaiming certain WASTE LANDS belonging to it. This survey being completed, there would naturally follow some discussion about the TENURE of land, the CAPITAL required for its profitable cultivation, the condition of FARM LABOURERS, the necessity for devoting more attention to the EDUCATION of the agricultural community, and the duty of the legislature to remove certain OBSTRUCTIONS to agricultural improvement.

Section 1.—*Soils.*

The soil constituting the subject-matter on which the husbandman operates, its character necessarily regulates to a large extent the nature of his proceedings. The soil or surface covering of the earth in which plants are produced is exceedingly varied in its qualities. Being derived from the disintegration and decomposition of the rocks which constitute the solid crust of the globe, with a mixture of vegetable and animal remains, soils take their character from that of the rocks from which they have chiefly been derived. There is hence a generally prevailing resemblance betwixt the soils of a district and the rocks over which they lie, so that a knowledge of the composition of the one affords a key to the character of the other. But this connection is modified by so many circumstances that it is altogether impossible by the mere study of geology to acquire an easy and certain rule for determining the agricultural character of the soil of any particular district or field, as it has been the fashion with some writers of late years to assert. "When indeed, we regard a considerable tract of land, we can for the most part trace a connection between the subjacent deposits and the subsoil, and consequently, the soil. Thus, in a country of sandstone and arenaceous beds we shall find the soil sandy; in one of limestone, more or less calcareous; in one of schistose rocks, more or less clayey. But even in tracts of the same geological formation, there exist great differences in the upper stratum, arising from the prevalence of one or other member of the series, or from the greater or less inclination of the strata, by which the debris of the different beds are more or less mixed together on the surface. The action of water, too, in denuding the surface at one part, and carrying the debris in greater or smaller quantity to another, exercises everywhere an important influence on the character of soils. Thus the fertility of a soil on the higher ground from which the earthy particles are washed, is found to be very different from that of the valley to which these particles are carried. It is seen accordingly, that within the limits of the same geological formation, soils are greatly varied, and that the mere knowledge of the formation will not enable us to predicate the character of the soil of any given tract, either with respect to its texture, its composition, or its productiveness."* Even a very limited acquaintance with the geology of Great Britain serves, however, to account for the exceedingly diversified character of its soils. The popular definitions of soils, and to which it is safest for practical farmers to adhere, have respect to their most obvious qualities. Thus they are designated from their composition, as *clays, loams, sands, gravels, chalks, or peats;* or from their texture, in which respect those in which clay predominates are called *heavy, stiff,* or *impervious;* and the others *light, friable,* or *porous.* From the tendency of the former to retain moisture they are often spoken of as *wet* and *cold,* and the latter, for the opposite reason, as *dry* and *warm.* According to their measure of fertility they are also spoken of as *rich* or *poor.* The particular crops for the production of which they are respectively considered to be best adapted, have also led to clays being spoken of as *wheat* or *bean soils,* and the friable ones as *barley,* and *turnip soils.* This latter mode of discriminating soils is however becoming every day less appropriate; as those of the lighter class, when sufficiently enriched by suit-

* Low's Practical Agriculture, p. 42.

able manuring, are found the most suitable of all for the growth of wheat; while the efforts of agriculturists are now successfully directed to the production of root crops on those so strong as heretofore to have been reckoned unfit for the purpose. But still, such extreme diversities as we everywhere meet with in our soils, must necessarily lead to a corresponding diversity in their agricultural treatment, and hence the necessity for keeping this fact prominently in view in every reference to British agriculture as a whole.

Section 2.—Influence of Climate.

But if diversity of soil necessarily modifies the practice of the husbandman, that of climate does so far more powerfully. The soils of the different parts of the globe do not very materially differ from each other, and yet their vegetable products vary in the extreme. This is chiefly owing to difference of temperature, which decreases more or less regularly as we recede from the equator, or ascend from the sea-level. Places in the same latitude and at the same elevation, are found however to vary exceedingly in temperature, according to their aspect, the prevailing winds to which they are exposed, their proximity to seas or mountains, and the condition of their surface. The different parts of Great Britain are accordingly found to possess very different climates. In passing from south to north its mean temperature may be taken to decrease one degree Fahrenheit for every 80 miles of north latitude and the same for every 300 feet of elevation. The temperature of the west side of our island also differs materially from that of the east, being more equal throughout the year. This is owing to the prevalence of mild westerly winds charged with moisture, which, while they equalise the temperature, cause the average fall of rain on the west side of Britain to be in many cases the double, and in some nearly the triple, of that on the opposite side. In the central parts of England cultivation is carried on at 1000 feet of elevation, but 800 may be taken as the ordinary limit. In Scotland the various crops are usually from two to three weeks later in coming to maturity than in England. In both divisions of the island the western counties, owing to their mild and humid climate, are chiefly devoted to pasturage, and the eastern, or dry ones, to tillage. As compared with the continent of Europe our summers are neither so hot, our winters so cold, nor our weather so steady. We want therefore many of its rich products, but on the other hand, our milder winter and moister climate are eminently favourable to the production of pasturage and other cattle crops, and admit of agricultural operations being carried on more regularly throughout the year. Indeed, looking to the immense varieties of the products of our soil, there is probably no other country so favourably circumstanced for a varied and successful agriculture.

Section 3.—*Influence of Population, etc.*

Besides those variations in the agricultural practice of this country which arise from diversities of soil and climate, there are others which are due to the distribution of the population. The proximity of cities and towns, or of populous villages, inhabited by a manufacturing or mining population, implies a demand for dairy produce and vegetables, as well as for provender and litter, and at the same time affords an ample supply of manure to aid in their reproduction. Such commodities, from their bulk or perishable nature, do not admit of long carriage. The supplies of these must therefore be drawn from comparatively limited areas, and the character of the husbandry there pursued is determined apart from those general influences previously referred to. From these and other causes there is a diversity in the practice of British agriculture which increases the difficulty of describing it accurately. Indeed, it is so well known that there are peculiarities of character attaching to almost every individual field and farm, and still more to every different district or county, which demand corresponding modifications of treatment in order to their successful cultivation, that a prudent man, if required to take the management of a farm in some district greatly inferior in its general system of farming to that which he may have left, will yet be very cautious in innovating upon specific practices of the natives.

To such peculiarities it is obviously impracticable to refer in such a treatise as the present. They are referred to now because they suggest an explanation of some of those discrepancies in the practice and opinions of farmers, equally successful in their respective localities, which we constantly meet with; and because, in proceeding to delineate the practice of Berwickshire, where our personal experience has been gained by nearly thirty years of actual farming, we would deprecate the idea of claiming for its modes a superiority over those of other districts. Its geographical position, and the mixed husbandry pursued in it, would justify, in some measure, its being referred to as a fair sample of the national agriculture. But it is on the specific ground that it is best to speak from actual experience as far as that will serve, that we vindicate this selection.

CHAPTER II.

FARM BUILDINGS.

Section 1.—*General Requisites.*

In pursuance of the plan already indicated, let us now refer for a little to *Farm-Buildings.* We have spoken of the soil as the raw material upon which the farmer operates: his homestead may, in like manner, be regarded as his manufactory. That it may serve this purpose in any good measure it is indispensable that the accommodation afforded by it be adequate to the extent of the farm, and adapted to the kind of husbandry pursued upon it. It should be placed upon a dry, sunny, sheltered site, have a good supply of water, and be as near as possible to the centre of the farm. The buildings should be so arranged as to economise labour to the utmost. It should be constructed of substantial materials, so as to be easily kept in repair, and to diminish, to the utmost, risk from fire.

The most cursory examination of existing homesteads will suffice to shew that in their construction these obvious conditions have been sadly neglected. For one farm really well equipped in this respect, hundreds are to be met with in all parts of the kingdom, and more especially in England, most wretchedly deficient. Wherever this is the case it is impossible that the farmer, however skilful or industrious, can make the most of his materials, or compete on equal terms with his better furnished neighbours. As the agricultural community becomes more generally alive to the importance of economising labour by a judicious arrangement of buildings, and of reducing the cost of the production of beef (and adding to the amount and fertilizing power of the home-made manure) by the manner in which the live stock is housed, we may hope that improvement in this department will make rapid progress. Tenants will refuse to embark their capital, and waste their skill and labour, on farms unprovided with suitable apparatus for cultivating them to the best advantage. Landlords, and their agents, will by and by find that until this is done, they must put up with an inferior tenantry, an antiqu ted husbandry, and with lower and worse-paid rents.

Section 2.—Plans.

In erecting new homesteads, or in making considerable additions to or alterations upon existing ones, it is of much importance to call in the aid of an architect of ascertained experience in this department of his art, and then to have the work performed by contracts founded upon the plans and specifications which he has furnished. A reasonable sum thus expended will be amply returned in the cost, trouble, and disappointment, which it usually saves to both landlord and tenant. It is to be hoped that in future a greater number of thoroughly qualified architects will devote themselves to this department of their profession, and that they will meet with adequate encouragement. It is not, therefore, with the view of superseding their services, but simply to illustrate our references to existing practices, that we subjoin a plan of farm-buildings.

While protesting against the utter rudeness and inadequacy of the great majority of homesteads, we must also deprecate the hurtful expenditure sometimes lavished in erecting buildings of an extent and style altogether disproportionate to the size of the farm, and out of keeping with its homely purposes.

When royalty or nobility, with equal benefit to themselves and their country, make agriculture their recreation, it is altogether befitting that in such cases the farm-yard should be of such a style as to adorn the park in which it is situate. And even those intended for plain everyday farming need not be unsightly; for ugliness is sometimes more costly than elegance. Let utility, economy, and comfort, first be secured, and, along with these, as much as possible of that pleasing effect which arises from just proportions, harmonious arrangement, and manifest adaptation to the use the buildings are designed for.

Much has recently been written on this subject, in the journals of our national agricultural societies, and other agricultural periodicals; and plans in great variety have been offered to public notice. Indeed, there is at present so much diversity of opinion about the best plan of farm-buildings, that most practical farmers, if offered a new homestead, would have considerable difficulty in deciding upon that which should be adopted in their own case. Those now given have been designed by experienced practical farmers. The first plan, plate I., is by Mr. Robert Hardie, Harrietfield, near Kelso. It is calculated for a farm of 600 acres of good arable land, cultivated on the system presently pursued in Berwick or Roxburgh shires. It expresses very fairly the present state of opinion in these counties on the question of housing fattening cattle, as provision is made in it for using at once yards, stalls, and boxes. The second, by Mr. James Cowie, Mains of Haulkerton, Kincardineshire, is on the principle, of late eagerly advocated, of having the entire homestead under cover. The premium offered by the Highland Society several years ago for the best plan of farm buildings was awarded to Mr. Cowie for plans similar to those which he has obligingly furnished for this work.

"The plan, plate II., is calculated for a farm of 400 acres, and can be erected at a cost of about £1200, exclusive of carriages. I have given full sections and elevations along with a ground plan of it, accompanied by full specifications, which will enable readers to understand it fully, and in fact to make it available and ready for tradesmen to work by, if required. Notwithstanding, to those not accustomed to judge of buildings from drawings, a few explanations may not be unacceptable, as leading to a more ready understanding of the arrangements. It will be seen that the two granary lofts, upper and lower, are attached to the sheaf-loft and corn-room. The division between them can be made to shift, so as one can be lessened or enlarged as may be required. The adjacent house has, in the ground-floor, a boiling-house and hay or grass shed, which may extend above the water-wheel to the corn-room wall. The floor above can be occupied as an auxiliary sheaf-loft or granary, or for erecting machinery for bruising corn or other food, etc. The straw-barn is placed in the centre of the building, and allows two kinds of straw to be deposited separately. The hay-shed and infirmary, when not occupied, can serve as a store for straw or chaff, if need be. The turnip-sheds are placed quite adjacent to the cattle, which can be fed from a small waggon on a railway, by the arrangement adopted here, in nearly half the time required by employing the common wheel-barrow. The sheds or boxes for the loose cattle are placed four feet below the level of the rest of the interior, and are immediately behind the stalls, so as to admit of the dung being removed from the tied-up cattle with the least labour. The cow-byre is in a separate division, and the calves-house is in proximity to it. The stable, which has two doors opening externally for more ready access to the horses, is conveniently situated as regards proximity to the boiling-house, corn-room, straw-barn, dung-shed, and cart-sheds; and there is a room provided over the turnip-shed for a sleeping apartment for the persons in charge of the cattle and horses. There are two large loose boxes, carpenter's shop, pig-sties, an ample tool-house, and an enclosed shed, which is capable of containing two carts, or can be employed in a temporary way as a guano or potato house. The poultry-house has a yard, part of which can, as occasion may require, be staked off as an exterior area for an invalid beast requiring fresh air. The saddle-horse stable and gig-house may be simply referred to in concluding the description. This steading thus embraces within a comparatively compact circle, all the conveniences required for a farm of the size specified; and it is not the least recommendation to it that the farmer can see almost at a glance, in any part of the interior, all his 10 or 12 horses, his 50 stall cattle, his 60 shed cattle, and his 30 or more calves; and from the position of, and ready access to them all, he can at once see how they are supplied with food and litter. The whole homestead with its contents, live and dead stock, are in fact as much within the visible scope of its owner, and manual access of the servants, as anything of the kind can, or requires to be.*

"The plan, plate III., is that of a farm on the small property of Calvennan, in Wigtownshire. It was built last season at a cost of about £500. It has three roofs, and the arrangements, which are similar to those in the plan just described, will be understood by a reference to the accompanying plan and sections."

"SPECIFICATION FOR STEADING OF FARM-OFFICES.

"*Mason Work.*

"All necessary excavations will be performed by the tenant.

"The walls will be founded at the depth shewn by the sections, or as much more as will insure a firm and solid foundation. The con-

* In plate II. the plan of an ark for a water-mill is given, but should a steam-engine be required, the erections for it can be made in place of the ark in the same situation.

tractor must satisfy himself as to the extent of the necessary depths, as no addition will be allowed for extra building.

"The foundation course of the walls is to be laid with large flat-bedded stones laid close together, and their joints hard packed with stone shivers and lime mortar, and having a toe or ledge from 3 to 4 inches broad, projecting beyond the thickness of the walls on each side. The walls are to be of good coursed and well banded and packed common rubble work. The stones composing the outside courses are to be well axe-dressed on the face, and to have beds of not less than 7 inches of breadth, and not to exceed 12 inches in height, having headers laid in each course at from 5 to 6 feet apart, extending at least two-thirds the thickness of the walls, and the whole to be particularly snecked on the outside, and back-snecked. All corners, outband door and window rybats, to be 26 inches in length, and squared on the ends: and inband rybats to go through the walls; and the whole to have heads not less than 8 inches broad. The rybats of the large doors will have checks $1\frac{1}{2}$ inches by $2\frac{5}{8}$ inches on the outside all round. All other doors opening to the outside will have checks $1\frac{1}{2}$ inch by $2\frac{1}{8}$ inches; and the other door and window rybats will have checks 2 inches deep, and one inch check on the lintels. All the corners of the buildings, door and window rybats, soles, and lintels, tabling and put stones, and arch stones, are to be well droved and jointed, and the pillars of the cart sheds are to be close jointed, and all rybats to have a margin of 3 inches round the outside faces, and on each of the external corners. The heel-posts of the byres are to be of stones 8 inches square, to be well droved, and to have a groove cut in each $1\frac{1}{2}$ inch square, for the travisboards, and to be well sunk in the ground, two feet at least, and to stand $3\frac{1}{2}$ feet above the saddles as shewn.

"The feeding-troughs of the byres are to be raised above the causewaying 6 inches, and bottomed with well droved and jointed stones; and the wooden posts of the stable and byres are to have proper stone bases. The urine under drains are to be laid with glazed socket-pipes to communicate with the urine tank, as shall be pointed out.

"The internal walls of the corn-room, sheaf-loft, and granaries, are to have one good coat of plaster, and the walls of the same are to be beam filled between the couples.

"Such of the houses and passages as shall be pointed out for causewaying shall be done in a proper and sufficient manner by the contractor at the rate of threepence per yard.

"The foundation of the underground walls of the ark are to be laid with large flat-bedded stones, all well laid and packed, and the whole of the water walls are to be of well-sized stones squared up, axed on the face, and well jointed, to have full beds, and built in courses, and every third stone to be a header of at least 2 feet in length. All openings are to have squared up scuncheons. There will be a projecting course laid at centre 9 inches thick, and at least 1 foot 9 inches in breadth, well droved and jointed. The bottom of the ark is to be slabbed with good quarry stones, and the tail race through an arched opening 3 feet square, the thickness of the wall. The size and form of the stones for hanging the machinery, and all the necessary cuttings, boring, and levellings, etc., must be executed at the sight, and to the satisfaction of the mill-wright or inspector.

"All the lime for the building is to be of the best English shells, well slaked and made into a strong composition of mortar with clean sharp sand, and all the joints of the outside work are to be well ripped out and pointed with Scotch lime mortar, in a proper season, and the ark is to be pointed with Roman cement.

"All necessary raggles are to be made, window frames bedded and pointed in, and the lead and the running in of the hinge crooks of the doors, also the laying of the urine-pipes, and all inferior jobs necessary for the completion of the mason-work, must be done at the sight, and to the satisfaction of the inspector without any additional charge.

"*Carpenters' Work.*

"Safe lintels throughout the buildings to have 1 inch of thickness to every foot of extreme length, and to have 9 inches of wall-hold, and closely fitted up to the out-side stone lintels. All inside doors to have wood lintels.

"Joists and sleepers to be laid as shewn, 18 inches from centres. Joists to have 9 inches of wall-hold.

"To have one row of trimmers in centre 10 inches by 1.

"Mill beams to be laid as shewn, to have 12 inches of wall-hold; to be double mortised, and fixed with a $\frac{7}{8}$th-inch joining bolt.

"The main couples on wide roofs will be framed as shewn, and secured at the joinings with iron plates; the rafters to be placed 21 inches from centres, checked at joinings, and securely nailed.

"The wide roofs will be supported by cast-iron columns as shewn. These columns to have large bases and capitals, and to have 6 inches diameter at the centre, and not less than $\frac{5}{8}$ inch thick of metal, fixed at the top to a dressed beam 11 inches square, and let into the stone base at the bottom $\frac{1}{4}$ inch. The other roofs to be framed up as shewn —roofing to be checked at joinings, and properly nailed.

"Slate-lath to be nailed on to answer slates 16 inches by 8 inches, or as near to that size as can be conveniently got.

"Gutters between the roofs to be formed as shall be shewn; all to be properly bracketed up and laid with ploughed flooring.

"Luffer-windows for granary and ventilators to have frames 3 inches by 2 inches, boards one inch thick, and made to open and shut with a rod and wood brackets as shall be shewn.

"The window-frames to be two inches thick, and to be made to open on pivots 12 inches from the top, and to be filled with strong rough plate glass.

"All the large doors to be in two halves, bound with four bars each, 7 inches by $1\frac{1}{8}$ inch, and all to have margin stiles in both edges $3\frac{1}{2}$ inches by $1\frac{1}{8}$ inch. Covering to be $\frac{7}{8}$ inch thick, ploughed, and all beeded on the joints. Each door to have two slipping bolts 18 inches long, $\frac{3}{4}$ inch diameter, made to work on strong iron plates; hinges to be $2\frac{1}{4}$ inches broad, $1\frac{1}{2}$ inch at neck, and each hinge to be two-thirds the width of the door, and to have three screw-bolts each.

"Corn-room door to be cut across the centre horizontally. All the other outside doors to be in one piece, and all to be framed on the back-side with stiles and bars; stiles $3\frac{1}{2}$ inches, bars 7 inches by $1\frac{1}{8}$ inch. Each door to have four bars covered with $\frac{7}{8}$th inch deals, either to be ploughed and beeded on the joints, or plain joints separated $\frac{3}{8}$th inch between deals, as shall be required: hinges 2 inches broad, $\frac{1}{4}$ inch thick, and two-thirds the breadth of the door, and each to have a screw-bolt at neck. Such of the doors as shall be pointed out to have a sliding board 9 inches square at bottom to admit air at pleasure. All the doors to have strong ring latches, and those on the outside to have home-made locks of the value of 5s. each, to be put on with three screw-bolts each. Keys of stable-doors to have rings. The doors for granaries and sleeping apartments to be made similar to the others, but hung on posts with good hinges, and to have locks same as the others. All the doors, luffer and other windows to have three coats of white lead paint, finished to a tint to be approved of.

"Crooks to be feather-tailed, pins for large doors $1\frac{1}{8}$ inch, for small doors 1 inch.

"Mill-loft and granaries to be floored with $1\frac{1}{8}$ inch thick deal, not broader than 7 inches, clean dressed on face, grooved and tongued, and nailed down with 14 lb. spikes, and the bye-wood all cleaned off. Dressed skirting boards fixed to ducts round all the walls of granaries, corn-room, and sheaf-loft, 7 inches deep and 1 inch thick.

"The mangers to be 16 inches deep, and sloped from the back to

20 inches, and in addition to have a 3 inch deal biting of hard wood. The front and bottom to have $1\frac{3}{8}$ inch deal, the back 1 inch deal.

"The posts to be octagon, 8 inches diameter at foot, and 7 inches at top, grooved for travis $1\frac{1}{2}$ inch deep and 2 inches broad; to be fixed at top to a run-joist 7 inches by $2\frac{1}{2}$ inches, with a large oak pin, and at bottom with an iron pin 5 inches long, 1 inch diameter. Front posts same size, split up the centre and similarly fixed. Posts and run-joists to be clean dressed.

"Hay-racks to be fitted up in the stable 36 inches broad. The splits to be $2\frac{1}{4}$ inches by $1\frac{3}{8}$ inch, and to be four inches between. Rails to be 4 inches by 2 inches, and checked for splits, and properly nailed.

"Travis to be 2 inches thick, to be clean dressed, close-jointed, each joint to have 3 iron dowels $\frac{3}{8}$th inch diameter; and to be fixed between the front posts by screw-bolts. The gable walls to be lined the length of the stalls with one inch deal, ploughed and fixed to straps 1 inch by 2 inches. Travis to be finished on the top with an ogee, and strapped with thick iron hoop.

"Harness-pins and saddle-rests to be fitted up as shall be pointed out, each post to have an iron hook for hanging harness. Two rings to be fixed into each post for binding horses.

"Two corn-chests to be fitted up in recesses in walls of stable, of 1 inch ploughed deal, 4 feet long each, 2 feet wide inside, and 3 feet deep; provided with proper locks and hinges. One corn-chest 3 feet long for riding-stable, similar to the others.

"Fronts and backs of byre-troughs to be 2 inches thick and 12 inches deep, to slope towards the cattle, and rounded on the edge.

"Post to be fitted up as shewn, to be fastened at bottom and top same as stable, to be $5\frac{1}{2}$ inches diameter, champhered in corners. The front post to be grooved for receiving travis, the other one to be in two, and travis fixed to them same as stable. Run-joists to be 6 inches by 3 inches. Iron sliding rods 14 inches long, $\frac{3}{4}$ thick, to be fixed in the posts with screw-bolts for cattle-bindings.

"Racks to be fitted up 30 inches deep on the side next the cattle, and 24 inches on the other side. Same dimensions as stable racks, and fitted up in the same way; splits to be six inches between.

"Travis boards to be $1\frac{1}{4}$ inch thick, $4\frac{1}{2}$ feet high at front, and 3 feet 3 inches at back; and front-bar 5 inches broad, and 2 inches thick, to be nailed to the front posts, and 2 feet above the edge of the troughs.

"Troughs to be made into proper lengths for convenience in shifting. Sides to be 14 inches deep and 2 inches thick; bottom 1½ inch, to be properly secured by longitudinal spars, nailed to bottom and framing, frame 3 inches by 2 inches, and made to stand on feet. Width of troughs to be 2½ feet; all to be firmly nailed.

"One straw crib to be made for each division of sheds; posts to be 4 inches square, to have 3 rails on each side, 4 inches by 2 inches; to stand 4 feet high, 8 feet long, and 4 feet wide.

"Two traps to be made for corn-room, loft, and stable, of such length and dimensions as shall be pointed out.

"All scaffolding, centring, and moulds, are to be furnished to the contractor for the mason-work. All inferior jobs not specified, nor shewn in sections necessary for the proper completion of the carpenter work, shall be done without any additional charge, unless from its nature and extent such as shall be allowed by the inspector of the work.

"All the timber shall be of good Baltic timber, or American red pine, and must be well seasoned.

"*Scantlings of Timber.*

"Sleepers, 6½ inches by 2½.
Joists, 10½ inches by 2½.
Rafters, narrow roof, 6 inches at bottom, 5 inches at top, 2½ inches thick.
Baulks or ties, 6½ inches by 2.
Cross-beam for thrashing-mill, 10 inches by 14.
Longitudinal beams, 7 inches by 14.
Safe lintels for large shed-doors, 10 inches by 10.
Slate lath, 1½ inches by 1.
Rafters of main-couples, 5 inches by 8.
Tie beams of do., 9 inches by 5.
King posts of do., 5 inches by 5.
Spurs or anglers, 5 inches by 5.
Purlins, 5½ inches by 5½.
Intermediate rafters, wide roofs, 6 inches by 2.

"*Slater Work.*

"The roofs to be covered with blue Welsh slates, size 16 inches by 8 inches; to have 2-inch cover or overlap, and all to be fair and closely laid. To be nailed to laths with nails weighing eight pounds per thousand, steeped in oil when red hot, and each slate to have two nails. Skylights to be put in as shewn, of strong sheet-glass of the size of 12 inches by 18 inches, fitted into zinc frames, weighing 16 ounces per square foot. The valley gutters to be covered with lead weighing 6 lb. per square foot, and 12 inches in breadth. The flat gutter between the roofs to be covered with lead weighing 6 lb. per square foot.

"The gutter at the narrow ends will be 9 inches in breadth, and the lead to rise up on the roof the usual height.

"Gutters will have declivities of 1½ inch on every ten feet of length, and to have boxes formed where shewn, 5 inches deep; to have 3-inch lead pipes soldered into the same, and carried through the beam below into the cast-iron columns. All the roofs to be upheld sound and water-tight for eighteen months after being finished.

"The whole of the work, including materials, but excluding carriages, must be performed by the day of in a most substantial and workmanlike manner, to the entire satisfaction of or any other person to be named by the employer. Any alterations that may be made in the progress of the work at the suggestion of the inspector shall be paid for, or deducted according to his estimate."

Section 3.—Principles of Arrangement.

The barn, with its thrashing machinery, and other appurtenances, naturally forms the nucleus of the homestead, and regulates the distribution of the other buildings. The command of water-power will often determine the exact site of the barn, and indeed of the whole buildings. The cheapness and safety of this motive-power render it well worth while to make considerable sacrifices to secure it, when a really sufficient and regular supply of it can be had. But the difficulty of securing this when the adjoining lands are thoroughly drained, with the great efficiency and facility of application of steam-power, are good reasons why precarious supplies of water-power should now be rated very differently than they were when a horse-wheel or windmill were the only alternatives. A very usual and suitable arrangement is to have the whole buildings, forming a lengthened parallelogram, facing south or south-east. The barn being placed in the centre of the north range, with the engine-house behind it, and the straw-house at right angles in front, with doors on both sides for the ready conveyance of litter and fodder to the yards, etc. It is always advantageous to have the barn of sufficient height to afford ample accommodation to the thrashing and winnowing machinery. When the disposition of the ground admits, it is a great convenience to have the stackyard on a level with the upper barn, so that the unthrashed corn may be wheeled into it on barrows, or on a low-wheeled truck drawn by a horse. Failing this, the sheaves are usually pitched in at a wide opening from a framed cart. The space on which the cart stands while this is going on is usually paved, that loose ears and scattered grain may be gathered up without being soiled; and it is a further improvement to have it covered by some simple roof, to protect the sheaves from sudden rain.

In several recent instances stackyards have been laid with rails, and the stacks built on low platforms set on wheels, so that each stack, as required, can be pushed close up to the barn, and the sheaves pitched from it directly to the side of the feeding board. A friend who recently visited the farm of Mr. Favell at Stockeld near Harrowgate, where this plan has been adopted, has kindly furnished the following notice of it. The rails for the stackyard are laid 7 feet 3 inches apart. On these are ranged a series of trucks, each on two pairs of wheels, the axles of which are eleven feet apart, and having a platform 20 feet long and 7½ feet wide formed of planks placed close together to prevent the ascent of vermin. On this the stack is built to the height of 16½ feet above the truck. The stacks are ranged on one set of rails only, which lead directly to the door of the thrashing machine. Mr. Favell admitted the inconvenience of having his wheat, barley, beans, and oats, all on one line, and stated his intention of having a series of rails radiating from the door of the barn.

On a farm near Hull the stackyard is fitted with rails and turn-tables in a more complete manner. Where this expedient has been adopted, the rails, trucks, etc., have usually been second-hand railway materials.

It is a good arangement to have the straw-barn fitted up with a loft, on the level of the opening at which the straw is discharged from the thrashing-mill, so as to admit of fodder being stored above and litter below. A sparred trap-door in front of the shaker retains the straw above, or lets it fall to the ground as required. This upper floor of the straw-barn is the most convenient place for fixing a chaff-cutter to be driven by the thrashing-power. The granary should communicate with the upper barn, that the dressed grain may be raised to it by machinery.

A loft over the engine-room, communicating with the upper barn and granary, forms a suitable place for fixing a grinding-mill, bruising-rollers, and cake-breakers, as it affords opportunity for having these machines easily attached to the steam-power. It suits well to have the house in which cattle food is cooked attached to and under the same roof as the engine-house. One coal store and chimney thus serves for both. Over this cooking house and communicating with the grinding loft may advantageously be placed a kiln, to be heated by the waste steam from the engine. An open shed outside the barn, for the accommodation of a circular saw, is also a desideratum. By the aid of the latter machine and a handy labourer, the timber required for ordinary repairs on the farm may be cut out at trifling expense.

The cattle-housing of whatever description, where there are the largest and most frequent demands for straw, is placed nearest to the straw-house, and in communication with the turnip-stores, and the house (if any) in which food is cooked or otherwise prepared. Where cattle are bred, the cow-house and calf-house are kept together. A roomy working court is always a great convenience, and it suits well to have the stable opening to it, and the cart-shed and tool-house occupying another side. Costly machines, such as corn-drills, require to be kept in a locked place, to preserve them from the collisions, and the loss or derangement of their minute parts, to which they are exposed in an open cart-shed.

An abundant supply of good water is a most important matter. The best source is from springs, at such an elevation as to admit of its being brought in a pipe, with a continuous flow. Failing this a well and pump is the usual alternative, although it is sometimes necessary to collect the rain-water from the roofs, and preserve it in a capacious and carefully-made tank. In every case it is desirable to have a regulating cistern, from which it is distributed by pipe to every part of the homestead where it is required. It is, in every case, of importance to have the eaves of the whole buildings spouted, and the rain water carried where it can do no mischief. Where fattening cattle are kept, in open yards with sheds, by spouting the eaves, and slightly hollowing the yards towards their centres, the whole urine is absorbed by their litter, and retained in the manure. If stall feeding is practised, a pit is required, into which the solid dung is wheeled and the liquid conveyed by drains. Liquid manure tanks are at present in universal repute, but we shall endeavour to shew, when treating of manures, that they are not such an indispensable appendage to a farm-yard as is generally asserted. In Scotland, it is customary to carry the dung from the byres into a yard in which young cattle are kept, where it is daily spread about and subjected to further treading, along with such quantities of fresh litter as are deemed necessary. That from the stables is carried into the adjoining feeding-yard, and it is usually remarked, that the cattle occupying it make more rapid progress than their neighbours.

An important part of the buildings of a farm are the cottages for its labourers. It is in all cases expedient to have the people required for the ordinary working of a farm resident upon it; and it is always much better to have families, each in their own cottage, than a number of young people boarded in the farm-kitchen, or with the farm-overseer. These cottages are usually a little removed from the other farm-buildings, and it is, on various accounts, better to have them so. There is, however, an advantage in having the cottages of the farm-steward and cattleman either within the court-yard, or close to its entrance, that these responsible functionaries may at all times be near to their charge, and especially that they may be at hand when any of the live stock require night attendance. As there are manifold advantages in having but one main entrance to the homestead, and that closed by a gate which can be locked up at night, it will be obviously necessary to have the keeper of the key close at hand to open the gate by night if required. Much more attention than formerly is now paid to the construction of cottages. The apartments are better floored, higher in the roof, and so arranged as to secure comfort and decency. Besides a small garden, each cottage is usually provided with a pig-sty and ash-pit, and in some cases with a coal-place and privy besides.

The position and style of the farmer's dwelling also claims a remark here. The approved mode used to be, to place it either directly in front or rear of the farm-yard, on the ground that the farmer would thus have his premises and cattle under his eye even when in his parlour or bedroom. As has been well remarked, "The advantages of this parlour-farming are not very apparent, the attendant evils glaringly so. If the condition of ready communication be obtained, the farm-house should be placed where the amenities of a country residence can be best enjoyed."* On all hands we now hear it urged, that it is only by men possessed of capital and intelligence that the business of farming can be rendered remunerative. Those who desire to have such men for tenants, will be more likely to succeed by providing a commodious and comfortable Farmery, pleasantly placed among trees and shrubs, than by setting it down in the precincts of the dung-heap.

* For further information on Farm Buildings, see also *Morton's Cyclopædia of Agriculture*, article "Farm Buildings," and *The Book of Farm Buildings*, by Henry Stephens and R. Scott Burn, Edinburgh, 1861.

CHAPTER III.

FENCES.

Section 1.—*Benefit of Fences.*

THE fences by which farms are generally enclosed and subdivided form another part of what may be termed their fixtures, and may therefore be suitably noticed here. When lands are let to a tenant, the buildings and fences are usually put into sufficient repair, and he is taken bound to keep and leave them so, at the issue of his occupancy. Although there are some persons who advocate the total removal of subdivision fences, it is admitted on all hands, that the farm as a whole, and the sides of public thoroughfares which may intersect it, should be guarded by sufficient fences of some kind. The general belief has hitherto been, that there is a farther advantage in having the land subdivided by permanent fences into enclosures of moderate size. The use of such partition fences is not only to confine the live stock to particular fields, or restrain them from trespassing on the other crops; but to afford shelter from cutting winds. It is now frequently urged, that the heavier cattle should never be turned to pasture at all, but kept on roots and green forage the whole year round, and that sheep can be managed satisfactorily by means of movable hurdles. It is highly probable that the practice of soiling will become more general, as it undoubtedly deserves to do. Still this does not necessarily call for the total removal of subdivision fences, which we cannot but regard as an imprudent proceeding. It is probable that those who have adopted it have done so very much owing to the prevalence of the opposite extreme. There are large portions of the finest land in England so encumbered with hedges and hedgerow trees, as to be utterly incapable of profitable cultivation. In many cases the fields are so small and the trees so large, that their roots actually meet from the opposite sides and pervade the entire surface soil of the area enclosed by them. When manure is applied to such fields, it is monopolised by these freebooters from the hedges, and the crops of grain or hay, such as they are, are so screened from the sun and wind, that there is great risk of their being spoiled in the harvesting. If drains are made in such fields they are speedily filled up by the rootlets, and thus rendered useless. It has been computed that not less than one and a quarter million acres are occupied by hedgerows in England and Wales, and that, if the land overshaded and plundered by roots be included, the amount is three millions. In Devonshire one-fourth of the enclosures in many parishes are under *two* acres; more than one-third under *three* acres, and nearly two-thirds under *four* acres. Two millions, at least, of these acres might be redeemed, and what a margin is here available for increased production. The land thus wasted would probably yield a sum equal to county and poor rates, and perhaps malt-tax too.* In such circumstances, it is no wonder that zealous agricultural improvers should look upon hedgerows much as American settlers do upon their forests, and, like them, be sometimes indiscriminate in their clearings. We believe that there is an advantage in having land, whether for pasture or tillage, subdivided into parallel-sided fields of from ten to forty acres each, according to the size of the farm, by means of permanent fences of a kind adapted to the locality.

* See *Farmer's Magazine* for March 1852, p. 253.

Section 2.—Kinds of Fences.

When the soil and climate are favourable to the growth of the common *white thorn*, hedges formed of it combine efficiency, economy, and ornament, in a greater degree than any other fence. But to have a really efficient thorn hedge, much attention must be paid to its planting, rearing, and after management. In proceeding to *run* a new line of thorn hedge, care must be taken that the soil is clean and in good heart; and that the subsoil is porous and dry. When these conditions do not obtain, they must be secured by fallowing, manuring, draining, and trenching. The young quicks should be stout and well rooted; not taken indiscriminately as they stand in the nurserymen's beds, but of uniform stoutness. Such selected plants are always to be had for a small additional price, which will be found to be well repaid in the superior progress of such plants, when contrasted with that of others taken as they chance to come to hand. The embryo fence must be kept free of weeds, and secured from the encroachments of cattle by a line of rails on both sides. Some persons advise that the young hedge should from the first be trimmed into line by using the pruning hook after each year's growth. It is certainly better not to touch it with the knife, or, at least, only to restrain an occasional shoot that unduly overtops its neighbours, until the centre stems are at least a couple of inches in diameter. If the plants are then headed over fence-high, and the lateral shoots pruned to a straight line, a close fence with a substantial backbone in it is secured; whereas by pruning annually from the first, a fence is obtained that pleases the eye, but which, consisting only of a mass of spray, presents no effectual barrier to cattle. When a thorn hedge has reached the stage just referred to, the protecting rails may be removed, and the hedge kept in a neat and efficient state by annual pruning. On good, deep soil, thorns will stand this constant removal of the annual growth of spray for many years without injury. In less favourable circumstances, it is found necessary from time to time to withhold the pruning knife for a few years together. When the hedge has been reinvigorated by such periods of unrestrained growth, it can again be cut back to the centre stems, and subjected anew to a course of annual pruning. To insure a close fence, the bottom of the hedge must at all times be kept clear of tall weeds. The constant use of the weeding-iron is however objectionable ; for, besides being expensive, it injures the bark of the thorns and thereby impairs their health. It is quite sufficient to cut the weeds close to the surface, twice a year, by means of a reaping hook or short scythe.

In arable lands, by this plan of keeping hedges about four feet high, and cutting down the weeds as required, an efficient and ornamental fence is maintained at comparatively small cost, and with little injury to the adjoining crops from shading, or the harbouring of weeds and vermin.

Although the white thorn forms a better hedge than any shrub yet tried for the purpose in this country, there are many upland situations where the beech or hornbeam grow more freely, and are to be preferred either alone or in mixture with it. These plants, and also crab or sloe, are sometimes useful in filling a gap occasioned by the removal of a hedgerow tree, or the death of a portion of thorn hedge.

In exposed situations where thorns do not thrive, *dry-stone walls* are the most usual substitute. When carefully constructed, of stones suitable for the purpose, they last a long time, and form an excellent fence. Their durability is much enhanced by having the cope-stones set in lime-mortar. A layer along the centre of the wall, and an external pointing, of lime-mortar will also repay the additional first cost thus incurred. A wall of this kind four feet high, exclusive of the cope, while quite sufficient to restrain cattle and the heavier kinds of sheep, is no barrier to the mountain breeds, which can easily clear a six-foot wall.

A simple and very effective fence has however come much into use of late years. It is composed of iron wire (No 8 being the size most commonly used), which is attached by small staples to common stakes, such as are used for wooden railings, driven firmly into the ground about five feet apart. The wire is drawn out of the coil, and the ends of the various lengths or *threads* are neatly joined by first heating them and then twisting the one into the other, until the quantity required for the stretch of fence is run out. It is then attached to every third or fourth stake by a staple, which must not be driven home. The other lines of wire are then treated in the same manner, each being attached to the stakes at such width apart as has been determined upon, and marked upon the stakes. A ready way of doing this is by stretching along the stakes a common gardener's line which has been previously rubbed with chalk, or a charred stick, and striking it against the stakes at the required heights, in the way that sawyers mark a plank. When the requisite number of wires has thus been loosely attached, they are pulled as tight as possible by the hands of the workmen, after which a screw or lever is applied to each in turn until it is made perfectly tight. As the efficiency of this kind of fence is wholly dependent on perfect tightness being obtained, a stout straining-post must be fixed securely in the ground at the end of each line of fence. This serves the double purpose of furnishing a fulcrum for the stretching instrument, and a secure attachment for the ends of the wires. When the straining is accomplished, each wire is stapled to each stake. The gates are usually hung upon these straining posts. Although wooden straining-posts are commonly used, some persons prefer iron ones, fixed into large blocks of stone. Five wires thus stretched, at an average width of six inches, form an effectual fence for the wildest sheep. They could indeed easily clear it so far as height is concerned, but they are afraid to leap at an object which they cannot see until they are close upon it. They may be seen at first walking along the line anxiously looking for an opening, and if one more bold than the others makes a run at it, he is sure to catch such a fall as effectually deters him from repeating the attempt. A cwt. of No. 8 wire costs at present 16s., and when drawn out, yields a line about 620 yards in length. Staples cost 1s. 8d. per gross; stakes ready for driving, from one penny to twopence each. With these cheap and portable materials, which any labourer of ordinary intelligence can easily put together, a fence admirably adapted for enclosing or subdividing mountain pastures is now quite attainable by every sheep-farmer, and will well repay its cost. It is equally available for protecting young thorn hedges, and generally for all purposes for which wooden railing is used. As a fence for cattle or horses, it is advisable to add a single rail of wood nailed *flat* along the top of the stakes, which must be sawn off evenly for this purpose. As compared with wooden railing, wire is much cheaper and more durable, and more easily kept in repair. It is cheaper also than stone walls, available in many situations where they are not, and a more certain barrier to agile sheep; but it is less durable, and affords no shelter.

The latter defect can in some situations be remedied by raising a low mound of turf, running the wire-fence along the top of this mound, and sowing on it the seeds of the common whin.

We have already noticed, that the fences of a farm are usually erected by the landlord, and kept in repair by the tenant. The latter is at least usually taken bound in his lease to keep and leave them in good order; but as this obligation is often very indifferently performed, and much damage and vexation occasioned in consequence, it is always expedient that a person should be appointed by the landlord to attend to the fences, and the half of his wages charged against the tenant. By such a course, dilapidation and disputes are effectually guarded against, and the eyesore of defective, ill-kept fences is wholly removed.

CHAPTER IV.

MACHINES AND IMPLEMENTS OF HUSBANDRY.

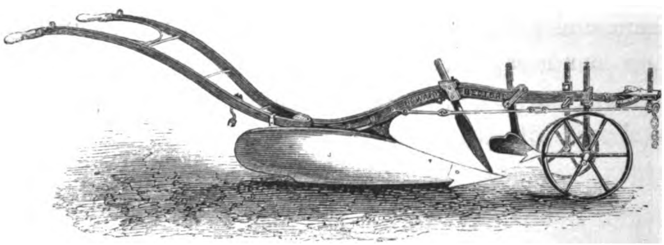
Section 1.—*Recent Improvements.*

THAT the cultivation of the soil may be carried on to the best advantage, it is necessary that the farmer be provided with a sufficient stock of machines and implements of the best construction. Very great improvement has of late years taken place in this department of mechanics. The great agricultural societies of the kingdom have devoted much of their attention to it; and under their auspices, and stimulated by their premiums and exhibitions, manufacturers of skill and capital have embarked largely in the business. In many instances the quality of the article has been improved and its cost reduced. There has hitherto been a tendency to produce implements needlessly cumbrous and elaborate, and to introduce variations in form which are not improvements. The inventors of several valuable implements, the exclusive manufacture of which they have secured to themselves by patent, appear to have retarded their sale, and marred their own profits by the exorbitant prices which they have put upon them. Some, however, have become alive to the advantages of looking rather to large sales with a moderate profit on each article, and of lowering prices to secure this. A most salutary practice has now become common of inventors of implements of ascertained usefulness granting license to other parties to use their patent-right on reasonable terms, and thus removing the temptation to evade it by introducing some alteration which is trumpeted as an improvement, although really the reverse.

The lower price and extended use of iron in the construction of agricultural implements is materially adding to their durability, and, generally to their efficiency, and is thus a source of considerable saving. While great improvement has taken place in this department, it too commonly happens, that the village mechanics, by whom a large portion of this class of implements is made and repaired, are exceedingly unskilled, and lamentably ignorant of the principles of their art. They usually furnish good materials and substantial workmanship, but by their unconscious violation of mechanical laws, enormous waste of motive power is continually incurred, and poor results are attained. This can probably be remedied only by the construction of the more costly and complex machines being carried on in extensive factories, where, under the combined operation of scientific superintendence, ample capital, and skilled labour, aided by steam-power, the work can be so performed as to combine the maximum of excellence with the minimum of cost.

Section 2.—*Ploughs.*

We begin our brief notice of the implements of the farm with those used for the tillage of the soil. Of these the first place is unquestionably due to the plough. A history of this implement, tracing its gradual progress from the ancient Sarcle to its most improved form at the present day, is necessarily a history of Agriculture. So much is this the case, that a tolerably correct estimate of the progress of the art in any country, whether in ancient or modern times, may be formed by ascertaining the structure of the plough. Much attention has been paid to its construction in Britain for the last hundred years, and never more than at the present day. After all that has been done, it is still, however, an unsettled point, which is the best plough for different soils and kinds of work; and, accordingly, many varying forms of it are in use in those parts of the kingdom which have the reputation of being most skilfully cultivated. Ever since the introduction of *Small's* improved *swing-plough*, the universal belief in Scotland, and to a considerable extent in England, has been, that this is the best form of the implement. Wheel-ploughs have accordingly been spoken of by Scottish Agriculturists in the most depreciatory terms, and yet it turns out that this has been nothing better than an unfounded prejudice. For when subjected to careful comparative trial, as has been frequently done of late, the balance of excellence is undoubtedly in favour of the plough with wheels. Its advantages are, that it is easier of draught



HOWARD'S CHAMPION PLOUGH.

—that the quality of its work is better and greatly more uniform than can be produced by a swing plough—that in land rendered hard by drought, or other causes, it will enter and turn over even furrows where its rival either cannot work at all, or at best with great irregularity and severe exertion to the ploughman; and lastly, that its efficiency is independent of skill in the ploughman. This last quality has indeed been usually urged as an objection to wheel-ploughs, as their tendency is said to be to produce an inferior class of workmen. Those who know the difficulty of getting a field ploughed uniformly, and especially of getting the depth of furrow specified by the master adhered to over a field, and by all the ploughmen, can best appreciate the value of an implement, that when once properly adjusted will cut every furrow of an equal width and depth, and lay them all over at exactly the same angle. The diversity in the quality of the work at those ploughing competitions, to which only the picked men of a neighbourhood are sent, and where each may be supposed to do his very best, shews conclusively how much greater it must be on individual farms, even under the most vigilant superintendence. In every other art the effect of improved machinery is to supersede manual dexterity; and it does seem absurd to count that an objection in agriculture which is an advantage in everything else. There is more force in the objection that wheel-ploughs are inferior to swing ones in ploughing cloddy ground, or in crossing steep ridges, and that they cannot be used for forming drills for turnip or other crops. This objection vanishes when it is known that in the most improved wheel-ploughs, the wheels can be laid aside at pleasure, and that they can then be used in all respects as swing-ploughs. A mould-board, somewhat higher and wider behind than that best adapted for ordinary work, is required for forming turnip-drills. This, however, is easily managed by having two distinct mould-boards for each plough. An important feature in the English ploughs is, that they are fitted with cast-iron shares, which being case-hardened on their under surface, wear unequally and so preserve a sharp edge. The necessity for daily recourse to the smithy is thus removed, and along with it, that irregularity in the quality of the work and draught of the plough, which so often arises from witting or unwitting alterations being made in the *set* of the share in the course of its unceasing journeys thither. These cast-iron shares are slightly more brittle than those made of malleable iron with steel points; but it is of importance in determining their comparative merits, to bear in mind that the prime cost of the former—10d. to 1s. each—is so small as to render them at the year's end the least expensive of the two. When it is desired to turn a very deep furrow, a plough is used differing from the common one only in being somewhat larger and stronger in all its parts, with four horses to draw it.

Ploughs which break and stir the subsoil, without bringing it to the surface, by following in the wake of the common plough, are now much used. The first of the kind—the invention of the late Mr. Smith of Deanston—is a ponderous implement, requiring at least four good horses to draw it. It is well adapted for displacing and aiding in the removal of earth-fast stones. The inventor has happily described its operation by terming it a "horse pick." Read's subsoil-plough is a much lighter implement, which can usually be drawn by two horses. Since the introduction of thorough draining, it is found beneficial to loosen the soil to a much greater depth than was formerly practicable, and this class of implements is well fitted for the work. But this laborious operation is too costly and tedious to admit of its ever being practised as generally as its usefulness demands until steam-propelled implements can be used for the performance of it.

Broadshare or paring ploughs are much used in various parts of England in the autumn cleaning of stubbles. A broad-cutting edge is made to penetrate the soil to the depth of three or four inches, so as to cut up the root-weeds which at that season lie for the most part near the surface. These, as well as the stubble, being thus detached from the firm soil, are removed by harrowing and raking; after which, the land is worked by the common plough. An implement of this kind is frequently used in carrying out the operation of paring and burning. Bentall's Broadshare has the reputation of being the best of its class; but we can confidently recommend the common plough, stripped of its mould-board and fitted with a share twelve inches broad, as not only the cheapest but decidedly the most efficient scarifier that has yet been used.

Various implements of the plough type, so modified as to adapt them for particular processes, have from time to time been offered to public notice, but have failed to meet with general favour. We limit our notice to those of ascertained utility, and refer the reader who desires fuller information, to "Ransome's Implements of Agriculture,"* and the more recent work by Messrs. Stephens and Scott Burn, where he will find descriptions of the most interesting of them.

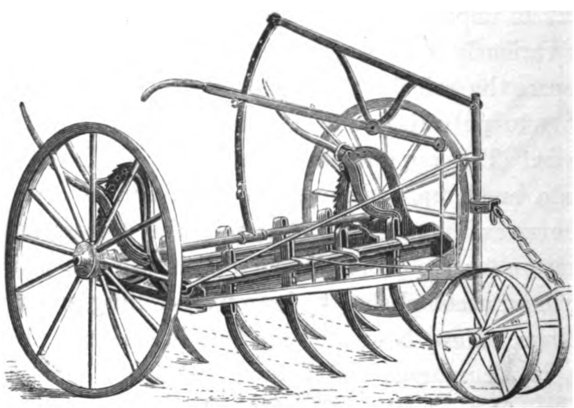
Section 3.—*Grubbers, etc.*

Next in importance to the plough, is the class of implements variously called grubbers, cultivators, or scarifiers. To prepare the soil for the crops of the husbandman, it is necessary to pulverize it to a sufficient depth, and to rid it of weeds. The appropriate function of the plough is to penetrate, break up, and reverse the firm surface of the field. This, however, is only the first step in the process, and does but prepare for the more thorough disintegration which has usually been accomplished by harrowing, rolling, and repeated ploughings. Now, however excellent in its own place, the plough is a cumbrous and tedious pulverizer, besides needlessly exposing a fresh surface at each operation, and cutting the weeds into minute portions, which renders their removal more difficult. These defects were long felt, and suggested the desirableness of having some implement of intermediate character betwixt the plough and harrow, which should stir

* *The Implements of Agriculture* by J. Allen Ransome, Lond. 1843. *The Book of Farm Implements and Machines* by Henry Stephens and R. Scott Burn, Edin.

the soil deeply and expeditiously without reversing it, and bring the weeds unbroken to the surface. The whole tribe of grubbers, etc., has arisen to meet this demand, and we shall now consider the comparative merits of the more prominent of the group. The first notice is due to Finlayson's harrow, which, as improved by Scoular, was, until recently, the best implement of its kind. Its faults—and they attach equally to Kirkwood's and Wilkie's—are, that it is severe work for two horses, is liable to choke in turfy or foul ground, and that it consolidates the bottom of the furrow, while producing a fine tilth on the surface. Finlayson's grubber, in its improved form, weighs about five cwt., and costs as many pounds.

Another useful implement of this class which enjoys a large reputation in England is Biddle's scarifier. It is mounted

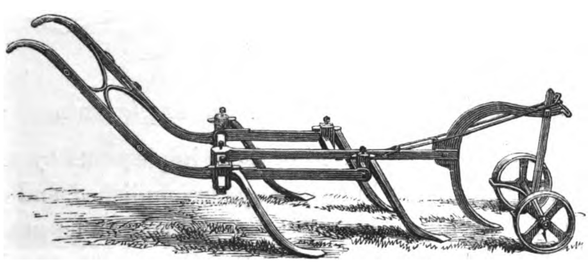


BIDDLE'S SCARIFIER, AS MADE BY RANSOME AND CO.

on four wheels; two small ones in front and two much larger behind. The frame and tines are of cast-iron, and can be raised and depressed at pleasure by means of two levers which regulate the depth to which the tines shall penetrate. The tines are prepared to receive case-hardened cast-iron points of different widths, or steel hoes of nine inches width so that the implement can be used for breaking up and paring the surface, or for grubbing out weeds and pulverising the soil, as may be required. An important feature in this scarifier is, that it keeps its hold of a hard surface much better than a plough. It weighs half a ton, is drawn by four or six horses, and costs about £18.

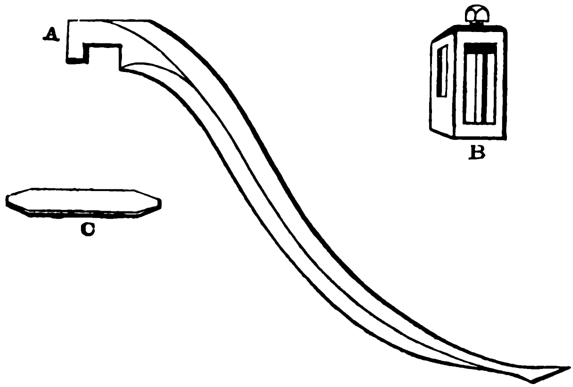
The *Ducie* or Uley cultivator has many features in common with Biddle's, and although brought forward as an improvement upon it, has not established its title to be so regarded. The great weight, high price, and amount of horse-power required to work them, are serious objections to all of these implements.

Of more recent notoriety than these, and contrasting with them favourably in these respects, is an implement invented by Mr. John Tennant, at Shields, near Ayr, and now popularly known as Tennant's grubber. Its construction, as the annexed cut will shew, is simple in the extreme. Its weight is about two cwt., its price £4, 10s., and its draught



TENNANT'S GRUBBER, AS IMPROVED BY T. BROWN, EDINGTON.

easily overcome by two horses. The depth at which it works is regulated by raising or lowering the shank which supports its wheels in front. Its tines can be easily moved on their supporting bars, and it may be worked with five or seven as desired. By substituting a shorter hind bar, and setting the tines more closely together, it makes a most efficient drill grubber. We shall have occasion to refer to this implement frequently in treating of tillage operations. The improvement which Mr. T. Brown has made on Tennant's grubber consists mainly in the mode of attaching the tines to the bars. This attachment, which the cut explains, has the merit of being at once very simple and very effectual. The tines when thus fixed are as rigid as if welded to the bars, and yet, by merely slackening the screws and driving out the wedges, they can with ease and rapidity be either adjusted at varying widths apart, or detached for repair.



A TINE, B KEEPER, C WEDGE, ⅛ ACTUAL SIZE.

Section 4.—Steam-Power Tillage Implements.

Such are the most important of those implements by which the tilling of the soil has hitherto been accomplished, and upon which the farmer must continue to rely so long as he uses the muscular force of animals as his motive power. But we have now reached a point at which the progress of invention has at last made the steam engine practically available for this purpose, and accordingly we here introduce some notice of what has now been accomplished in applying steam power to the cultivation of the soil. The attainment of this object is sought in several ways.

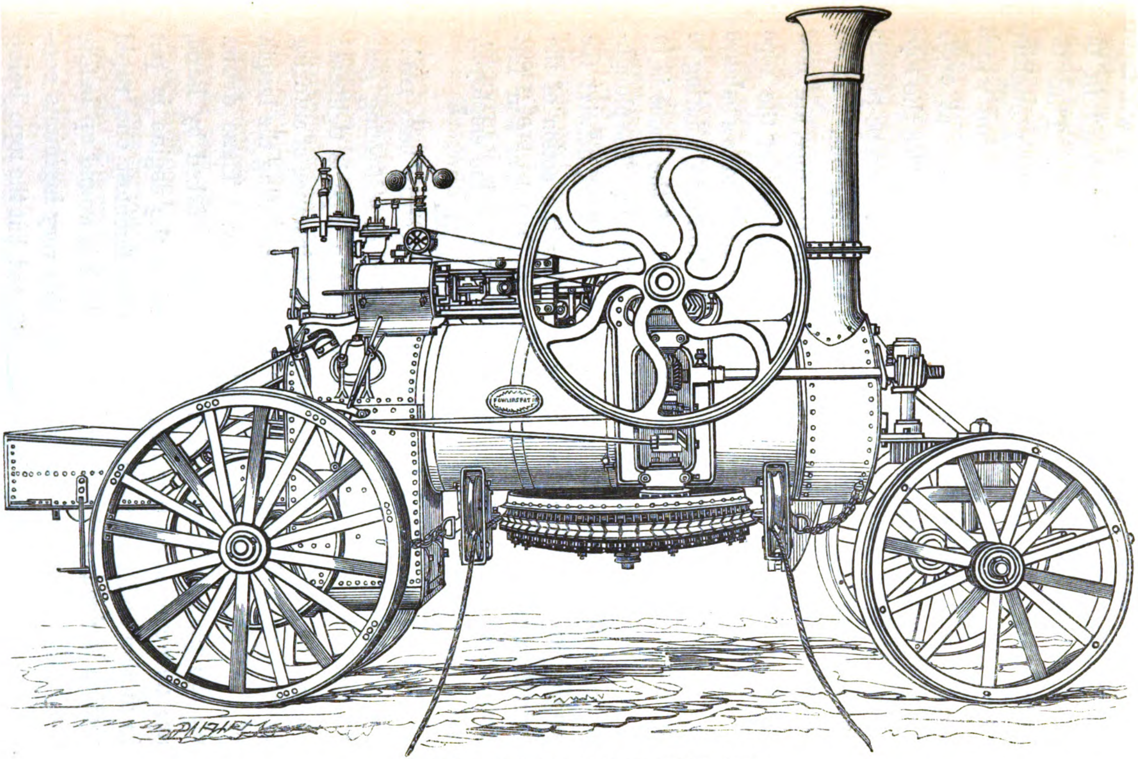
1st, By portable engines—locomotive or otherwise—which by means of a system of windlasses, anchors, and wire ropes, haul ploughs, grubbers, or other implements to and fro across the land to be operated upon.

2d, By locomotive engines propelling themselves over the land, and giving motion to a transverse shaft or cylinder armed with shares, tines, picks, or other instruments, which, working in the wake of the engine, break up and comminute the soil. This principle of action has been ably advocated by Mr. Hoskyn, and is exemplified in the machines brought out by Usher, Romaine, Ricketts, and others, none of which, however, have yet got beyond a few experimental trials of dubious issue. The enormous waste of power incurred in moving a ponderous engine and appendages over the land seems to preclude the hope of ever attaining success by this mode.

3d, By laying down permanent rails over a farm, at widths of 30 to 50 feet apart, and by means of pairs of locomotive engines and their connecting platform working on these rails, to conduct the whole operations of tilling the soil, manuring, drilling, hoeing, watering, and ultimately harvesting the crops produced upon it. This is done by Halkett's *guide-way* system, which has been tried on a small scale near London. The excessive cost seems to present an insuperable objection to the adoption of this system.

The first of these modes is that which obtains most favour with practical farmers, and indeed is the only one which up to this time is really available for actual service in the fields. Various parties have from time to time, with more or less success, attempted to use steam power for hauling the ordinary tilling implements of the farm; but it is only of late that any of their inventions have attained to such a position as to warrant business men to embark their capital in the purchase of an apparatus necessarily very costly. Of the numerous inventions of this kind now before the public, two, namely, that of Mr. John Fowler of Cornhill, London, and that of Mr. Smith of Woolston, Bedfordshire, have undoubtedly attained to this position, as is proved by the fact that in the spring of 1861 about sixty of Mr. Fowler's engines and tackle, and about one hundred of Mr. Smith's, were actually at work in various parts of England. The purchasers, who, for the most part are tenant farmers, have most of them written to the inventors to express their entire satisfaction with the working of these engines. It is very interesting to find that these purchasers are chiefly located in clusters; the explanation of this fact being, that when one farmer in a district has adopted steam tillage, his immediate neighbours, after watching his proceedings for some time, by and bye follow his example. Altogether there are probably not less than two hundred steam ploughs of one kind or another now at work in Great Britain.

The steam plough of Mr. Fowler claims the first notice, both on the ground of priority of date, and because to it have been awarded the prizes offered by our National Agricultural Societies for the most successful application of steam power to the tilling of the soil. Mr. Fowler's first efforts were directed to the production of a draining apparatus, and it was after mastering this apparently more arduous effort that he adapted his tackle to the hauling of tillage implements. In its most recent form Mr. Fowler's apparatus consists of a locomotive steam engine with a windlass attached to it under the boiler. Around this windlass an endless steel-wire rope passes with a single turn in a most ingeniously constructed groove, which, by means of hinged clips, lays hold of nearly the entire circumference of the rope, and that with a force proportioned to the strain upon the rope, which thus obtains sufficient grip to convey the necessary hauling power without risk of slipping upon the drum. This wire rope, which requires to be just twice as long as the field to be tilled is wide, passes round a sheave upon a self-acting anchor placed at the farther side of the field opposite to the engine. This anchor is a prominent feature in Mr. Fowler's apparatus. It consists of a low truck on four wheels, with sharp disc edges, which cut deeply into the soil, and thus obtain a hold sufficient to resist the strain of the wire rope. A box, loaded with stones, is fixed on the outer side of this truck to hinder it from canting over. The



FOWLER'S LOCOMOTIVE ENGINE WITH CLIP DRUM.

sheave mounted upon this truck, besides serving its primary use, gives motion, when required, to a drum, which winds up a rope, the other end of which is fixed well a-head in the direction in which the truck is required to move. Thus the apparatus warps itself along the headland as the ploughing progresses, and is kept always vis-a-vis to the engine which moves itself forward by its own locomotive power at every bout of the ploughs, and keeps abreast of them. That the rope may not drag upon the ground, friction rollers, or rope-porters as they are called, are placed at suitable intervals. These being mounted on wheels and strung upon the rope, are now in a good measure self-acting, as the tautness of the rope keeps them in its own line. The ploughs are fixed to a balance frame carried on two wheels, and are in duplicate, pointing to each other, so that when the set at one end of the frame is in work, the opposite set is carried aloft in the air. The plough-frame is thus hauled to and fro across the field, betwixt the engine and movable anchor, by reversing the action of the windlass, and it is adapted for taking two, three, or four furrows at once, according to the power of the engine employed, or the nature of the soil that is operated upon.

A very important improvement has recently been made on the plough frame by the introduction of self-acting gear for actuating the two drums by which the rope is tightened or slackened, as the case requires, at each instance of entering the plough at the land's end, and in accommodating the length of the rope to a varying length of furrow. These drums on the plough frame, which at first were worked by hand, are now connected together, so that when the engine is put in motion and the strain comes upon the foremost one, rapid motion is given to the other, and the slack is wound up before the plough frame can move on. By this very ingenious contrivance not only is a saving of ~~line~~ effected, but the rope being always kept tight a few rope porters easily suffice to keep it clear of the ground, and so avoid the waste of power and

Time /

damage to the rope which unavoidably ensue when it drags upon the ground. And what is perhaps of equal importance, when the plough encounters earth-fast stones, the shock is so distributed over the entire rope and all its bearings, that the risk of breakage is almost neutralised.

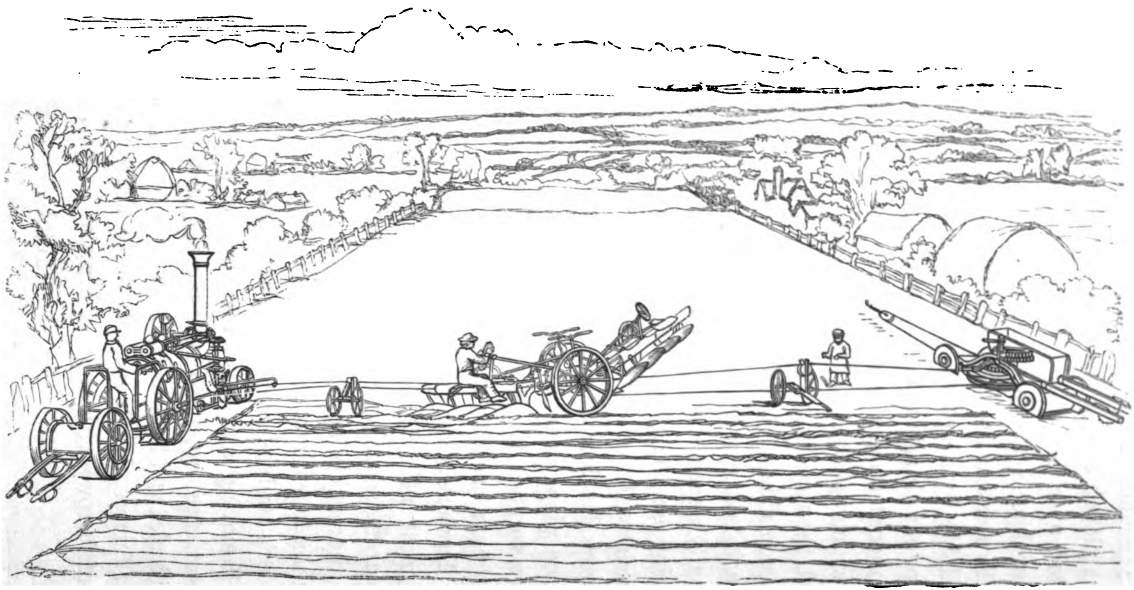
Mr. Fowler has now also made his apparatus more generally available by adapting it for attachment to the ordinary 8-horse power thrashing engine. When thus used the clip-drum is mounted on a separate frame and connected with the engine, which being stationed in a corner of the field to be ploughed, the rope is carried to *two* of his self-acting anchors, one at each side of the field, and thus encloses a triangle. The plough is drawn to and fro betwixt these anchors, and as it gradually approaches the engine at each successive bout, the gearing on the plough-frame tightens up the rope and accommodates it to the diminishing length required.

To work Fowler's apparatus there is required one engine-driver, one ploughman, a stout lad to attend to the anchor, two boys to shift the rope-porters, and a horse and boy to supply the engine with water and fuel.

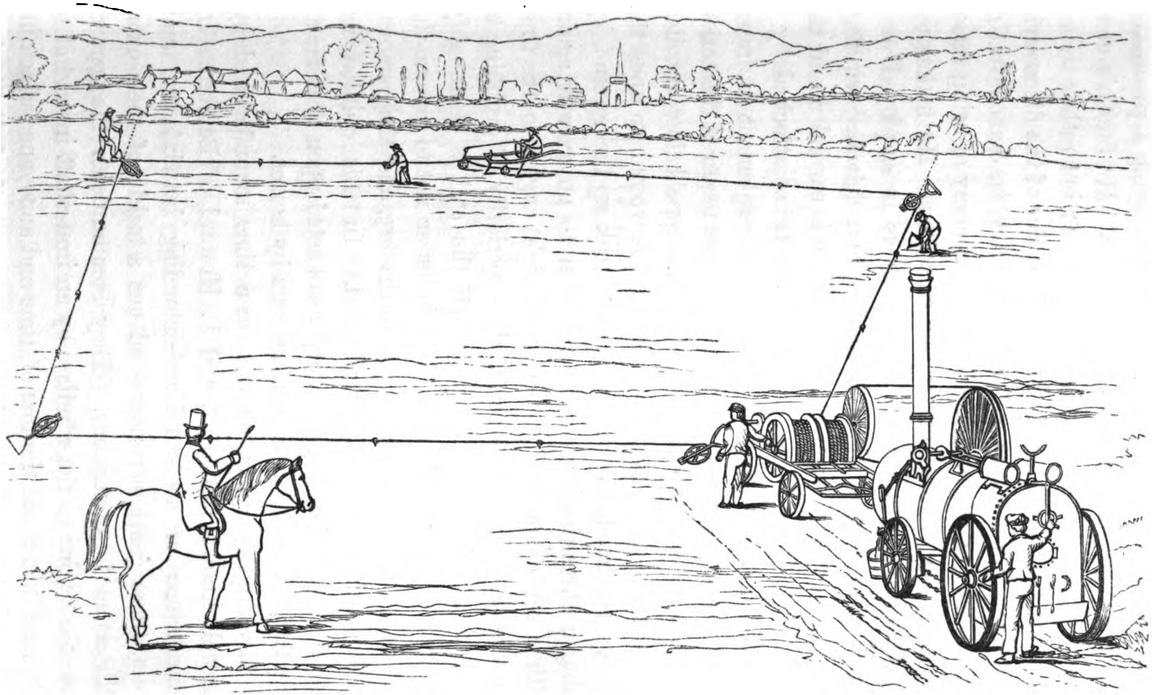
Mr. Fowler's plough readily admits of being converted into a most efficient cultivator by merely removing the mouldboards and using a separate set of shares. When thus used it thoroughly breaks up and comminutes the soil to a uniform depth without reversing the surface.

Fowler's twelve-horse engine and tender (double cylinder) with self-moving and reversing gear, windlass, anchor, 800 yards best steel rope, 20 rope-porters, headland ropes, two snatch-blocks, and field-tools, costs . .	£699	0	0
Four-furrow plough (adjustable to different widths of furrow) with scarifier breasts . .	81	0	0
Total . .	780	0	0

The best quality of steel rope, 6—6, No. 15, for 12-horse engine, costs £11 : 7 : 9 per 100 yards.



FOWLER'S STEAM-PLOUGH AS AT WORK.



SMITH'S STEAM CULTIVATOR AS AT WORK.

We have already referred to Mr. Smith of Woolston Bedfordshire, as, next to Mr. Fowler, occupying a prominent position in connection with steam tillage. Mr. Smith's merit is not largely that of an original inventor; but rather that of a zealous, persevering, and successful applier of the discoveries of others. He deserves well of his country, for demonstrating as he has done, the practicability and economy of using steam power in the ordinary cultivation of a farm. He makes use of the ordinary portable engine, such as is employed as a thrashing power, which gives motion to a detached windlass with two drums, from which a wire rope is carried round the area to be operated upon. This rope being attached by a turning bow to a powerful grubber, the implement is drawn to and fro across the field by reversing as required the action of the windlass, the slack half of the rope being uncoiled from the one drum, as the part in work is wound up upon the other. His mode of working is to break up the ground, by using a three-tined grubber, and then to go over it again, with a seven-tined one, working at right angles to the first. Mr. Smith zealously advocates the superiority of grubbing to ploughing, being of opinion that if the soil is thoroughly broken up to a sufficient depth, it is better not to reverse the surface, as weeds are thus kept on the top, and the removal of them thereby greatly facilitated. In this opinion we entirely concur, having for many years acted upon it as far as is practicable, with implements drawn by horses.

Mr. Smith's apparatus, was for a time manufactured by the well known firm of J. and F. Howard, of Bedford. In consequence of some misunderstanding betwixt him and them, these gentlemen now send out a tackle of their own, with some improvements. They communicate the power from the engine to the windlass by an iron shaft instead of a belt, and thus avoid the loss of time and annoyance which in wet or windy weather was apt to occur from the belt slipping or coming off. They have also introduced a self-acting drag, which acts upon the drum which for the time being is giving out the slack rope, and by retarding its motion serves to keep it tight and off the ground. Their grubber is so constructed as not to need to be turned at the ends, in working it to and fro upon a field, by having the tines in the form of a letter T reversed (⊥), and thus a set of points looking both ways. They have also introduced a plough-frame on four wheels, the ploughs being attached to a horizontal shaft, a half turn of which brings the one set or the other into action as required.

To work this system, there are required one engine driver, one ploughman, two men to shift the anchors, one boy to attend to the rope-porters, and one boy and horse for water cart.

A set of this apparatus consists of

The New Patent Windlass.	2 Wood Anchors.
1400 yards of Steel Wire Rope.	30 Improved Rope-porters.
New Patent double-action Steam Cultivator.	1 Rope Coiler.
	2 Beetles.
6 Snatch Blocks, including a	3 Wood Levers.
Patent Double Snatch Block.	2 Crow Bars.
8 Iron Anchors.	1 Connecting Chain.

In the prolonged trial of steam ploughs which took place at Leeds in July 1861, under the auspices of the Royal Agricultural Society of England, the competition was mainly betwixt Fowler's and this modification by Howard, of what is popularly known as Smith's system. The award of the judges was as follows:—"The £100 prize offered for the most economical application of steam-power to the cultivation of the soil, was awarded to Mr. Fowler for his 12-horse-power engine, moving anchorage, and plough; and of the £100 offered for the most economical application of the ordinary thrashing engine of the farm to steam cultivation, £75 was given to Mr. Fowler and £25 to Mr. Howard. Besides these a silver medal is given to Mr. Hayes, for his clever windlass for the same purpose; and the same to Mr. Roby for his combined engine and windlass."

Steam-power tillage is still of too recent introduction to admit of a thoroughly reliable statement being presented of its actual cost per acre, or of a satisfactory comparison of it in all respects with horse-power tillage. In every instance the purchaser and his servants have had to learn the use of the machinery, often at the cost of many avoidable breakages and much waste of time. In a few instances, when the purchaser either was not able to give his personal superintendence, or lacked the energy and perseverance which are requisite to overcome the difficulties inseparable from almost any new enterprise, these machines have proved a failure. But with these very few exceptions the parties who have tried steam-power tillage with one consent testify to the great superiority of the work so performed over anything that can be done by horse-power. During the summer and autumn of 1861, Mr. J. C. Morton, editor of the Agricultural Gazette, has personally inspected the farms of many of these parties, and has published from time to time in that paper detailed accounts of his own observations and of the information supplied to him in regard to each case. In his "New Farmer's Almanac for 1862," he has condensed these reports, and from it we give the following extracts:—

"A light land farm near Carshalton, Surrey (Fowler's apparatus).—A thirteen horse farm, and a light land farm as well, is hardly the place for the steam plough. Nevertheless, two years' experience of the steam plough on such a farm has amply satisfied the occupier—a tenant farmer—that his enterprise has been successful—that on the lightest soil there is a great advantage in being able to make the full use of good seasons for cultivation, and in ability to plough 12 inches deep, even though chalk and flint be every now and then thrown upwards to the surface. And he now declares that on entering a farm, even though no larger than 400 acres and those light soil, he would as a first investment spend £700 or £800 on a steam plough.

"Little Woodcote farm lies—a tract of open country and light calcareous soil of various depth—upon the chalk, about a mile from the Carshalton station on the London and Epsom railway. Mr Arnot has had Fowler's 10-horse-power steam-engine and ploughing apparatus since the harvest of 1859. His apparatus, rope, and engine cost £700. He works a three-furrow plough. The work done each year by the steam plough on this 400 acre farm has thus been 393 acres in 1859-60, and 389 acres in 1860-61. It has been done at the rate of six or seven acres a day for ordinary ploughing, and three acres a day (one acre per furrow) when at the 10 and 12-inch deep work. It may average on the whole five acres a day, including all stoppages and removals, and has thus taken close upon eighty days for its accomplishment. Besides this, however, 150 acres have been ploughed during the time for neighbours, at a charge, including everything, of 12s. an acre. The engine is also used for thrashing purposes, and 220 acres at home, and 250 acres elsewhere, are thus thrashed out for hire.

"The cost of repairs has been uncommonly small—including a new cogwheel, repacking cylinders, and a thorough overhaul and cleaning of the whole apparatus at the end of two years —besides the replacement of shares and sharpening of coulters for the plough, and the gradual wearing of the rope-porters. In all it has not nearly reached £10 a year, at which, nevertheless, we put it. The tear and wear of rope is reported as follows:—A new 400-yard rope, lately bought, costing £35, has made the stock stronger and better than it was at the beginning. This charge may therefore be put against more than two years' work, and is equal to about £15 a year. The weekly cost of labour when at work is as follows:—Engineer, 18s.; ploughman, 14s.; anchor lad, 9s.; two porter lads, 6s. each; horse and water-cart, about 24s. weekly—in all, £3 17s. weekly, or as nearly as possible 12s. a day. The cost for oil is 1s. a day, and for fuel, at nine or ten cwt. a day, it may be put at 10s. daily. The charge for depreciation at 10 per cent is £70 a year, and for interest of capital £35 a year. The whole annual cost may thus be estimated:—

"Labour, 80 days	£48
"Fuel and oil	44
"Repairs and rope	25
"Depreciation and interest of capital	105
"Total	£222

"But 500 acres of thrashing, and 70 or 80 acres per annum of steam ploughing for hire, equal in all to at least forty days' work per annum, are also done by this engine. And the profits of this work should be deducted from this sum before Mr. Arnot's experience of his investment can be accurately described. The sum of £222, at which if there had been no other use for engine and apparatus his cost must have been estimated, is equal to 11s. per acre over the work accomplished, much of which, however, was 12 inches deep. But if the proper share of the interest and depreciation of capital be charged upon its work elsewhere for hire, the cost of steam ploughing will not exceed £190, or 10s. 6d. an acre. But Mr. Arnot would contend that the engine is not £30 worse than when he purchased it two years ago; and one-half of this, with interest of capital, will amount to £50, two-thirds only of which should be charged against the plough-work—and £150 would thus appear to be the annual cost of ploughing 400 acres, or 7s. 6d. an acre. In fact, he might very well claim that this sum should be still further reduced by all the profit of his hire elsewhere, which can hardly be put at less than 20s. a day, and this on forty days per annum will amount to £40 or more;

so that the net cost to him of his machinery has not been more than £110 a year, or 5s. 6d. an acre over his ploughing.

"What did it use to cost him when he worked thirteen horses on his farm? He now works six horses. His horses get 2½ bushels of oats, and 2½ trusses of hay weekly each, during seven months:—

"30 weeks at 11s. amount to . . .	£16	10	0
"22 weeks on clover, etc., at 5s. . .	5	10	0
"The annual food per horse costs	£22	0	0

"The annual charge for depreciation, farrier, blacksmith, saddler, and implements, is at least £5 per horse, and for interest of capital in horse and implements, at least £2 more. This makes the annual cost of each horse £29. The wages paid, in cash and cottage, to ploughmen is at least £32 per pair, or £16 per horse, and the whole cost is thus equal to £45 per horse per annum; which, over seven horses, amounts to £315 per annum—one half more than the expenditure, even on the highest estimate, upon the engine which has displaced them, and nearly double what Mr. Arnot has actually incurred when he deducts his profits on its hire.

"A clay land farm near Bedford (the Woolston or Bedford apparatus), the Tithe Farm of Stevington, occupied by Mr. William Pike, is a tract naturally of poor clay soil. The extent farmed by Mr. Pike has till lately been about 475 acres, of which 357 were arable; and fifteen horses were employed, in five three-horse teams, upon this extent. Now, about 600 acres are farmed, of which 420 acres are arable; and the whole is managed with ten horses and an eight-horse power engine, working grubbers on the Woolston system. If the additional land requires the same horse-power per 100 acres as was needed on the original farm, then in place of ten horses, seventeen or eighteen must have been needed, and probably Mr. Pike's mere saving by the use of his 8-horse engine and cultivating apparatus does not fall short of £300 a year.

"The present cropping of the land is as follows:—125 acres are in wheat, of which 105 were partly after beans, cross-grubbed by steam-power before sowing, and partly after clover, having been cross-grubbed also by steam-power more than once before the previous harvest time, and then horse scarified and harrowed. The remainder was after horse-cultivation. There are 60 acres of beans after wheat, its stubble having been dressed with farm-yard dung, and then ploughed by horse-power. There are 60 acres of grass and clover; 20 acres now in vetches have been cross-grubbed after a manuring; 25 acres in mangolds and turnips have been cross-grubbed in autumn, and again steam-scarified and crossed in spring; 50 acres in barley, and 25 acres in oats, make up the extent of the farm, and were got in after steam-cultivation.—By "cross-grubbing" it is meant that the operation was repeated.

"More horse cultivation than usual was done in 1860. Clay land was fit only on rare occasions, and both horse and steam-power were then used to the utmost. Mr. Pike has had Mr. Smith's grubber worked by an ordinary thrashing-engine since July 1858. Since that time 731 acres have been cross-grubbed, *i. e.*, doubly-worked. In addition to this Mr. Pike informs me that he has also cross-grubbed for hire 300 acres of land. For this he charges 25s. an acre, the coals being supplied to the employer.

"Excluding this item from our consideration in the meantime, and assuming that 730 acres—double cultivated between July 1858 and June 1861—correspond to 250 acres annually, the average performance of the engine, including all stoppages except removals, has been six acres daily once cultivated. To do 250 acres twice would therefore occupy at least eighty-three days; adding three days for removals, there are eighty-six days' work of the steam engine to be charged upon the steam cultivation of the farm. The following is the labour and its cost per week:—1 engineer, 16s.; 1 ploughman, 11s.; 2 men shifting anchors, 22s.; 1 man at windlass, 12s.; 1 porter boy, 6s.; 1 boy and horse with water cart, 24s.: the whole amounts to £3, 19s., or 13s. 2d. daily. In addition to this we add the cost of coals, 10 cwts. at 19s. a ton on the ground, or 9s. 6d. daily. The oil at 5s. a gallon costs about 1s. a day.

"The daily cost thus comes to 23s. 6d., and this over eighty-six days amounts to about £100. Against the engine and apparatus, costing about £510, we must put 10 per cent, or £51, for depreciation, and 5 per cent, or £25, 10s. for interest of capital. The cost of repairs may perhaps be satisfied by an annual charge of £15; and for tear and wear of rope we have the following items: 1400 yards of iron wire rope originally purchased, £50; steel ropes, 1400 yards, since purchased, £60. Probably the annual charge needed to maintain this may be made on the theory that the rope will last three years, and £25 a year may suffice for this particular. Adding up these items, we have a sum total of £216, 10s. to be charged against the farm for steam cultivation. Putting £216 against 500 acres once grubbed in the course of the year, we have a charge of about 8s. 7d. an acre for the grubbing. Mr. Pike informed me that, during the three years of his steam cultivation, on several of the ten fields already specified, he has not used the plough at all. Even the mixing of manure with the soil is done by the grubber. No plough is used to bury it. It is laid upon the land, and grubbed to and fro, and thereby mixed sufficiently. The cleanness of the land, too, is a fair testimony to the quality of cultivation by implements which stir, but do not overturn the soil.

"Mr. Pike has till lately used the grubber invented by Mr. Smith of Woolston, with the turnbow apparatus for turning the tool at the land's end. Latterly he has used the cultivator of Messrs. Howard, each tine of which is double, pointing both fore and aft, so that no turning at all is needed, the claw which follows in the wake of the working tooth as it goes coming into operation in its turn as it comes back again."

Mr. Pike thus writes to Messrs. Howard, of date December 2, 1861 :—

Gentlemen—I have cultivated my farm by steam power for the last four years, and therefore feel myself in a position to speak positively of the merits of the system.

My farm, belonging to the Duke of Bedford, consists principally of poor, strong, hilly, clay land, which, before I entered upon it, was laid up in three yard ridges, with water gutters drawn across the ridges to take off the water. Since I have steam-cultivated it, I have done away with ridges and furrows entirely; my fields of 40 and 50 acres each, which are steep in places, are all laid on the flat, and during the wettest season, I have never seen any water stand upon them. I am convinced if land is broken up a good depth by the cultivator, and under drained, there is no need of any furrows, if it is ever so strong.

I am enabled to manage my farm with about half the number of horses. I do it with less trouble to myself. I am always more forward with my work, and the horses I do keep *cost much less* per head than formerly, as all the *hard work* is done by steam.

The effect of deep stirring this soil is very apparent in the crops; my land is naturally very poor, so that very large yields are out of the question, but I am convinced I can grow much more corn by steam than by horse cultivation, and I can also grow a larger breadth of root crops. I also find that by constant deep tillage, my land moves easier every year, consequently it is less expense to cultivate. I seldom use the plough, except my horses have got nothing else to do.

I break up my clover lays before harvest, and make a *bastard* fallow of them. I am convinced this is the surest way of getting a good wheat crop on strong soil; and, besides cleaning the land, it has this advantage, it does not leave so much work to do at Michaelmas. I also break up my tare land before harvest, so that, after harvest, I have nothing to do but cultivate my bean and wheat stubbles.

I put away my tackle as soon as possible after we have heavy rains, the latter part of October or beginning of November, and do not bring it out again until the turnip land is ready to break up for barley.

My object is to make the best use of the summer and the early autumn.

When I commenced cultivating by steam, I used to set down to little pieces, but I found *that* too much trouble, therefore increased the length of my ropes, as I found it made very little difference to my 8-horse engine, whether I had out a long or short length of rope. I have now sufficient to do a 50 acre field, without moving either engine or windlass; this is my largest field; I dug a pond at one end, and I do the whole without moving from the pond. When I can, I set my engine and windlass in an adjoining field, so as to finish headlands and all complete, without going into it. Water carting is a great expense, and in a wet season, a great nuisance. I therefore have dug some ponds, and sometimes I dam up a ditch or master drain, to obtain a supply.

I am particularly pleased with the new apparatus you made for me last spring. The windlass is much easier moved about, and is very simple to manage. The cultivator takes less time at land's end, there is no danger of overturning, it does not jump so much in work, and the hind shares cause the land to lay looser. No matter how hard the ground it will break it up, and on sidehills it goes much steadier and better than my old one.

The first steel rope I had did above 2000 acres, and I have a small portion of it at work yet. If people mean to have their ropes last, they must keep them off the ground, and attend well to the coiling on the windlass drums. I like your new rollers, which carry the rope further from the ground.

I am, Gentlemen, yours very truly,

WILLIAM PIKE.

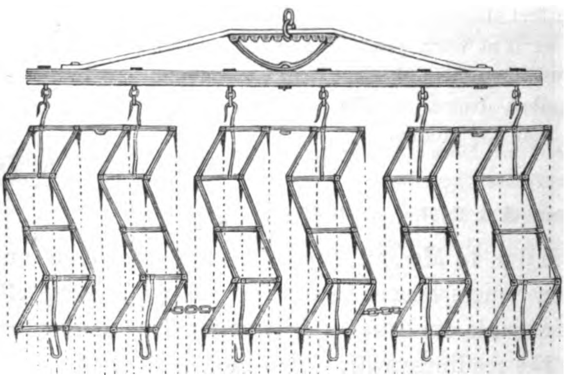
Messrs. J. & F. Howard, Bedford.

It is due to Messrs. Howard to state that their numerous other customers concur in testifying to the general efficiency of their tackle, its little liability to breakage or derangement, and to the readiness with which their ordinary farm labourers have attained to the efficient working of it.

Section 5.—*Harrows.*

When a field has been broken up by the plough, it is usually next operated upon by the harrow, whether the object be to prepare it for and to cover in seeds, or to bring clods and roots to the surface. It is virtually a rake dragged by horses. In its most ordinary form, the frame-work is of wood with iron tines, of which each harrow contains twenty. Formerly each horse dragged a single harrow, although two or more were worked abreast. Under this arrangement the harrows had too much independent motion, and were liable to get foul of each other. This has been remedied, first, partially, by coupling them loosely by riders, and then more effectually by a hinge-like joining, which allows a separate vertical motion, but only a combined horizontal one. A rhomboidal form is also given to this *pair* of harrows—usually called *brakes*—so that when properly yoked, no two tines can work in the same track. This description of harrow is now frequently made entirely of iron.

Howard's patent harrows are a further improvement on this implement. The zigzag form given to each section

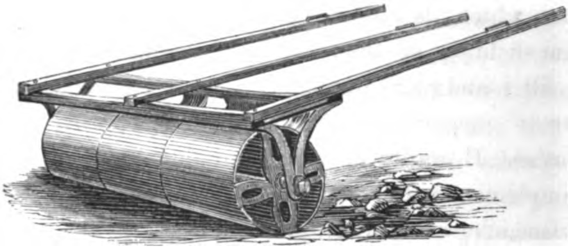


HOWARD'S PATENT HARROW.

enables the whole so to fit in, that the working parts are equally distributed over the space operated upon. The number of tines is 75, instead of 40, as in the form last noticed, and yet from the form of frame and manner of coupling, the tines are well apart, and have each a separate line of action. Practical farmers speak very highly of the effective working of this implement. By an exceedingly simple contrivance the centre part when turned on its back forms a sledge on which its fellows can be piled, and drawn along from one field to another. A light description of harrows with smaller and more numerous tines, is sometimes used for covering in grass-seeds. If a harrow is to be used at all for this purpose, Howard's is a very suitable kind, but a much better implement is Cartwright's chain-harrow, which abrades the surface over which it is drawn to a degree that could not be anticipated from a mere inspection of the implement. It is formed by attaching to a draught bar pairs of square-linked chains, each 7½ feet long, connecting them by cross links, and keeping the whole expanded by two movable stretchers. The old-fashioned ponderous break harrow is now entirely discarded, and the more efficient cultivator used in its stead. A form of the latter, from its close resemblance to harrows, is noticed now rather than before. It is a very strong iron harrow, with the tines made longer, and very considerably curved forwards. An iron rod with a loop handle is fixed to the hind bar, by means of which the driver can easily hitch it up and get rid of weeds, etc. Two such harrows are coupled together and drawn by four horses. Its pulverizing power is very considerable. But when clods have been brought to the surface they are most effectually reduced by various kinds of

Section 6.—*Rollers.*

Those formerly used were solid cylinders of timber or stone attached to a frame and shafts, for which hollow ones of cast-iron are now generally substituted. The simplest form of these has a smooth surface, and is cast in sections to admit of more easy turning. They are made of diverse weights, so as to be adapted for the draught of one or two horses as required. Those of the former description, weighing in all 6 cwt., and costing as many pounds sterling, are exceed-

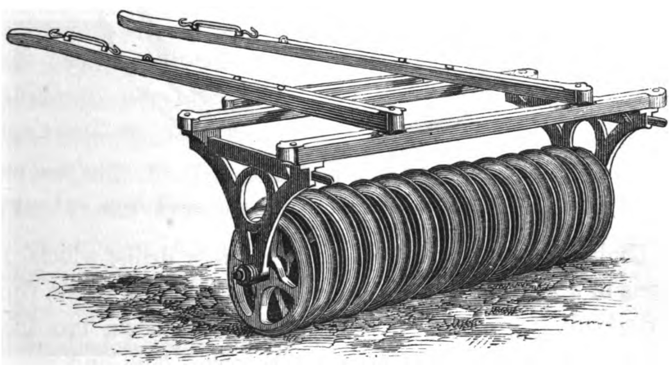


SMOOTH CAST-IRON FIELD ROLLER.

ingly useful for all purposes where expedition rather than heavy pressure is wanted. From their greater durability, smoother surface, and less liability to clog, the readiness with which they can be cast of any weight that is required, and their moderate price, it is probable that cast-iron cylinders will speedily supersede all others.

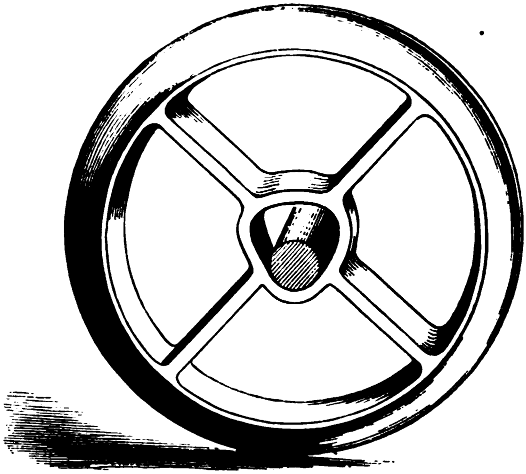
Several important variations on the common smooth roller have been introduced of late years. Of these the first notice is due to Crosskill's clod-crusher, on the ground both of its intrinsic merit and the date of its introduction. It consists of cast-iron discs 2½ feet in diameter, with serrated edge and a series of sideway projecting teeth. Twenty-three of these discs are strung loosely upon a round axle, so as to revolve independently of each other. The free motion thus given to each disc, and which has latterly been increased by casting each alternate one of greater diameter in the eye, adds at once to the pulverizing and self-cleaning power of the roller. Three horses yoked abreast are required to work it. The axle is prolonged at each end sufficiently to receive travelling wheels, on which it is transported from place to place. Although primarily designed and actually much used for breaking clods, it is even more in request for consolidating loose soils, checking the ravages of wire-worm, and covering in clover and grass seeds. For the latter purpose, its action is perfected by attaching a few bushes to it, which fill up the indentations and leave a surface so beautifully even, as to rival the accuracy and neatness of a well-raked border. It is now to be had on a smaller scale adapted to the draught of two horses.

Cambridge's roller posseses several features in common with Crosskill's, and is used for similar purposes. In the form in which it was first brought out it consisted of discs,



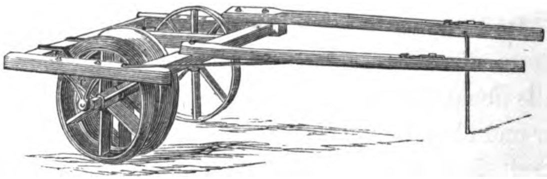
CAMBRIDGE'S PRESS-WHEEL ROLLER.

fitting close to each other, with fluted instead of serrated edges. In its recently improved form the discs are not made of uniform diameter as formerly, but each alternate one in the set is about two inches taller, and has the centre hole, not circular and close fitting to the axle, but triangular and wide. The result is that while the discs press uniformly on the surface over which they are rolled, the larger ones rise above their fellows with a jerking motion which gives a most efficient self-cleaning power to the implement, and thus admits of its being used when other rollers would be clogged. The eccentric discs are now made either with serrated or smooth edges as customers prefer. After careful trial we have come to the conclusion that it is the most useful roller for general purposes which we yet possess.



DISC OF CAMBRIDGE'S ROLLER, SHEWING SELF-CLEANING ACTION.

Under this head may be noticed press drills, which, by means of a series of narrow cylinders with conical edges, form corresponding grooves in loose soil. Seeds sown broadcast over a surface thus treated come up in rows. The land-presser is a modification of the press-roller. It is made with two or



LAND-PRESSER.

three conical edged cylinders to fit into the seams of the same number of plough furrows, the other end of the axle on which they are fixed being supported by a plain carriage wheel. It is drawn by one horse, and follows in the wake of two or three ploughs, according to the number of its cylinders.

When wheat is sown after clover lea, this implement is found exceedingly useful in closing the seams, and forming a uniform seed-bed.

The Norwegian, or as it should rather be called, the Swedish harrow, is strictly a clod-crushing implement. From its radiating spikes penetrating the surface over which it is drawn, it has been called a harrow; but its revolving motion entitles it rather to be classed with rollers. In its usual form it consists of three rows of cast-iron rowels arranged upon parallel axles fixed in an iron frame, which is supported on three wheels,—one in front and two behind. The outline and arrangements are in fact the same as in Finlayson's grubber, only substituting parallel rows of rowels for tines. There is also the same leverage for raising and depressing the frame. But this implement has recently been constructed on a much simpler and cheaper plan, in which the wheels and lever apparatus are discarded altogether. It thus consists of a simple wrought-iron frame with four rows of rowels. A few boards are laid across the frame, forming a platform over the rowels, on which the driver stands when it is wished to increase the weight and efficiency of the implement. On the upper side at either end, is fixed a piece of wheel-tire, on which the implement, when turned on its back, can slide along, sledge-fashion, when it is wished to move it from place to place. As thus constructed, it can be made for about £5. This is the best implement yet introduced for breaking *moist* clods.

Section 7.—Breast-Plough and Trenching-Fork.

Before leaving the implements of tillage, it may be proper to notice two, which have been a good deal brought under notice of late years, viz., the breast-plough and trenching-fork. The former is extensively used in carrying out the process of paring and burning. It is the implement so well known in

Scotland as the flaughter spade. In using it the workman guards his thighs with a piece of board, fastened on apron-wise, and with this presses against the cross-head of the implement, and urges forward its cutting edge. When a thin turf has thus been severed from the surface he throws it topsy-turvy by a jerk of his arms. The fork is used in giving a deep autumn digging to land, in preparation for root crops. Both operations can ordinarily be more economically performed by using horse-power with suitable implements. But for clearing out corners of fields, hedge sides, and similar places, manual labour with these tools can frequently be made to supplement the plough to good purpose.

Section 8.—*Implements for Sowing.*

A large portion of the grain annually sown in Great Britain, is still distributed by hand from the primitive sowing sheet.

> "The sower stalks
> With measured step, and liberal throws the grain
> Into the faithful bosom of the ground."

In Scotland, a decided preference is still given to broadcast sowing, for which purpose a machine is used which covers from 15 to 18 feet, according to the width of ridges adopted. It consists of a long seed-box carried on a frame mounted on two wheels. From these, motion is communicated to a spindle which revolves in the seed-box, and expels the seed by means of cogs or brushes, through openings which can be graduated to suit the required rate of seeding. It is drawn by a single horse, is attended by one man, and can get over 30 acres a-day. It is peculiarly adapted for the regular distribution of clover and grass seeds. In one made by Sheriff at West Barns, by an ingenious apparatus on the principle of the odometer, the machine itself is made to register the space which it travels over, and thus to indicate the rate per acre at which it is distributing the seed. Excellent results have been, and still are, obtained from broadcast sowing. But as tillage becomes more perfect, there does arise a demand for greater accuracy in the depth at which seeds are deposited in the soil, for greater precision in the rate and regularity of their distribution, and for greater facilities for removing weeds from amongst the growing crop. These considerations led, at a comparatively early period, to the system of sowing crops in rows or drills, and hence the demand for machines to do this expeditiously and accurately. We accordingly find, in our best cultivated districts, the sowing and after-culture of the crops now conducted with a precision which reminds the spectator of the processes of some well-arranged factory. This is accomplished by means of a variety of drilling machines, the most prominent of which we shall now notice.

The Suffolk drill is the kind in most general use. It is a complicated and costly machine by which manure and seeds can be simultaneously deposited. That called the "general purpose drill," can sow ten rows of corn, with or without manure, at any width between the rows, from 4½ to 10 inches, and at any rate per acre betwixt two pecks and six bushels. It can be arranged also to sow clover and grass seeds,—the heavier seeds of clover being thrown out by minute cups,—and the lighter grass seeds brushed out from a separate compartment. It is further fitted for sowing beans and turnips —the latter either two drills at a time on the ridge, or three on the flat. This drill, as most recently improved by Messrs. Hornsby of Grantham, and Garrett of Leiston, has an apparatus for preserving the machine in a level position when working on sloping ground. As a main object in drilling crops at all is to admit of the use of the hoe, it becomes an important point to accomplish the drilling with undeviating straightness, and exact parallelism in each successive course of the drill. This is now obtained by means of a fore carriage, which an assistant walking alongside so controls by a lever as easily to keep the wheel in the same rut down which it had previously passed. Messrs. Hornsby have also introduced India-rubber tubes for conducting the seed, in place of the tin funnels hitherto used. These drills cost about £42.

The Woburn drill of the Messrs. Hensman is simpler in its construction than those already noticed. "In all other drills, the coulters, which distribute the manure or seed, hang from the carriage. In this drill the carriage rests upon the coulters, which are like the iron of skates; it may be said, indeed, to run on four pairs of skates. Hence this drill's power of penetrating hard ground, and of giving a firm bed to the wheat-seed in soft ground. Each drill coulter, however, preserves its independence as when suspended. This self-adjustment is required by the inequality of tilled ground, and is thus obtained: each pair of coulters is fixed to the end of a balance beam, these again to others, and they to a central one. Thus each coulter, in well-poised rank, gives its independent share of support. It varies from the generality of drills, as it is drawn from the centre by whipple-trees instead of shafts; and the drill-man behind can steer or direct the drill with the greatest nicety. The corn-box of the drill is entirely self-acting, and delivers the seed equally well going either up or down hill. It is also capable of horse-hoeing, by attaching hoes to the levers instead of the coulter-shares. It is drawn by a pair of horses, and the price from £18 to £20."*

Turnip drill. In Scotland, and in the north and west of England, turnips are usually sown on the ridge by a machine which sows two rows at a time. In the south-eastern parts of England, which are hotter and drier, it is found better to sow them on the flat, for which purpose machines are constructed

* See Mr. Pusey's Report on Implements.—*Journal of the Royal Agricultural Society of England*, vol. xii. p. 604.

which sow four rows together, depositing manure at the same time. Both kinds are adapted for sowing either turnips or mangold-wurzel seeds as required. With the view of economising seed and manure, what are called drop-drills have recently been introduced, which deposit both—not in continuous streams—but in jets, at such intervals apart in the rows as the farmer wishes the plants to stand. What promises to be a more useful machine is a water-drill invented by a Wiltshire farmer—Mr. Chandler of Market Lavington. "His water-drill pours down each manure-coulter the requisite amount of fluid, mixed with powdered manure, and thus brings up the plant from a mere bed of dust. Having used it largely during three years, I may testify to its excellence. Only last July, when my bailiff had ceased turnip sowing on account of the drought, by directing the use of the water-drill, I obtained from this latter sowing an earlier and a better show of young plants than from the former one with the dust-drill. Nor is there any increase of expense, if water be within a moderate distance, for we do not use powder-manures alone. They must be mixed with ashes, that they may be diffused in the soil. Now the expense and labour of supplying these ashes are equal to the cost of fetching mere water; and, apart from any want of rain, it is found that this method of moist diffusion, dissolving, instead of mingling only, the superphosphate, quickens its action even upon damp ground, and makes a little of it go further." *

Section 9.—Manure Distributors.

The practice of top-dressing wheat, vetches, clover, or meadows, with guano and various light manures, has now so much increased, and the inconvenience of scattering them

* See Mr. Pusey's Report on Implements.—*Journal of the Royal Agricultural Society of England*, vol. xii. p. 607.

over the surface by hand is so great, that various machines have recently been invented for distributing them, which can also be used for sowing such manures over turnip drills, covering three at once. Such machines will probably be used in future for distributing lime, which can thus be done much more regularly than by cart and shovel, especially when it is wished to apply small quantities for the destruction of slugs or for other purposes. It seems quite practicable to have this or a similar machine so constructed as that it could be readily hooked on to the tail of a cart containing the lime or other substance which it is desired to distribute by it. The top-dressing material could by such an arrangement be drawn into the hopper of the distributor, as it and its tender move along, and the cart when emptied be replaced by a full one with little loss of time.

A cheap and effective machine, capable of being in a similar manner attached to a dung-cart, and which could tear asunder fold-yard manure, and distribute it evenly in the bottoms of turnip drills, would be a great boon to farmers, and seems a fitting object to be aimed at by those possessed of the inventive faculty.

Section 10.—*Horse-Hoes.*

It has already been remarked, that the great inducement to sow grain and green crops in rows is that hoeing may be resorted to, for the double purpose of ridding them of weeds and stimulating their growth by frequent stirring of the soil. It is now upwards of a century since Jethro Tull demonstrated, in his books and on his fields, the facility with which horse-power could be thus employed. His system was early adopted in regard to turnips, and led, as we have seen, to a complete revolution in the practice of agriculture. The peculiar manner in which he applied his system to grain crops, and the principles on which he grounded his practice, have hitherto been for the most part repudiated by agriculturists, who have thought it indispensable to drill their grain at intervals so narrow as to admit, as was supposed, of the use of the hand-hoe only. But the accuracy with which corn-drills perform their work has been skilfully taken advantage of, and we now have horse-hoes, covering the same breadth as the drill, which can be worked with perfect safety in intervals of but seven inches width. By such a machine, and the labour of a pair of horses, two men, and a boy, ten acres of corn can be hoed in as many hours. Not only is the work done at a fifth of the expense of hand-hoeing, and far more effectually; but it is practicable in localities and at seasons in which hand-labour cannot be obtained.

Garrett's horse-hoe is admitted to be the best implement of its kind. It can be used for hoeing either beans, turnips, or corn, as the hoes can be adapted to suit any width betwixt rows, and the axle-tree being movable at both ends, the wheels, too, can be shifted so as to be kept betwixt the rows of plants. The shafts can be attached to any part of the frame to avoid injury to the crop by the treading of the horses. Each hoe works on a lever independent of the others, and can be loaded with different weights, on the same principle as the coulters of the corn-drill, to accommodate it to uneven surfaces and varying degrees of hardness in the soil.

A great variety of implements, under the general names of horse-hoes, scufflers, scrapers, or drill-grubbers, fitted for the draught of one horse, and to operate on one drill at a time, is in use in those parts of the country where root crops are chiefly sown on ridgelets from 24 to 30 inches apart. With considerable diversity of form and efficiency, they in general have these features in common, viz., provision for being set so as to work at varying widths and depths, and for being armed either with hoes or tines, according as it is wished to pare the surface or stir the soil more deeply. A miniature Norwegian harrow is sometimes attached to drill-grubbers, by which weeds are detached from the soil, and the surface levelled and pulverized more thoroughly. Tennant's grubber, with its tines set close together, and two horses yoked to it abreast by a tree long enough to allow them to walk in the drills on either side of that operated upon, is the most effective implement for cultivating betwixt the rows of beans, potatoes, turnips, or mangold, that we have yet seen used for this purpose.

Section 11.—*Turnip Thinners.*

It sometimes happens, as when drought prevails, while the earlier sowings of turnips or mangold are made, and this is followed by copious rains and forcing weather, that the farmer finds it impracticable to get the thinning-out of the seedlings overtaken as fast as is needful. To aid him in such emergencies, a class of machines has been brought out, of which Huckvale's turnip-thinner may be named as a type. They are very favourably reported of by those who have used them. Such machines, drawn by one horse and made to operate upon either one or two rows of young turnip plants, have first a paring apparatus, which clears off weeds from the sides of the rows, and along with this a set of revolving hoes by which gaps are cut in the rows of turnip plants, and tufts of them are left standing at any required distance apart. This does not dispense with the after use of the hand hoe or fingers to effect a perfect singling of the plants; but as a large space can be gone over in a day at small cost, it enables the farmer to save his crop from getting overgrown and choked until he can overtake the more perfect thinning of it. The next class that claims attention is

Section 12.—*Harvesting Implements.*

These, until recently, comprised only the reaping-hook and scythe. An implement, by means of which horse-power could be made available for this important operation, has long been eagerly desired by farmers. Repeatedly during the past fifty years have their hopes been excited by the announcement of successful inventions of this kind; but, after much fair promise, have hitherto always met with disappointment. These hopes have recently been revived, and raised to a higher pitch than ever, by the appearance, in the Great Exhibition of the Industry of all Nations, of two reaping-machines, known as M'Cormick's and Hussey's, from the United States of America, where, for several years, they had been used extensively and successfully. These implements were subjected to repeated trials in different parts of England, on crop 1851, but never in circumstances which admitted of their capabilities being tested in a thoroughly satisfactory manner.

At the first of these trials, made under the auspices of the Royal Agricultural Society, the preference was given to M'Cormick's, to which the Exhibition Medal was in consequence awarded. It turned out, however, that at this trial Hussey's machine had not a fair chance, being attended by a person who had never before seen it at work, for, when a further trial took place before the Cleveland Agricultural Society, with Mr. Hussey himself superintending his own machine, an all but unanimous decision was given in his favour. Hussey's machine was in consequence adopted by the leading implement makers, such as Messrs. Garrett, Crosskill, etc.

Early in 1852, a very important communication from the pen of the late Mr. James Slight, curator of the museum of the Highland and Agricultural Society, appeared in the Transactions of the Society, by which the attention of the public was recalled to a reaping-machine of home-production, viz., that invented by the Rev. Patrick Bell, now minister of the parish of Carmylie in Forfarshire, and for which a premium of £50 had been awarded to him by the Highland Society. This machine attracted much attention at that time. Considerable numbers were made and partially used, but from various causes the invention was lost sight of, until by the arrival of these American machines, and the notoriety given to them by the Great Exhibition, with concurring causes about to be noticed, an intense interest was again excited regarding reaping by machinery. From Mr. Slight's report, the public learned that the identical Bell's machine to which the prize was awarded, had for the previous fourteen years been statedly employed on the farm of Inch-Michael in the Carse of Gowrie, occupied by Mr. George Bell, a brother of the inventor, who, during all that period, and on the average of years, had succeeded in reaping four-fifths of his crop by means of it. Mr. Slight further stated, that at least *four* specimens of it had been carried to America, and that from the identity in principle betwixt them and those now brought thence, with other corroborating circumstances, there is little doubt that the so-called American inventions are after all but imitations of this Scottish machine. When it became known that Bell's machine was to be exhibited, and, if possible, subjected to public trial, at the meeting of the Highland and Agricultural Society at Perth, in August 1852, the event was looked forward to by Scottish farmers with eager interest. On that occasion it was accordingly again brought forward, with several important improvements made upon it, by Mr. George Bell, already referred to, and was fully tested in competition with Hussey's, as made by Crosskill. To the disappointment of many, Mr. M'Cormick did not think fit to enter the lists at this or at some subsequent opportunities.

The success of Bell's machine on this occasion, and at some subsequent public trials, gave it a high place in public estimation, and accordingly a goodly number, manufactured by Mr. Crosskill of Beverly, was sold to farmers in all parts of Great Britain, although in greatest number to Scotland. After a hopeful start, the success of this machine has not been so decided as was at first anticipated. In common with other reaping machines, it had of course to contend with the disadvantages of unprepared fields and unskilful guides; but in addition to this, it was found to be too heavy in draught, too liable to derangement, and (in the first issues of it) too easily broken in some of its parts, to be fitted for general use. These drawbacks have all, to a greater or less extent, been obviated by subsequent improvements, and the machine continues to receive a fair measure of public patronage. But it has for the present been surpassed by its earliest rival, M'Cormick's, since the important improvements made upon the latter by Messrs. Burgess and Key of London. The chief of these is the addition to it of a self-acting side delivery, which is effected by means of rollers fitted with Archimedean screws which throw off the reaped grain at the right side in a continuous orderly swathe. The more recent addition to it of a hinged near side wheel to facilitate its turning, and of some minor improvements, has rendered Burgess and Key's M'Cormick a really efficient reaping machine, and has obtained for it a very large and rapidly increasing sale. Hussey's machine has also undergone considerable modifications and improvements since its introduction to this country. In particular, the addition to it of the tipping platform—as in Messrs. Deane and Dray's machine, has greatly enhanced its usefulness. While we have no hesitation in giving the preference to self-delivering machines, it is proper to state that the tendency at present in those parts of the country where reaping by machinery is most practised, is in favour of those with manual delivery, on the ground that they are lighter of draft, less liable to derangement, less costly, more easily managed, and thus more to be depended upon for the regular performance of a fair amount of daily work than their heavier rivals. And accordingly light machines on Hussey's principle, but with endless variations, are at present most in demand. It has been ascertained that, in the single county of East Lothian, 8000 acres of grain crop 1861 were reaped by machinery.

Before leaving this subject a remark is due in connection with the strange neglect of Bell's machine for twenty-five years, and the enthusiasm with which it was hailed on its re-appearance. The first is so far accounted for by the fact noticed by Mr. George Bell, that such specimens of his brother's machine as formerly got into the hands of farmers were so imperfectly constructed that they did not work satisfactorily and thus brought discredit on his invention. The true explanation seems to be, that at that date the country was not ready for such a machine. Not only was manual labour then abundant and cheap, from the number of Irish labourers, who annually, as harvest drew near, flocked into the arable districts of Great Britain; but thorough draining had made little progress, and the land was everywhere laid into high ridges, presenting a surface peculiarly unfavourable for the successful working of a reaping machine. Now, however, the conditions are reversed. Under the joint operation of a famine at home pressing out, and the gold discoveries in Australia alluring, emigration from Ireland and elsewhere has so thinned the population as already to tell seriously on the supply of labour. The lower price of farm produce consequent on free-trade urgently demands a reduction in the rate of producing it; and from the extent to which thorough draining has now been carried, high ridges and deep furrows are not merely useless, but positively hurtful. In these altered conditions lies the true explanation of the former apathy and present enthusiasm manifested by our farmers towards this invention.

Section 13.—*Mowing-Machines.*

Another class of labour-saving machines, closely allied to those we have just described, and for which we are indebted to our American cousins, is mowing-machines. Several different forms of these have been introduced and brought into somewhat general use during the years 1858 and 1859. Having used one of Altman and Miller's for three years, we can testify to its thorough efficiency, and to the very great saving of labour, and still more of time, which can be secured by means of it. In one instance 30 acres of clover—a very full crop, and partially lodged—were mown in 32 hours, and this under all the disadvantages of a first start. This machine being of very light draught, a pair of horses can work it at a smart pace without difficulty. By employing two pairs of horses and working them by relay it can, in the long days of June and July, be kept going 16 hours a day, and will easily mow from 16 to 18 acres of seeds or meadow in that time, making moreover better work than can ordinarily be obtained by using the scythe. These mowing machines, which cost from £20 to £30 each, are a most seasonable and truly important addition to our list of agricultural implements. That they may be used to advantage, it is absolutely necessary to have the land well rolled and carefully freed from stones.

Section 14.—*Haymakers.*

Haymakers are valuable implements, and well deserving of more general use. They do their work thoroughly, and enable the farmer to get through a great amount of it in snatches of favourable weather. Where manual labour is scarce, or when, as in Scotland, haymaking and turnip-thinning usually come on hand together, the mower and haymaker render the horse-power of the farm available for an important process which cannot be done well unless it is done rapidly and in season.

Section 15.—*Horse-Rakes.*

Horse-rakes are in frequent use for gathering together the stalks of corn which are scattered during the process of reaping; for facilitating the process of haymaking, and also for collecting weeds from fallows. By an ingenious contrivance in the most improved form of this implement, the teeth are disengaged from the material which they have gathered without interrupting the progress of the horse.

We seem to be verging on the time when, by means of machines worked by horse-power, farmers will be enabled to cut and carry their grass and grain with little more than the ordinary forces of their farms.

Section 16.—*Wheel-Carriages.*

The cartage of crops, manure, etc., upon an arable farm, is such an important part of the whole labour performed upon it (equal, as shewn by a recent estimate, to one-half),* that it is a matter of the utmost consequence to have the work performed by carriages of the most suitable kind. It was for a long time keenly debated by agriculturists, whether waggons or carts are most economical. This question is now undoubtedly settled. Mr. Pusey says, "It is proved beyond question, that the Scotch and Northumbrian farmers, by using one-horse carts, save one-half of the horses which south-country farmers still string on to their three-horse waggons

* See *Morton's Cyclopædia of Agriculture.* Article "Carriages."

and three-horse dung-carts, or dung-pots, as they are called. The said three-horse waggons and dung-pots would also cost nearly three times as much original outlay. Few, I suppose, if any, farmers *buy* these expensive luxuries now; though it is wonderful they should keep them; for last year at Grantham, in a public trial, *five* horses with five carts were matched against five waggons with *ten* horses, and the five horses beat the ten by two loads."* The one-horse carts here referred to are usually so constructed as to be easily adapted to the different purposes for which wheel-carriages are needed upon a farm. For each pair of wheels and axle there is provided a close-bodied cart, and another with sparred sides and broad shelvings, called a long-cart, or harvest-cart, either of which can easily be attached to the wheels, according to the nature of the commodities to be carried. Such a cart, weighing from 7 to 8 cwt., with iron axle and oak shafts, costs at present, in Berwickshire, from £10 to £12, when complete, with both close and sparred frames. Sometimes a simple movable frame is attached to the close-body to fit it for carrying hay or straw; but although one or two such frames are useful for casual purposes throughout the year, they are inferior for harvest work to the regular sparred cart with its own shafts. In some districts the whole of the close-bodied carts used on the farm are made to tip. For many purposes this is a great convenience; but for the conveyance of grain to market, and generally for all road work, a firm frame is much easier for the horse, and less liable to decay and derangement. The Berwickshire practice is to have one pair of tip-carts on each farm, and all the rest firm or dormant-bodied, as it is sometimes called.

Many farms are now provided with a water or tank cart, for conveying and distributing liquid manure.

* *Journal of the Royal Agricultural Society of England.* Mr. Pusey's Report, p. 617 (vol. xii.)

Section 17.—*Portable Railway.*

A plan for lessening the expenditure of horse-labour in the carriage of roots, etc., and accomplishing it with less injury to the land, by means of a portable railway, has been introduced by R. Neilson, Esq., of Halewood, near Liverpool, and tried by others in various parts of the country. When we first heard of this portable farm railway, we confess to have regarded it as a mere toy for amateurs to whom expense was no object. Further inquiry and reflection have led us to a different conclusion, and we now regard it as likely in course of time to come into general use. In the Agricultural Gazette of 22d March 1851, Mr. Neilson, after stating that his farm consists of heavy clay land, on which the difficulty of carting off root crops, or carting on manures, etc., was so great as to lead him to invent a rude sort of railway of wood, which so well answered the purpose, that for the last nine or ten years he had used it always for taking off his root crop, and frequently in putting on manure, thus describes his contrivance :—" The sides are of the common deal, 18 feet long, or shorter if thought more desirable, nearly 3 inches deep and 2½ thick. A balk of timber 18 feet long and 12 inches by 13 square, will cut up into 20 of them. They are connected by means of wooden sleepers of tougher material (slabs or thinnings of oak, ash, beech, etc.), 2 feet 5 long, 3 inches broad by 2 inches thick, and morticed through the side pieces about 4 feet; the tenon is left in the upper side of the cross piece, and the mortice is cut in the side piece, so as to allow the bottom of it and the cross piece to be on a level, so that the flange of the wheel will travel above. The tenons are fastened by a half-inch wooden pin driven through the side piece ¾ of an inch from the outer edge ; on the upper and inner edge of the side piece is laid a strip of iron from ¼ to ½ an inch thick, and from ¾ to 1 inch broad (according to the weight of work required over it), screwed down at every 15 or 18 inches with two inch screws, the heads being countersunk in the iron rim. Thus the iron strip is clear of the wooden pin that fastens the cross pieces, and need not be removed if any of the latter break and require renewing. The ends of the iron strip are bent over the ends of the side rails and let in flush, and are secured by a band of hoop-iron covering the mortice hole outside, passing round the end, and for six inches along the inside of the side rail, and through this plate is fastened the joint for attaching to the next rail. After many contrivances, I have found the following the best and most convenient mode of connecting two consecutive rails together: a pin three inches long, of half-inch square iron, turned with a half-inch eye at one end, and driven nearly home in each end of each side piece. Care must be taken that these pins are fixed half an inch on the inside of the centre on one end, and half an inch on the outside of the centre on the other end of the same rail, so that when two rails are brought together, the two pins of the one rail are both inside or both outside the two pins of the other rail, which prevents them separating sideways, and the eyes being level, are fastened by a half-inch pin or plug put through them, and which forming a joint, enables the railway to be laid more easily over undulating ground. These pins or plugs are secured to the side pieces by a small piece of light jack chain. Though this description is but an imperfect one, I trust that with the accompanying sketch it may be sufficiently understood to be tried; and where the surface is suitable and not too hilly, I'll answer for it, that on heavy land it will not readily be discontinued. Of the waggons and turn-tables I presume no description is needed; the latter is very simple, adapted to the length of the former, and costs about £10. The former will hold about ten or twelve cwt. of turnips, and discharges sideways over the wheel which is about 18 inches high. Cost about £2, 15s., or £3. My arrangement for getting off my turnips is to deliver the rails, waggons, and turn-tables, in proper working order to the labourers who contract to deliver the turnips at the field-gate at so much per acre, and to restore the rails, etc., in good order, or pay for breakage and damage."*

Mr. Caird, who visited Mr. Neilson's farm in October 1850, thus notices the invention :—" A light tramway with waggons is made use of for taking the turnip crop off the ground in moist weather. The tramway is readily shifted, and the crop is thrown into the waggons, which are then each pushed along by a man, so that the entire crop may be removed from the ground, which thus receives no injury from the feet of horses. The tramway can be constructed for 1s. 4d. per yard, and might be very advantageously introduced on all heavy farms where it is found difficult to take off the turnip crop in moist weather. A gang of men are at present employed on a considerable field of Mr. Neilson's in taking off the turnip crop, which they draw from the ground, fill into the waggons, and convey outside of the gate, at the rate of 6s. an acre, shifting the tramway at their own cost. At this work they earn 2s. 3d. a day."† On the home farm of Earl Grey at Howick, he found the same contrivance in use, and thus refers to it,— "The root crops are taken from the ground, without injury to the surface, by the use of Crosskill's portable railway. The rails are found very easy to shift, and the work goes on with great expedition. The Swedes are carried on the rails to the headland, where they are stored till required, in long narrow heaps, thatched with straw."‡

* See *Agricultural Gazette* for 1851, p. 186.

† See *Caird's English Agriculture*, 1850-51, p. 270.

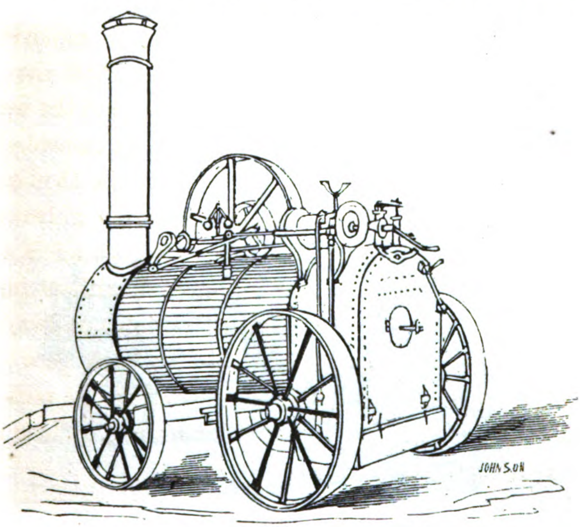
‡ *Ibid.*, p. 375.

MACHINES FOR PREPARING CROPS FOR MARKET.

(Sections 18, 19, 20).

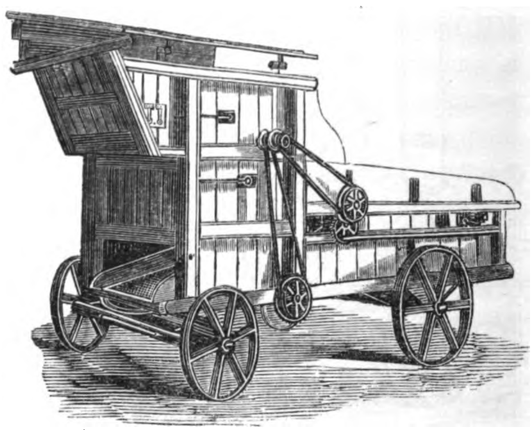
Section 18.—*Steam-Engines.*

The extent to which steam-power is now employed for the purposes of the farm is another marked feature in the recent progress of agriculture. We have already referred to the value of water power for propelling agricultural machinery when it can be had in sufficient and regular supply. As it is only in exceptional cases that farms are thus favoured, the steam-engine is the power that must generally be reckoned upon; and accordingly its use is now so common that a tall chimney has become, over extended districts, the prominent feature of nearly every homestead. It has been satisfactorily shewn that grain can be thrashed and dressed by well-con-



PORTABLE STEAM-ENGINE. (CLAYTON, SHUTTLEWORTH, AND CO.)

structed, steam-propelled machinery, at one-fourth the cost of thrashing by horse-power and dressing by hand-fanners. So great indeed is the improvement in steam-engines, and so readily can the amount of power be accommodated to the work to be done, that we find them everywhere superseding the one-horse gin, and even manual labour, for pumping, churning, coffee-grinding, etc. Wherever, then, a thrashing-mill is used at all, it may be safely asserted that, next to water, steam is the cheapest power by which it can be propelled. The *portable* engine is the form which has hitherto found most favour in the southern parts of the kingdom. Mr. Pusey thus states the reasons for which he regards them as preferable to fixed engines,—"If a farm be a large one, and especially if, as is often the case, it be of an irregular shape, there is great waste of labour for horses and men in bringing home all the corn in the straw to one point, and in again carrying out the dung to a distance of perhaps two or three miles. It is therefore common, and should be general, to have a second outlying yard. This accommodation cannot be reconciled with a fixed engine.



PORTABLE THRASHING-MACHINE. (CLAYTON, SHUTTLEWORTH, AND CO.)

"If the farm be of a moderate size, it will hardly—and if small will certainly not—bear the expense of a fixed engine: there would be waste of capital in multiplying fixed engines to be worked but a few days in the year. It is now common, therefore, in some counties for a man to invest a small capital in a movable engine, and earn his livelihood by letting it out to the farmer.

"But there is a further advantage in these movable engines, little, I believe, if at all known. Hitherto corn has been thrashed under cover in barns; but with these engines and the improved thrashing-machines we can thrash the rick in the open air at once as it stands. It will be said, how can you thrash out of doors on a wet day? The answer is simple. Neither can you move your rick into your barn on a wet day; and so rapid is the work of the new thrashing-machines, that it takes no more time to thrash the corn than to move it. Open-air thrashing is also far pleasanter and healthier for the labourers, their lungs not being choked with dust, as under cover they are; and there is, of course, a saving of labour to the tenant not inconsiderable; but when these movable steam-engines have spread generally, there will arise an equally important saving to the landlord in buildings. Instead of three or more barns clustering round the homestead, one or other in constant want of repair, a single building will suffice for dressing corn and for chaff-cutting. The very barn-floors saved will be no insignificant item. Now that buildings are required for new purposes, we must, if we can, retrench those buildings whose objects are obsolete. Open-air thrashing may appear visionary: but it is quite common with the new machinery; nor would any one perform the tedious manœuvre of setting horses and men to pull down a rick, place it on carts, and build it up again in the barn, who had once tried the simple plan of pitching the sheaves at once into the thrashing-machine."*

To us these reasons are inconclusive. A fixed engine can

* Mr. Pusey's Report on Implements.—*Journal of the Royal Agricultural Society of England*, vol. xii., p. 621.

be erected and kept in repair at greatly less cost than a portable one of the same power. It is much easier to keep the steam at working pressure in the common boiler than in the tubular one, which, from its compactness, is generally adopted in portable engines. It is no doubt very convenient to draw up engine and machinery alongside a rick and pitch the sheaves at once upon the feeding-board, and very pleasant to do this in the sunshine and "caller air," but we should think it neither convenient nor pleasant to have engine and thrashing gear to transport and refix every time of thrashing; to have grain and chaff to cart to the barn; the thrashed straw to convey to the respective places of consumption, and all this in circumstances unfavourable to accurate and cleanly disposal of the products, and excessive exposure to risk of weather. Sudden rain will no doubt interrupt the carrying in of a rick in the one case as the thrashing of it in the other; but there is this vast difference in favour of the former, that the partially carried rick is easily re-covered, machinery, products of thrashing, and work-people, are safely under cover, and the engine is ready by a slight change of gearing for other work, such as bruising, grinding, or chaff-cutting. Mr. Favell and others have also now shewn, that it is quite as practicable and much less laborious to bring the rick to the engine as to take the engine to the rick.

It is urged on behalf of the portable engine that in districts where the farms are generally small, one may serve a good many neighbours. Now, not to dwell on the expense and inconvenience to small occupiers of frequently transporting such heavy carriages, and of having as much of their crop thrashed in a day (there being manifest economy in having at least a day's work when it is employed) as will meet their demands for fodder and litter for weeks to come, we are persuaded that on farms of even 80 or 100 acres, a compact fixed engine of two or three horse power will thrash, bruise grain, cut chaff, work a churn, and cook cattle food, etc. more economically than such work can be done in any other way. It is very usual to find on such farms, especially in dairy districts, an apparatus for cooking cattle food by steam, or by boiling in a large copper, where as much fuel is used every day, and as much steam generated, as would work such an engine as we have referred to, and do the cooking over and above. Even a small dairy implies a daily demand for boiling water to scrub vessels and cook food for cows. How manifestly economical, then, when the steam is up at any rate, to employ this untiring, obedient agent, so willing to turn the hand of anything, in performing the heavy work of the homestead with a power equal perhaps to that of all the men and horses employed upon the farm.

Whenever tillage by steam-power is fairly available there will undoubtedly be an inducement to use the portable engine as a thrashing power that has not hitherto existed, as there will be a manifest economy in having both operations performed by the same engine. Even then, however, there is a high probability of its being found impracticable during the six or eight weeks immediately after harvest, when it will be of such consequence to make diligent use of every available hour for pushing on the tillage, to withdraw the engine even once a week for the needful thrashing.

The prices of portable engines by the best makers, are, for 4-horse power, with tubular boiler, four wheels, double shafts, etc. about £200. For a 6-horse power, from £250 and upwards.

A fixed engine, of the best construction, such as is used in

	£	s.	d.
the Lothians, of 4-horse power, can be got for	£95	0	0
The building of a brick chimney, and engine-house, setting engine and boiler, and supplying water, costs	55	0	0
In all	150	0	0

Six-horse power £180. 8-horse power £205.

The kind of fixed engine most approved for farm work in the north of England and south of Scotland is the overhead crank engine, attached by direct action to the spur-wheel, and sometimes even to the drum-shaft of the thrashing-machine. Their cheapness, simplicity of construction, easy management, and non-liability to derangement, fit them in an eminent degree for farm-work.*

Section 19.—*Thrashing-Machines.*

It is now 65 years since an ingenious Scotch mechanist, Andrew Meikle, produced a thrashing-machine so perfect, that its essential features are retained unaltered to the present day. Indeed, it is frequently asserted that, after all the modifications and supposed improvements of the thrashing machine, which have been introduced by various parties, the mills made by Meikle himself have not yet been surpassed, so far as thorough and rapid separation of the grain from the straw is concerned. The unthrashed corn is fed evenly into a pair of slowly revolving fluted rollers of cast iron, by which it is presented to the action of a rapidly revolving cylinder or drum armed with four beaters, which are square spars of wood faced with iron, fixed parallel to its axis, and projecting about four inches from its circumference. The drum is provided with a dome or cover, and the corn being partly held by the fluted rollers as it passes betwixt the drum and its cover, the rapid strokes of the beaters detach the grain from the ears and throw the straw forward upon slowly revolving rakes, in passing over which, the loose grain is shaken out of the straw and falls through a grating into the hopper of a

* See article on "Comparative Advantages of Fixed and Portable Steam-power for the Purposes of a Farm." By Robert Ritchie, Esq., C. E., Edinburgh, in *Transactions of Highland Society for March* 1852, p. 281.

winnowing and riddling machine, which rids it of dust and chaff, and separates the grain from the unthrashed ears and broken straw, called *roughs* or *shorts.* The grain and roughs are discharged by separate spouts into the apartment below the thrashing-loft, where the corn is fed into the rollers, and the thrashed straw falls from the rakes into the straw-barn beyond. Since Meikle's time, further additions have been made to the machinery. In the most improved machines driven by steam or a sufficient water-power, the grain is raised, by a series of buckets fixed on an endless web, into the hopper of a double winnowing-machine, by which it is separated into clean corn, light, whites or capes, and small seeds and sand. The discharging spouts are sufficiently elevated to admit of sacks being hooked on to receive the different products as they fall. When barley is thrashed, it is first carried by a separate set of elevators, which can be detached at pleasure, into a "hummeller," in which it is freed from the awns, and then raised into the second fanners in the same manner as other grain. The hummeller is a hollow cylinder, in which a spindle fitted with transverse blunt knives revolves rapidly. The rough grain is poured in at the top, and after being acted upon by the knives, is emitted at the bottom through an opening which is enlarged or diminished by a sliding shutter, according to the degree of trimming that is required. A larger set of elevators is usually employed to carry up the roughs to the feeding-board, that they may again be subjected to the action of the drum. The roughs are not emptied directly on the feeding-board, but into a riddle, from which the loose grain passes by a canvas funnel direct to the winnower in the apartment below, and only the unthrashed ears and short straw are allowed to fall upon the board.

The alterations that have been made upon the thrashing-machine since Meikle's time chiefly affect the drum. Meikle himself tried to improve upon his beaters by fixing a projecting ledge of iron on their outer edges so as to give them a scutching action similar to that of flax-mills. This strips off the grain from oats or barley very well, when thinly fed in; but its tendency is to rub off the entire ears, especially of wheat, and also to miss a portion of the ears, whenever there is rapid feeding in. More recent trials with drums on the scutching principle shew it to be on the whole inferior to the plain beater.

We have already referred to the general use of portable thrashing-machines in the eastern counties of England. These, for the most part, have drums with six beaters upon a skeleton frame, which revolve with great rapidity (about 800 times per minute, hence often called high-speed drum), within a concave, or skreen, which encloses the drum for about one-third its circumference. This skreen consists alternately of iron ribs and open wire-work, and is so placed that its inner surface can be brought into near contact with the edges of the revolving beaters, and admits of this space being increased or diminished by means of screws. No feeding rollers are used with this drum, the unthrashed corn being introduced directly to it.

Another form of drum, acting on the same principle as that just referred to, but cased with plate-iron, and having for beaters eight strips of iron projecting about one-fourth of an inch from its surface, and which works within a concave which embraces it for three-fifths of its circumference, is in use when it is desired to preserve the straw as straight and unbroken as possible. These are made of sufficient width to admit of the corn being fed in sideways, and are called *bolting* machines, from the straw being delivered in a fit state for being at once made up into *bolts* or bundles for market. Although the term *beaters* is retained in describing these drums, it is evident that the process by which the grain is separated from the ears, is rubbing rather than beating. This necessarily requires that only a narrow space intervene betwixt drum and concave, and that the corn be fed in somewhat thinly. Such machines thrash clean, whether the ears are all at one end of the sheaf or not, and deliver the straw straight and uninjured; but it is objected to these by some that they are slower in their operation than the common beating drum,—are liable to choke if the straw is at all damp,—that the grain is sometimes broken by them,—and that they require greater power to drive them.

A further and more recent modification is the peg-drum. In this case the drum is fitted with parallel rows of iron pegs, projecting about 2½ inches from its surface, which in its revolutions pass within one-fourth of an inch of similar pegs fixed in the concave, in rows running at right angles to the drum. Great things were at first anticipated from this invention, which, however, it has failed to realize. But iron pegs have more recently been added to the common beater-drum with apparent success. The beaters in this case are made one half narrower than usual, and have stout iron pegs, formed of square rods, driven into their faces, angle foremost, and slightly reflected at the points. These act by a combination of beating and rippling, and are said to thrash clean, and to be easily driven.

There is thus a great variety of thrashing-machines to be found in different parts of the country, the comparative merits of which are frequently and keenly discussed by agriculturists. The extraordinary discrepancies in the amount and quality of the work performed by different machines, and in the power required to effect it, are quite as much due to the varying degrees of skill with which their parts are proportioned and put together, as to varying merit in the respective plans of construction.

In the best examples of 6-horse power stationary steam-engines and thrashing machinery, as found in the Lothians, fifty quarters of grain, taking the average of wheat, barley, and oats, are thrashed, dressed, and sacked up ready for market, in a day of ten hours, with a consumption of 7½ cwt. of good coals, and a gross expenditure for wages, value of horse-labour, fuel, and wear and tear of machinery, of 9d. per quarter.

The Royal Agricultural Society of England has done much towards ascertaining the real merits of the various thrashing-machines now in use, by the carefully conducted comparative trials to which it has subjected those which have been presented in competition for its liberal prizes. The accuracy of these trials, and the value of the recorded results, have been much enhanced by the use of an ingenious apparatus invented by Mr. C. E. Amos, consulting engineer to the Society, which is figured and described at p. 479 of vol. xi. of the Society's Journal. A pencil connected with this apparatus traces a diagram upon a sheet of paper recording every variation of the power employed during the experiment to work the machine under trial. For reasons already stated we regard it as unfortunate that the patronage of this great Society has hitherto been so exclusively bestowed upon portable machines.

Section 20.—*Winnowing-Machines.*

We have already referred to the fanners, which, except in portable machines, are almost invariably found in combination with thrashing machinery, so as to deliver the grain into the corn-chamber in a comparatively clean state; and we have also noticed the further contrivances by which, when there is a sufficient motive power at command, the complete dressing of the grain goes on simultaneously with the thrashing. The winnowers used in such cases do not differ in construction from those worked by hand. Indeed, it is usual to have one at least that can be used in either way at pleasure. In these machines the separation of the clean from the light grain, and of both from dust, sand, and seeds of weeds, or other rubbish, is effected by directing an artificial blast of wind upon a stream of grain as it falls upon a riddle. There is thus a combination of fanning and sifting, which is used in different degrees according to the views of the mechanist. In some forms of this machine, the benefit of the artificial blast is in a great measure lost through an injudicious application of it.

Section 21.—*Corn-Bruiser and Grinding-Mill.*

The now frequent use of various kinds of grain in the fattening of live-stock creates a necessity for machines to prepare it for this purpose, either by breaking, bruising, or grinding. A profusion of these, to be worked by hand, is everywhere to be met with. Such machines are always most economically worked by steam or water power. When that can be had, a set of rollers for bruising oats or linseed, and millstones to grind the inferior grain of the farm, form a most valuable addition to barn machinery.

Section 22.—*Cake-Crushers.*

Machines for breaking linseed-cake into large pieces for cattle, or smaller ones for sheep, are now in general use. The breaking is performed by passing the cakes between serrated rollers, by which it is nipt into morsels. These are usually driven by hand; but it is always expedient to have a pulley attached to them, and to take advantage of mechanical power when available.

Section 23.—*Chaff-Cutters.*

The use of this class of machines has increased very much of late years. Fodder, when cut into lengths of from half to whole inch, is somewhat more easily masticated than when given to animals in its natural state, but the chief advantages of this practice are, that it prevents waste, and admits of different qualities—as of hay and straw, straw and green forage, or chaff and pulped roots—being so mixed that animals cannot pick out the one from amongst the other, but must eat the mixture as it is presented to them. Such cut fodder also forms an excellent vehicle in which to give meal or bruised grain, either cooked or raw, to live-stock. This is peculiarly the case with sheep when feeding on turnips, as they then require a portion of dry food; but waste it grievously when not thus prepared. They are constructed on a variety of plans; but the principle most frequently adopted is that of radial knives bolted to the arm of a fly-wheel, which work across the end of a feeding-box fitted with rollers which draw forward the straw or hay, and present it in a compressed state to the action of the knives. A machine on this principle, made by Cornes of Barbridge, has gained the first premium, in its class, at recent meetings of the Royal Agricultural Society of England. Gillets' guillotine chaff-cutter is an exceedingly ingenious and efficient machine, performing its work with great accuracy and without frequent sharpening of its one double-edged knife. These machines are most economically worked by the power used for thrashing. The most convenient site for them is in the upper loft of the straw-barn, where the straw can be supplied with little labour, and the chaff either shoved aside or allowed to fall as it is cut, through an opening in the floor, into the apartment below, and at once conveyed to other parts of the homestead. The practice on some farms where there is a fixed steam-engine, is to thrash a stack of oats in the forenoon, and to cut up the straw, and bruise or grind the grain simultaneously, in the afternoon.

Section 24.—*Turnip-Cutters.*

Cattle and sheep which have arrived at maturity are able to scoop turnips rapidly with their sharp gouge-like front teeth, and so can be fattened on this kind of food without an absolute necessity of slicing it for them. Even for adult animals there is, however, an advantage in reducing turnips to pieces which they can easily take into their mouths, and at once get between their grinders without any preliminary scooping; but for young stock, during the period of dentition, it is indispensable to their bare subsistence. It is largely through the use of slicing-machines that certain breeds of sheep are fattened on turnips, and got ready for the butcher at fourteen months old. It seems to be admitted on all hands that Gardener's patent turnip-cutter is the best that has yet been produced for slicing roots for sheep. It is now made entirely of iron, and is an exceedingly useful machine.

In cattle feeding it is not usually thought necessary to divide the roots given to them so minutely as for sheep. A simple machine, fashioned much on the principle of nutcrackers, by which, at each depression of the lever handle, one turnip is forced through a set of knives which divide it into slices each an inch thick, is very generally used in Berwickshire for this purpose. Many persons, however, prefer to have the turnips put into the cattle-troughs whole, and then to have them cut by a simple cross-bladed hand-chopper, which, at each blow, quarters the piece struck by it. The mode of housing fattening cattle largely determines whether roots can be most conveniently sliced before or after being put into the feeding-troughs.

Section 25.—*Turnip-Pulpers.*

An opinion now obtains and is on the increase that it is advantageous to rasp roots into minute fragments and mix them with chaff before giving them to cattle, as this not only facilitates mastication, but in wintry weather avoids the chilling effects of a bellyful of such watery food as turnips are when eaten alone. This system is peculiarly appropriate when it is desired to give a few roots to store cattle which are being fed mainly upon straw or coarse hay. When a few turnips or mangels are put down in their natural state there is a scramble for the better food, in which the stronger cattle get more than their share and the weaker are knocked about. But by pulping the roots and mixing them with a full allowance of chaff, every animal gets its fill, and there is nothing to quarrel about.

At the Carlisle meeting of the Royal Agricultural Society a premium was offered for machines to perform this kind of work under the somewhat inappropriate designation of "pulping machines." The prize was awarded to Mr. Philips for his machine, which reduces roots to minute fragments by means of a series of circular saws. We learn from parties who have made trial of most of the machines of this class yet brought out, that they give the preference to that made by Bentall of Maldon in Sussex.

Section 26.—*Steaming Apparatus for Cooking Cattle Food.*

We have several times alluded to the cooking of food for cattle. This is performed either by boiling in a common pot, by steaming in a close vessel, or by infusion in boiling water. Varieties of apparatus are in use for these purposes. A convenient one is a close boiler, with a cistern over it, from which it supplies itself with cold water by a self-acting stop-cock. This is alike suitable for cooking either by steaming or infusing.

Section 27.—*Weighing-Machines.*

It is of course indispensable for every farm to be provided with beam and scales, or other apparatus, for ascertaining the weight of grain, wool, and other commodities, in quantities varying from 1 lb. to 3 cwt. But, besides this, it is very desirable to have a machine by which not only turnips, hay, manures, etc., can be weighed in cart-loads, but by which also the live weight of pigs, sheep, and bullocks, can be ascertained. Such a machine, conveniently placed in the homestead, enables the farmer to check the weighing of purchased manure, linseed-cake, coal, and similar commodities, with great facility. It affords the means of conducting various experiments for ascertaining the comparative productiveness of crops, the quantities of food consumed by cattle, and their periodic progress, with precision and facility. To persons unable to estimate the weight of cattle by the eye readily and accurately, such a machine is invaluable.

Section 28.—*Concluding Remarks on Implements.*

We have thus enumerated, and briefly described, those machines and implements of agriculture which may be held to be indispensable, if the soil is to be cultivated to the best advantage. The list does not profess to be complete; but enough is given to indicate the progress which has recently taken place in this department. We have already referred to this department of the proceedings of the Royal Agricultural Society of England, and would earnestly recommend to all engaged in agriculture the careful study of the reports on implements contained in the ninth and subsequent volumes of their Journal. The care with which they have selected their judges, and the skilful manner in which those entrusted with the difficult and responsible office have discharged their duties, are truly admirable. A few extracts from these reports will serve to shew the extent and value of this department of the Society's labours. In the report for 1847, Mr. Thomson of Moat-Hall says, "The Society's early shows of implements must be viewed chiefly in the light of bazaars or expositions. Neither stewards nor judges had yet acquired the experience requisite for the adequate discharge of their office, so that such men as Messrs. Garrett, Hornsby, Ransome, and a few others, would have laughed in their sleeves had they been told that they could learn anything in the Society's show-yard. In spite, however, of a creditable display on the part of a few leading firms, the majority of the implements exhibited at these early shows were of inferior construction and workmanship, and the general appearance of the exhibitions meagre and unsatisfactory.

"The attention of some of the leading members of the Society (especially of the late lamented Mr. Handley) was earnestly directed to the improvement of this department, and they soon perceived that little was gained by collecting implements in a show-yard for people to gaze at, unless an adequate trial could be made of their respective merits. To attain this end great exertions were made, and every improvement in the mode of trial was followed by so marked an increase in the number and merit of the implements brought forward at subsequent shows, as to prove the strongest incentive to further effort.

"At the Cambridge and Liverpool meetings, when these trials were in their infancy, their main attraction consisted of ploughing-matches on a large scale, which gratified sight-seers, but gave no results that could be depended upon, and therefore disappointed all practical men. It would occupy time unnecessarily to trace the gradual changes which have led to the discontinuance of these showy exhibitions, and the substitution in their place of quiet, business-like trials, in the presence of stewards and judges alone. Suffice it to say, that what they have lost in display, they have gained in efficiency, and consequently in favour with those classes for whose benefit they were designed. At the York meeting, the improved mode of trying the thrashing-machines supplied a deficiency, which, until that time, had been much felt, viz., the absence of any means of ascertaining the amount of power expended in working the machines under trial; and it may now be asserted, with some confidence, that, with the exception of an occasional error or accident, the best implements are uniformly selected for prizes.

"It now remains to answer the question proposed for consideration, viz., to what extent the great improvement made of late in agricultural implements is due to the exertions of this Society; and with this view a tabular statement is subjoined, which shews the relative extent and importance of the Society's two first and two last shows of implements:—

	No. of Exhibitors.	Awards.	
		Money.	Medals.
1830 Oxford . .	23	£5	4
1840 Cambridge .	36	0	7
1848 York . .	146	230	21
1849 Norwich . .	145	364	13

"From this it will be seen that at Cambridge, where the trial of implements was confined to one day, and was, in other respects, so immature as to be of little practical value, the number of exhibitors was only thirty-six, and the judges, in whom a certain discretionary power was vested, awarded no money and but seven medals, in consequence of the scarcity of objects deserving of reward; whilst at York, eight years after, when trials lasted several days, and had attained a considerable degree of perfection, the number of exhibitors had increased four-fold. The additional amount offered in prizes at the later meetings has undoubtedly assisted in creating this great increase of competition, but it cannot be considered the principal cause, since the implement-makers are unanimous in declaring that, even when most successful, the prizes they receive do not re-imburse them for their expenses and loss of time. How, then, are the increased exertions of the machine-makers to be accounted for? Simply by the fact that the trials of implements have gradually won the confidence of the farmer, so that, when selecting implements for purchase, he gives the preference to those which have received the Society's mark of approval. This inference is corroborated by the makers themselves, who readily admit that the winner of a prize, for any implement of general utility, is sure to receive an ample amount of orders, and that the award of a medal is worth on an average £50."

In reporting upon the agricultural implement department of the Great Exhibition, Mr. Pusey says, "The yearly shows and trials of the Royal Agricultural Society have certainly done more in England for agricultural machines within the last ten years, than had been attempted anywhere in all former time. . . . . It seems proved that since annual country shows were established by Lord Spencer, Mr. Handley, and others yet living, old implements have been improved, and new ones devised, whose performances stand the necessary inquiry as to the amount of saving they can effect. To ascertain that amount precisely is difficult; but, looking through the successive stages of management, and seeing that the owner of a stock-farm is enabled, in the preparation of his land, by using lighter ploughs, to cast off one horse in three, and by adopting other simple tools, to dispense altogether with a great part of his ploughing,—that in the culture of crops by the various drills, horse labour can be partly reduced, the seed otherwise wanted partly saved, or the use of manures greatly economised, while the horse-hoe replaces the hoe at one-half the expense,—that in harvest the American reapers can effect thirty men's work, whilst the Scotch cart replaces the old English waggon with exactly half the number of horses,—that in preparing corn for man's food, the steam thrashing-machine saves two-thirds of our former expense,—and in preparing food for stock, the turnip-cutter, at an outlay of 1s. adds 8s. a-head in one winter to the value of sheep; lastly, that in the indispensable but costly operation of draining, the materials have been reduced from 80s. to 15s.—to one-fifth, namely, of their former cost; it seems to be proved that the efforts of agricultural mechanists have been so far successful, *as in all these main branches of* farming labour, taken together, to effect a saving, on outgoings, of little less than one-half."

Since these reports were made the demand for improved agricultural implements and machinery has increased enormously, so much so that the manufacture of them is now a most important and a rapidly increasing branch of our national industry, and we quite anticipate that in a short time there will be such a general appreciation of the benefits of cultivation by steam-power, and such a demand for engines and tackle to carry it out, as the makers of them will find it difficult to satisfy.

Scottish agriculturists, in reading these reports, will probably note with self-gratulation, that some of the improvements referred to as of recent introduction in England, viz., two-horse ploughs and one-horse carts, have long been established among themselves. Indeed they will find graceful notice of the fact on the face of these reports. Unless altogether blinded by prejudice they will, however, see that our brethren south of the Tweed have already outstripped us in many particulars, and that unless our national society, our mechanists, and farmers, exert themselves with corresponding judgment and zeal, we must henceforth be fain to follow, where we at least fancy that we have hitherto been leading. But we have more important motives and encouragements to exertion than mere national emulation. The extent to which the cost of production of farm produce has been lessened by recent improvements on the implements of husbandry, and in the details of farm management, is greater than many are aware of. It seems to be in this direction mainly that the farmer must look for a set-off against the steadily increasing cost of land and labour. If by farther improvements in his machinery and implements he is enabled to keep fewer horses, to get his deep tillage performed by steam-power, and his mowing and reaping accomplished by the ordinary forces which he requires throughout the year, the reduction upon the prime cost of his produce will be really important. A hopeful element in this anticipated progress is that it tends directly to elevate the condition of the rural labourer. Every addition to the steam-power and labour-saving machines used upon the farm implies an increased demand for cultured minds to guide them, a lessening of the drudgery heretofore imposed upon human thews and sinews, an equalizing of employment throughout the year, and a better and steadier rate of wages. Believing, as we do, that on every farm enormous waste of motive power, mechanical, animal, and manual, is continuously going on through the imperfection of the implements and machines now in use, we would urge upon all concerned to look well to this; for, with all our improvements, there is undoubtedly yet a large margin for retrenchment here.

Besides the bulky and costly implements now enumerated, every farm must be provided with a considerable assortment of hand-implements and tools, all of which it is of consequence to have good of their kind. Although not individually costly, they absorb a considerable capital in the aggregate. When not in use, they require to be kept under lock, and at all times need to be well looked after. Without waiting to describe these in detail, let us now see how the work of the farm is conducted.

CHAPTER V.

PREPARATION OF THE LAND FOR TILLAGE OPERATIONS.

Section 1.—*When Required.*

BEFORE those simple tillage operations which are necessary in every instance of committing seeds to the earth can be gone about, there are more costly and elaborate processes of preparation which must be encountered in certain circumstances, in order to fit the soil for bearing cultivated crops. It is now only in exceptional cases that the British agriculturist has to reclaim land from a state of nature. The low-country farmer does occasionally meet with a patch of woodland, or a bank covered with gorse or brushwood, which he sets about converting into arable land. It is in the higher districts that, from the facilities now afforded for readily enriching poor soils by portable manures, the plough still frequently invades new portions of muir and bog, and transforms them into fields. The occupiers of land in these upland districts are accordingly still familiar with the processes of paring and burning, trenching, removing earth-fast stones, and levelling inequalities of surface. In breaking up land that has been for a course of years under pasturage, paring and burning are also frequently resorted to in all parts of the country. The grand improvement of all, thorough underground drainage, is common to every district and class of soils.

Section 2.—*Draining.*

From the moist climate of Britain, draining is undoubtedly the all-important preliminary operation in setting about the improvement of the soil.

To drain land is to rid it of its superfluous moisture. The rivers of a country with their tributary brooks and rills are the natural provision for removing the rain water which either flows directly from its surface, or which, after percolating through porous strata to an indefinite depth, is again discharged at the surface by springs. The latter may thus be regarded as the outlets of a natural underground drainage. This provision for disposing of the water that falls from the clouds is usually so irregular in its distribution, and so imperfect in its operation, that it leaves much to be accomplished by human labour and ingenuity. The art of the drainer accordingly consists—

1st, In improving the natural outfalls by deepening, straightening, or embanking rivers; and by supplementing these, when necessary, by artificial canals and ditches; and,

2d, In freeing the soil and subsoil from stagnant water, by means of artificial underground channels.

The first of these operations, called *trunk drainage*, is the most needful; for until it be accomplished there are extensive tracts of land, and that usually of the most valuable kind, to which the secondary process either cannot be applied at all, or only with the most partial and inefficient results. Very many of our British rivers and streams flow with a sluggish and tortuous course through valleys of flat alluvial soil, which, as the coast is approached, expand into extensive plains, but little elevated above the level of the sea. Here the course of the river is obstructed by shifting shoals and sand banks, and by the periodic influx of the tides. The consequence is, that immense tracts of valuable land are at all times in a water-logged and comparatively worthless state, and on every recurrence of a flood are laid entirely under water. In a subsequent chapter on "Waste Lands" some account shall be given of the extent of this evil, and of the efforts that have been successfully devoted to its remedy. Some of these fen-lands and estuary drainage works have been accomplished in the face of natural obstacles of the most formidable character, and constitute trophies of engineering talent of which the country may well be proud. Great as the natural difficulties are which have to be encountered in such cases, there are others of a different kind which have often proved more impracticable. It has been found easier to exclude the sea and restrain land-floods, than to overcome the prejudices and reconcile the conflicting interests of navigation companies, commissioners of sewers, owners of mills, and landed proprietors. Although all these classes suffer the most serious losses and inconveniences from the defective state of many of our rivers, yet it is found extremely difficult to reconcile their conflicting claims, and to allocate to each their proper share of the cost of improvements by which all are to benefit. A most interesting and instructive illustration of the urgent necessity for improving the state of our rivers, of the difficulties to be encountered in doing so, and of the incalculable benefits thus to be obtained, has been given in an essay on Trunk Drainage, by John Algernon Clarke, Esq., published in vol. xv., part 1st, of the *Journal of the Royal Agricultural Society of England.* Mr. Clarke, after some most important observations on trunk drainage, describes in detail works projected under powers granted in an act of parliament, passed in 1852, "constituting commissioners for the improvement of the river Nene and the navigation thereof."

There is not a district of the kingdom in which works similar in kind are not absolutely indispensable, before extensive tracts of valuable land can be rendered available for profitable cultivation by means of underground drainage. It is interesting to know that the necessity for trunk drainage, and the means of accomplishing it, were distinctly set before the public 200 years ago by a practical draining engineer, to whose writings the attention of the agricultural community has been frequently directed of late by Messrs. Parkes Gisborne, and others. From the third edition (1652) of *The Improver Improved*, by Walter Blithe, the author referred to, in which the true principles of land drainage are stated as distinctly, and urged as earnestly, as by any of our modern writers, we here quote the following remarks:—

"A strait watercourse, cut a considerable depth, in a thousand parts of this nation, would be more advantageous than we are aware of, or I will task myself here to dispute further. And though many persons are interested therein, and some will agree, and others will oppose; one creek lyeth on one side of the river, in one lord's manor, and another lyeth on the other side, and divers men own the same; why may not one neighbour change with another, when both are gainers? If not, *why may they not be compelled for their own good, and the commonwealth's advantage?* I daresay thousands of acres of very rich land may hereby be gained, and possibly as many more much amended, that are almost destroyed; but a law is wanting herein for the present, which I hope will be supplied if it may appear advancement to the public; for to private interests it is not possible to be the least prejudice, when every man hath benefit, and each man may also have an equall allowance if the least prejudiced.

"But a word or two more, and so shall conclude this chapter—and it is a little to further this improvement through a great destruction (as some may say); it is the removing or destroying of all such mills, and none else, as drown and corrupt more lands than themselves are worth to the commonwealth, and they are such as are kept up or dammed so high as that they boggyfie all the lands that lye under their mill-head. Such mills as are of little worth, or are by constant great charges maintained, I advise to be pulled down; the advance of the land, when the water is let run his course, and not impounded, will be of far greater value many times. But in case the mills should be so necessary and profitable too, and far more than the lands they spoil, I shall then advise, that under thy mill-dam, so many yards wide from it as may prevent breaking through, thou make a very deep trench all along so far as thy lands are putrefied, and thereinto receive all the issuing, spewing water, and thereby stop or cut off the feeding of it upon thy meadow, and carry it away back into thy back-water or false course, by as deep a trench, cut through the most low and convenient part of thy meads. But put case that thou shouldst have no convenient fall on that side thy mill-dam, then thou must make some course, *or plant some trough under thy mill-dam,* and so carry it under into some lower course that may preserve it from soaking thy meadows or pastures under it; and by this means thou maist in a good measure reduce thy land to good soundness, and probably wholly cure it, and preserve thy mill also."

It is painful to reflect, that after the lapse of two centuries, we should still see, as Blithe did, much "gallant land" ruined for want of those draining operations which he so happily describes.

A clear outfall of sufficient depth being secured, the way is open for the application of *underground draining.* And here it may be proper to state, that there is very little of the land of Great Britain naturally so dry as not to be susceptible of improvement by artificial draining; for land is not in a perfect condition with respect to drainage, unless all the rain that falls upon it can sink down to the minimum depth required for the healthy development of the roots of cultivated crops, and thence find vent, either through a naturally porous subsoil or by artificial channels. Much controversy has taken place as to what this minimum depth is. Suffice it to say, that opinion is now decidedly in favour of a greater depth than was considered necessary even a few years ago, and that the best authorities concur in stating it at from three to four feet. There are persons who doubt whether the roots of our ordinary grain or green crops ever penetrate to such a depth as has now been specified. A careful examination will satisfy any one who makes it that minute filamentary rootlets are sent down to extraordinary depths, wherever they are not arrested by stagnant water. It has also been questioned whether any benefit accrues to crops from this deep descent of their roots. Some persons have even asserted that it is only when they do not find food near at hand that they thus wander. But it must be borne in mind that plants obtain moisture as well as nourishment by means of their roots, and the fact is well known that plants growing in a deep soil resting on a porous subsoil seldom or never suffer from drought. It is instructive, too, on this point, to observe the practice of the most skilful gardeners, and see the importance which they attach to trenching, the great depth at which they often deposit manure, and the stress which they lay upon thorough drainage. On the other hand, it is well known that soils which soonest become saturated, and run from the surface in wet weather, are precisely those which parch and get chapped the soonest in drought. The effectual way to secure our crops at once from drowning and parching, is to put the land in a right condition with respect to drainage.

All soils possess more or less the power of absorbing and retaining water. Pure clays have it in the greatest degree, and gritty siliceous ones in the smallest. In dry weather this power of attracting moisture is constantly operating to supply from below the loss taking place by evaporation at the surface. In heavy rains, as soon as the entire mass has drunk its fill, the excess begins to flow off below; and therefore a deep stratum, through which water can percolate, but in which it can never stagnate—that is, never exceed the point of saturation—is precisely that in which plants are most secure from the extremes of drought and drowning.

If a perfect condition of the soil with respect to drainage is of importance for its influence in preserving it in a right condition as respects moisture, it is still more so for its effects upon its *temperature.* All who are conversant with rural affairs are familiar with that popular classification of soils in virtue of which such as are naturally dry are also invariably spoken of as *warm* and *early;* and conversely, that wet soils are invariably described as being *cold* and *late.* This classification is strictly accurate, and the explanation of it is simple. An excess of water in soil keeps down its temperature in various ways. In passing into the state of vapour it rapidly carries off the heat which the soil has obtained from the sun's rays. Water possesses also a high radiating power; so that, when present in the soil in excess, and in a stagnant state, it is constantly carrying off heat by evaporation and radiation. On the other hand, stagnant water conveys no heat downwards; for although the surface is warmed, the portion of water thus heated being lightest, remains floating on the surface, and will give back its heat rapidly to the atmosphere, but conveys none downwards. When the surface of stagnant water becomes colder than the general mass, the very opposite effect immediately ensues; for as water cools its density increases, and thus causes an instant sinking of the portion that has been cooled, and a rising of a warm portion from below to take its place—this movement continuing until the whole has been lowered to 42°, at which point water reaches its maximum density, after which it will freeze at the surface if the cold be great enough. It is thus that soil surcharged with water is kept at a lower temperature than similar soil that has a sufficient natural or artificial drainage.

But while the presence of stagnant water in a soil has this injurious power of lowering its temperature, a very different effect ensues when rain-water can sink freely into it to a depth of several feet, and then find a ready exit by drainage; for in this case the rain-water carries down with it the heat which it has acquired from the atmosphere and from the sun-heated surface and imparts it to the subsoil. There is as yet a lack of published experiments to shew the ordinary increase of temperature at various depths and in different soils, as the result of draining wet land. Those conducted by Mr. Parkes, in a Lancashire bog in June 1837, shewed as the mean of thirty-five observations, that the drained and cultivated soil at seven inches from the surface was 10° warmer than the adjoining undrained bog in its natural state at the same depth. It is understood that recent experiments conducted by the same gentleman on an extended scale fully establish the fact that an increased temperature of the soil is an unfailing accompaniment of thorough draining. The importance of this result cannot well be over-rated. The temperature and other conditions of the atmosphere, which we call climate, are placed beyond human control; but this power of raising the temperature of all wet, and consequently cold soils, becomes tantamount in some of its results to a power of improving the climate. There are, accordingly, good grounds for stating that in numerous cases grain crops have ripened sooner by ten or twelve days than they would have done but for the draining of the land on which they grew.

The points which we have thus briefly touched upon are so essential to an intelligent appreciation of the subject, that we have felt constrained to notice them, however meagrely. But our space forbids more than a mere enumeration of some of the many evils inseparable from the presence of stagnant water in the soil, and of the benefits that flow from its removal. Wet land, if in grass, produces only the coarser grasses, and many sub-aquatic plants and mosses, which are of little or no value for pasturage; its herbage is late of coming in spring, and fails early in autumn; the animals grazed upon it are unduly liable to disease, and sheep, especially, to the fatal rot. When used as arable land, tillage operations are easily interrupted by rain, and the period always much limited in which they can be prosecuted at all; the compactness and toughness of such land renders each operation more arduous, and more of them necessary, than in the case of dry land. The surface must necessarily be thrown into ridges, and the furrows and cross-cuts duly cleared out after each process of tillage, on which surface expedients as much labour has probably been expended in each thirty years, as would now suffice to make drains enough to lay it permanently dry. With all these precautions, the best seed-time is often missed, and this usually proves the prelude to a scanty crop, or to a late and disastrous harvest. The cultivation of the turnip and other root crops, which require the soil to be wrought to a deep and free tilth, becomes either altogether impracticable, and must be abandoned for the safe but costly bare fallow, or is carried out with great labour and hazard; and the crop, when grown, can neither be removed from the ground, nor consumed upon it by sheep without damage by poaching. The dung, lime, and other manure, that is applied to such land, is in a great measure wasted; and the breaking of the subsoil and general deep tillage, so beneficial in other circumstances, is here positively mischievous, as it does but increase its power of retaining water. Taking into account the excessive labour, cost, and risk, inseparable from the cultivation of wet land, and the scanty and precarious character of the crops so obtained, it would in many cases be wiser to keep such lands in grass, than to prosecute arable husbandry under such adverse circumstances. These very serious evils can either be entirely removed, or, at the least, very greatly palliated by thorough draining. It often happens that naturally porous soils are so soaked by springs, or so water-logged by resting upon an impervious subsoil, or, it may be, so drowned for want of an outfall in some neighbouring river or stream, that draining at once effects a perfect cure, and places them on a par with the best naturally dry soils. In the case of clay soils, the improvement effected by draining is in some respects greater than in any other class, but still it cannot change the inherent properties of clay. This has sometimes been overlooked by sanguine improvers, who, hastily assuming that their strong land, when drained, would henceforward be as friable and sound as the more porous kinds, have proceeded to treat it on this assumption, and have found to their cost that clay, however well drained, will still get into mortar and clods, if it is tilled or trodden on too soon after rain. It is entirely owing to such rash and unskilful management that an opinion has sometimes got abroad, that clay lands are injured by draining. They merely retain the qualities peculiar to clay, and when they are treated judiciously, shew as good a comparative benefit from draining as other soils. The only instances in which even temporary injury arises from draining is in the case of some peaty and fen lands, which are so loose, that they suffer from drought in protracted dry weather. As such lands are usually level and have water-courses near them, this inconvenience admits of an easy remedy by shutting up the main outlets and then admitting water into the ditches. The drains in this way become ready channels for applying the needed moisture by a kind of subterraneous irrigation.

The beneficial effects of thorough draining are of a very decisive and striking kind. The removal of stagnant water from a stratum of 4 feet in depth, and the establishing of a free passage for rain-water and air from the surface to the level of the drains, speedily effects most important changes in the condition of the soil and subsoil. Ploughing and other tillage operations are performed more easily than heretofore, in consequence of a more friable state of the soil. Moderate rains which formerly would have sufficed to arrest these operations do so no longer, and heavy falls of rain cause a much shorter interruption of these labours than they did when the land was in its natural state. Deep tillage, whether by the common or subsoil plough (which formerly did harm), now aids the drainage, and is every way beneficial. Ridges and surface furrows being no longer needed, the land can be kept flat with great benefit to crops, and furtherance to field operations. An earlier seed-time and harvest, better crops, a healthier live-stock, and an improved style of husbandry, are the usual and well-known sequents of judiciously conducted drainage operations. In short, the most experienced and skilful agriculturists now declare with one consent that good drainage is an indispensable preliminary to good cultivation.

Although it has been reserved to the present times to see land draining reduced to a system based on scientific principles, or very great improvement effected in its details, it is by no means a modern discovery. The Romans were careful to keep their arable lands dry by means of open trenches, and there are even some grounds for surmising that they used covered drains for the same purpose. Indubitable proof exists that they constructed undergound channels by means of tubes of burned earthenware; but it seems more probable that these were designed to carry water to their dwellings, etc., than that they were used simply as drains. Recent inquiries and discoveries have also shewn that it is at least several centuries since covered channels of various kinds were in use by British husbandmen for drying their land. It is, at all events, two centuries since Captain Walter Blithe wrote as follows:—

"Superfluous and venomous water which lyeth in the earth and much occasioneth bogginesse, mirinesse, rushes, flags, and other filth, is indeed the chief cause of barrenesse in any land of this nature. . . . Drayning is an excellent and chiefest means for their reducement; and for the depth of such draynes, I cannot possibly bound, because, I have not time and opportunity to take in all circumstances. . . . And for thy drayning trench it must be made so deepe that it goe to the bottome of the cold, spewing moyst water, that feeds the flagg and the rush; for the widenesse of it, use thine owne liberty, but be sure to make it so wide as thou mayest goe to the bottome of it, which must be so low as any moysture lyeth, which moysture usually lyeth under the over and second swarth of the earth, in some gravel or sand, or else, where some greater stones are mixt with clay, under which thou must goe halfe one spades graft deepe at least;

yea, suppose this corruption that feeds and nourisheth the rush or flagg should lie a yard or foure foot deepe, to the bottome of it thou must goe, if ever thou wilt drain it to purpose. . . . And for the drayning trench be sure thou indeavour to carry it as neare upon a straight line as possible. . . . To the bottome where the spewing spring lyeth thou must goe, and one spades depth or graft beneath, how deep so ever it be, if thou wilt drayne thy land to purpose. I am forced to use repetitions of some things, because of the suitableness of the things to which they are applyed; as also because of the slownesse of peoples apprehensions of them, as appears by the non-practice of them, the which wherever you see drayning and trenching you shall rarely find few or none of them wrought to the bottome. . . . Go to the bottome of the bog, and there make a trench in the sound ground, or else in some old ditch, so low as thou verily conceivest thy selfe assuredly under the level of the spring or spewing water, and then carry up thy trench into thy bogg straight through the middle of it, one foot under that spring; . . . but for these common and many trenches, oft times crooked too, that men usually make in their boggy grounds, some one foot, some two, never having respect to the cause or matter that maketh the bogg to take that way, I say away with them as a great piece of folly, lost labour and spoyle. . . . After thou has brought a trench to the bottom of the bog, then cut a good substantial trench about thy bog; and when thou hast so done make one work or two just overthwart it, *upwards and downwards*, all under the matter of the bog. Then thou must take good green faggots, willow, alder, elme, or thorne, and lay in the bottome of thy works, and then take thy turfe thou tookest up in the top of thy trench, and plant upon them with the green sward downwards; *or take great pebbles, stones, or flint stones, and so fill up the bottome of thy trench about fifteen inches high,* and take thy turfe and plant it as aforesaid, being cut very fit for the trench, as it may join close as it is layd downe, and then having covered it all over with earth, and made it even as thy other ground, waite and expect a wonderfull effect through the blessing of God."

These sagacious arguments and instructions were doubtless acted upon by some persons in his own times and since; but still they had never attained to general adoption, and were ultimately forgotten. Towards the close of last century, Mr. Elkington, a Warwickshire farmer, discovered and promulgated a plan of laying dry sloping land that is drowned by the outbursting of springs. When the higher lying portion of such land is porous, rain falling upon it sinks down until it is arrested by clay or other impervious matter, which causes it again to issue at the surface and wet the lower-lying ground. Elkington shewed that by cutting a deep drain through the clay, aided when necessary by wells or augur holes, the subjacent bed of sand or gravel in which a body of water is pent up by the clay, as in a vessel, might be tapped, and the water conveyed harmlessly in the covered drain to the nearest ditch or stream. In the circumstances to which it is applicable, and in the hands of skilful drainers, Elkington's plan by bringing into play the natural drainage furnished by porous strata, is often eminently successful. His system was given to the public in a quarto volume, edited by a Mr. John Johnston of Edinburgh, who does not seem to have shared the engineering talents of the man whose discoveries he professes to expound. During the thirty or forty years subsequent to the publication of this volume, most of the draining that took place was on this system, and an immense capital was expended in such works with very varying results. Things continued in this position until about the year 1823, when the late James Smith of Deanston having discovered anew those principles of draining so long before indicated by Blithe, proceeded to exemplify them in his own practice, and to expound them to the public in a way that speedily effected a complete revolution in the art of draining, and marked an era in our agricultural progress. Instead of persisting in fruitless attempts to dry extensive areas by a few dexterous cuts, he insisted on the necessity of providing every field that needed draining at all with a complete system of parallel underground channels, running in the line of the greatest slope of the ground, and so near to each other that the whole rain falling at any time upon the surface should sink down and be carried off by the drains. The distances between drains he shewed must be regulated by the greater or less retentiveness of the ground operated upon, and gave 10 feet as the minimum, and 40 feet as the maximum of these distances. The depth which he prescribed for his parallel drains was 30 inches, and these were to be filled with 12 inches of stones small enough to pass through a 3-inch ring—in short, a new edition of Blithe's drain. A main receiving-drain was to be carried along the lowest part of the ground with sub-mains in every subordinate hollow that the ground presented. These receiving drains were directed to be formed with a culvert of stone work, or of tiles, of waterway sufficient to contain the greatest volume of water at any time requiring to be passed from the area to which they respectively supplied the outlet. The whole cultivated lands of Britain being disposed in ridges which usually lie in the line of greatest ascent, it became customary to form the drains in each furrow, or in each alternate, or third, or fourth one, as the case might require, or views of economy dictate, and hence the system soon came to be popularly called *furrow draining.* From the number and arrangement of the drains, the terms *frequent* and *parallel* were also applied to it. Mr. Smith himself more appropriately named it, from its effects, *thorough draining.* The sound principles thus promulgated by him were speedily adopted and extensively carried into practice. The great labour and cost incurred in procuring stones in adequate quantities, and the difficulty of carting them in wet seasons, soon led to the substitution of tiles and soles of burned earthenware. The limited supply and high price of these tiles for a time impeded the progress of the new system of draining; but the opportune invention by the Marquis of Tweeddale of a tile-making machine, followed as this was by a rapid succession of more perfect machines for the same purpose, at once removed this impediment, and gave a mighty stimulus to this fundamental agricultural improvement. The substitution of cylindrical pipes for the original horse-shoe tiles has still further aided the progress of land-drainage, both by lowering the cost and increasing the efficiency and permanency of such works.

The system introduced and so ably expounded by Smith of Deanston has now virtually been adopted by all drainers. Variations in matters of detail (having respect chiefly to the depth and distance apart of the parallel drains), have indeed been introduced; but the distinctive features of his system (viz., provision for laying dry the entire area of land operated upon to the minimum depth required for the healthy growth of cultivated crops, by a series of parallel drains running in the line of the greatest slope of the ground), are now recognised and acted upon by all scientific drainers.

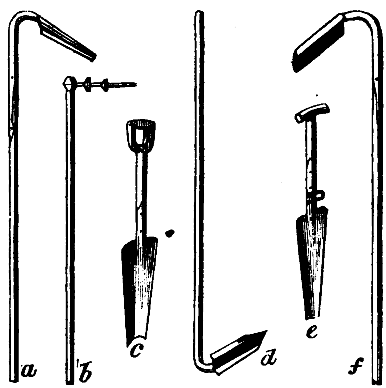
In setting about the draining of a field, or farm, or estate, the first point is to secure, at whatever cost, a proper outfall. The lines of the receiving drains must next be determined, and then the direction of the parallel drains. The former must occupy the lowest part of the natural hollows, and the latter must run in the line of the greatest ascent of the ground. In the case of flat land, where a fall is obtained chiefly by increasing the depth of the drains at their lower ends, these lines may be disposed in any direction that is found convenient; but in undulating ground a single field may require several distinct sets of drains lying at different angles, so as to suit its several slopes. When a field is ridged in the line of the greatest ascent of the ground, there is an obvious convenience in adopting the furrows as the site of the drains; *but wherever this is not the case the drains must be laid off to suit the contour of the ground, irrespective of the furrows altogether.* When parts of a field are flat and other parts have a considerable acclivity, it is expedient to cut a receiving drain near to the bottom of the slopes, and to give the flat ground an independent set of drains. In laying off receiving drains it is essential to give hedge-rows and trees a good offing, lest the conduit should be obstructed by roots. When a main drain is so placed that parallel ones empty into it from both sides, care should be taken that the inlets of the latter are not made exactly opposite to each other. Indeed, we have found it expedient in such cases to have two receiving drains parallel to each other, each to receive the subordinate drains from its own side only. As these receiving drains act also as ordinary drains to the land through which they pass, no additional cost is incurred by having two instead of one, provided they are as far apart as the other drains in the field. Much of the success of draining depends on the skilful planning of these main drains, and in making them large enough to discharge the greatest flow of water to which they may be exposed. Very long main drains are to be avoided. Numerous outlets are also objectionable, from their liability to obstruction. An outlet to an area of from ten to fifteen acres is a good arrangement. These outlets should be faced with mason-work, and guarded by iron gratings.

The depths of the parallel drains must next be determined. In order to obtain proper data for doing so, the subsoil must be carefully examined by digging test-holes in various places, and also by taking advantage of any quarries, deep ditches, or other cuttings in the proximity, that afford a good section of the ground. We have already expressed an opinion that the drains should not be less than four feet deep; but it is quite possible that the discovery at a greater depth than four feet of a seam of gravel, or other very porous material charged with water, underlying considerable portions of the ground, may render it expedient to carry the drains so deep as to reach this seam. Such a seam, when furnished with sufficient outlets, supplies a natural drain to the whole area under which it extends. When such exceptional cases are met with, they are precisely those in which deep drains, at wide intervals, can be trusted to dry the whole area. When the subsoil consists of a tenacious clay of considerable depth, it is considered by many persons that a greater depth than three feet is unnecessary. The greater depth is, however, always to be preferred; for a drain of four feet, if it works at all, not only does all that a shallower one can do, but frees from stagnant water a body of subsoil on which the other has no effect at all. It has indeed been alleged that such deep drains may get so closed over by the clay that water will stand above them. If the surface of clay soil is wrought into puddle by improper usage, water can undoubtedly be made to stand for a time over the shallowest drains as easily as over the deepest. But the contraction which takes place in summer in good alluvial clays gradually establishes fissures, by which water reaches the drains. In such soils it is usually a few years before the full effect of draining is attained. This is chiefly due to the contraction and consequent cracking of clay soils in summer just referred to, and partly, as Mr. Parkes thinks, to the mining operations of the common earthworm. Both of these natural aids to drainage operate with greater force with drains four feet deep than when they are shallower. The tardy percolation of water through clay soils seems also a reason why in such cases it should get the benefit of a greater fall, by making the drain deep.

Draining is always a costly operation, and it is therefore peculiarly needful to have it executed in such a way that it shall be effectual and permanent. We advocate a minimum depth of four feet, because of our strong conviction that such drains carefully made will be found to have both these qualities. And this opinion is the result of dear-bought experience, for we have found it necessary in our own case to re-open a very considerable extent of 30-inch drains in consequence of their having totally failed to lay the land dry, and to replace them by four feet ones, which have proved perfectly efficacious. In doing this we have seen a 30-inch drain opened up and found to be perfectly dry, and yet when the same trench was deepened to four feet there was quite a run of water from it. Now also that steam-power has become available for the tillage of the soil, and is certain, at no distant day, to be in general requisition for that purpose, it is peculiarly expedient to have the drains laid at such a depth as to admit of that potent agency being used for loosening the subsoil to depths hitherto unattainable, not only without hazard to the drains, but with the certainty of greatly augmenting their efficiency. Therefore we earnestly dissuade all parties who are about to undertake drainage works from giving ear to representations about the sufficiency and economy of shallow drains. These, doubtless, cost somewhat less to begin with, but in thousands of cases they fail to accomplish the desired end, and the unfortunate owners, after all their outlay, are left to the miserable alternative of seeing their land imperfectly drained, or of executing the works anew, and thus losing the whole cost of the first and inefficient ones. The extreme reluctance with which the latter alternative is necessarily regarded will undoubtedly operate for a long time in keeping much land that has been hastily and imperfectly drained from participating in the benefits of *thorough* drainage. The distance apart at which the drains should be cut must be determined by the nature of the subsoil. In the most retentive clays it need not be less than 18 feet. On the other hand, this distance cannot safely be exceeded in the case of any subsoil in which clay predominates, although it should not be of the most retentive kind. In all parts of the country instances abound in which drains cut in such subsoils from 24 to 30 feet apart, have totally failed to lay the land dry. When ground is once pre-occupied by drains too far apart, there is no remedy but to form a supplementary one betwixt each pair of the first set; and thus, by exceeding the proper width at first, the space betwixt the drains is unavoidably reduced to 12 or 15 feet, although 18 feet would originally have sufficed. It is only with a decided porosity in the subsoil, and in proportion to the degree of that porosity, that the space betwixt drains can safely be increased to 24, or 30, or 36 feet. In those exceptional cases in which drains more than 36 feet apart prove effectual, their success is due to the principle on which Elkington's system is founded. A few years ago an opinion obtained currency, that as the depth of drains was increased their width apart might with safety be increased in a corresponding ratio. And hence it came to be confidently asserted, that with a depth of 5 or 6 feet a width of from 40 to 60 feet might be adopted with a certainty of success, even in the case of retentive soils. We believe that experience has already demonstrated the unsoundness of this opinion. At all events, in recommending a minimum depth of 4 feet, we do so on the ground that (other things being equal), the whole benefits of drainage are more fully and certainly secured by drains of this depth than by those of 2½ or 3 feet. In ordinary cases an increase of depth does not compensate for an increase of the width apart of the drains. Draining can be carried on at all seasons; but is usually best done in summer or autumn. The digging is usually paid for by task work, and the setting of the pipes by day's wages. A thoroughly trustworthy and experienced workman is selected for the latter work, with instructions to set no pipes until he is satisfied that the depth of the drains and level of the bottoms are correct. When the soil is returned into the drains all defects are of course buried, and it therefore behoves the landlord, or his substitute, whether tenant or bailiff, to exercise a vigilant oversight of draining operations. Unless carefully executed they cannot be efficient; and without efficient drainage all other agricultural operations must be carried on under grievous disadvantages. The extent of land in Great Britain naturally so dry as not to need artificial drainage is very much less than even practical farmers, who have not studied the subject, are at all aware of.

Cylindrical pipes with collars are undoubtedly the best draining material that has yet been discovered. The collars referred to are simply short pieces of pipe, just so wide in the bore as to admit of the smaller pipes which form the drain passing freely through them. In use, one of these collars is so placed as to encase the ends of each contiguous pair of tubes, and thus forms a loose fillet around each joining. The ends of these pipes being by this means securely kept in contact, a continuous canal for the free passage of water is infallibly insured, the joinings are guarded against the entrance of mud or vermin, and yet sufficient space is left for the admission of water. Pipes of all diameters, from 1 inch to 16 inches, are now to be had; those from 1 to 2 inches in the bore are used for subordinate drains; the larger sizes for sub-main and main receiving drains. Collars are used with the smaller sizes only, large pipes not being so liable to shift their position as small ones. In constructing a drain it is of much importance that the bottom be cut out just wide enough to admit the pipes and no more. Pipes, when thus accurately fitted in, are much less liable to derangement than when laid in the bottom of a trench several times their width, and into which a mass of loose earth must necessarily be returned.

This accurate fitting is now quite practicable in the case of soils tolerably free from stones from the excellence of the draining tools that have lately been introduced. The following cut represents the most important of these tools.



c and *e* are long tapering spades for digging out the middle and bottom spits, *a*, *d*, and *f* recurved scoops for clearing out the debris, and *b* a pipe-layer, by means of which a workman standing at the margin of a drain hooks up a pipe and collar, and deposits them easily and accurately in the deep narrow trench.

If a quicksand is encountered in constructing a drain, it will be found expedient to put a layer of straw in the bottom of the trench, and then, instead of the ordinary pipe and collar, to use at such a place a double set of pipes—one within the other—taking care that the joinings of the inner set are covered by the centres of the outer ones. By such precautions the water gets vent, and the running sand is excluded from the drain. When a brook has been diverted from its natural course for mill-power or irrigating purposes, it often happens that portions of land are thereby deprived of the outfall required to admit of their being drained to a proper depth. In such cases it is frequently practicable to obtain the needed outlet by carrying a main drain through below the water-course, by using at that point a few yards of cast-iron pipe, and carefully filling up the trench with clay puddle, so that there may be no leakage from the water-course into the drain. While this is adoing the water must either be turned off or carried over the temporary gap in a wooden trough.

The cost of draining is so much influenced by the ever-varying price of labour and materials, and by the still more varying character of the land to be operated upon, that it is impossible to give an estimate of the cost that will admit of general application. The following tabular data, taken chiefly from Mr. Bailey Denton's valuable treatise, are presented to aid those who wish to form such an estimate :—

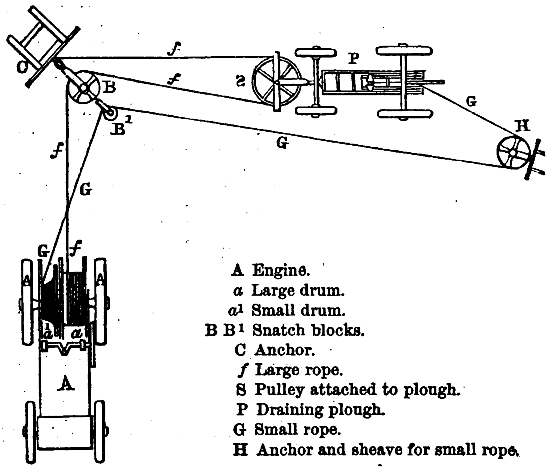
TABLE I.—*Shewing the number of rods of Drain per acre at given distances apart, and the number of Pipes of given lengths required per acre.*

Intervals between the Drains in feet.	Rods per acre.	Twelve-inch Pipes.	Thirteen-inch Pipes.	Fourteen inch Pipes.	Fifteen-inch Pipes.
18	146⅔	2420	2234	2074	1936
21	125 5/7	2074	1915	1778	1659
24	110	1815	1676	1555	1452
27	97 7/9	1613	1489	1383	1290
30	88	1452	1340	1244	1161

TABLE II.—*Shewing the Cost of Draining per acre at different intervals between the Drains.*

	Eighteen feet apart.			Twenty-one feet apart.			Twenty-four feet apart.			Twenty-seven feet apart.			Thirty feet apart.		
	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Labour, cutting and filling in at 6s. per rod............	3	13	4	3	2	10	2	15	0	2	8	11	2	4	0
Material, pipes for minor drains, 18s. per 1000	2	5	9	1	19	2	1	14	3	1	10	6	1	7	5
Haulage, two miles, and delivery in fields at 2s. 6d. per 1000	0	6	4	0	5	5	0	4	9	0	4	3	0	3	9
Pipe-laying and finishing, 1d. per rod	0	12	2	0	10	6	0	9	2	0	8	2	0	7	4
Superintendence, foreman .	0	5	0	0	5	0	0	5	0	0	5	0	0	5	0
Extra for mains	0	2	0	0	2	0	0	2	0	0	2	0	0	2	0
Iron-outlet pipes, and masonry, and extra labour...	0	1	6	0	1	6	0	1	6	0	1	6	0	1	6
Total	7	6	1	6	6	5	5	11	8	5	0	4	4	11	0
Add for collars, if used	1	2	10	0	19	7	0	17	1	0	15	3	0	13	8
£	8	8	11	7	6	0	6	8	9	5	15	7	5	4	8

Various attempts have from time to time been made to lower the cost of draining land by the direct application of animal or steam power to the work of excavation. The most successful of these attempts is the steam-draining aparatus invented by Mr. John Fowler of Bristol, usually called *Fowler's draining plough.* A six-horse portable steam-engine is anchored in one corner of the field to be drained. It gives



A Engine.
a Large drum.
a[1] Small drum.
B B[1] Snatch blocks.
C Anchor.
f Large rope.
S Pulley attached to plough.
P Draining plough.
G Small rope.
H Anchor and sheave for small rope.

motion to two drums, to each of which a rope 500 yards long is attached, the one uncoiling as the other is wound up. These ropes pass round blocks which are anchored at each end of the intended line of drain, and are attached one to the front and the other to the hind end of the draining apparatus. This consists of a framework, in which is fixed, at any required depth not exceeding 3½ feet, a strong coulter terminating in a short horizontal bar of cylindrical iron, with a piece of rope attached to it, on which a convenient number of drain pipes are strung. This frame being pulled along by the engine, the coulter is forced through the soil at a regulated depth, and deposits its string of pipes with unerring accuracy, thus forming, as it proceeds, a perfect drain. The supply of pipes is kept up by means of holes previously dug in the line of the drain, at distances corresponding to the length of the rope on which they are strung. This machine was subjected to a very thorough trial at the meeting of the Royal Agriculturel Society of England, at Lincoln, in 1854, on which occasion a silver medal and very high commendation were awarded to it. In March 1855 it was publicly stated that five of these implements are now at work in different parts of England, and that already 10,000 acres of land have been drained by means of them. At the Lincoln trial it was satisfactorily proved that this implement could work at a depth of 3½ feet. As it moved along, the soil on either side, to the width of 2 or 3 feet, seemed to be loosened. It is therefore probable that this implement, or at least one propelled on the same principle, may yet be used as a subsoil disintegrator.

A great stimulus has recently been given to the improvement of land by the passing of a series of acts of parliament, which have removed certain obstacles which effectually hindered the investment of capital in works of drainage and kindred ameliorations. By the first of these acts, passed in 1846, a sum of £4,000,000 of the public money was authorized to be advanced to landowners to be expended in draining their lands. The Inclosure Commissioners were charged with the allocation of this money, and the superintendence of its outlay. The most important provisions of this act are that it enables the possessors of entailed estates (equally with others) to share in the benefits of this fund—that it provides, on terms very favourable to the borrower, for the repayment of the money so advanced by twenty-two annual instalments—that before sanctioning the expenditure of these funds on drainage works, the commissioners must have a report from a qualified inspector, to the effect that they are likely to prove remunerative—and finally, that the works must be performed according to specifications prepared by the inspector, and approved by the commissoners, who have seldom allowed of a less depth of drain than 3½ feet. By the end of the year 1854 the whole of this money was allocated, and more than half of it actually expended. Scottish landowners were so prompt to discern, and so eager to avail themselves of this public fund, that more than half of it fell to their share. The great success of this measure, and the rapid absorption of the fund provided by it soon led to further legislative acts, by which *private capital* has been rendered available for the improvement of land, by draining and otherwise, on conditions similar to those just enumerated. These acts are—

1*st*, The *Private Moneys Drainage Act* (12th and 13th Vict., cap. 100), limited to draining only.

2*d*, The *West of England, or South-West Land Draining Company's Act* (11th and 12th Vict., cap. 142), for the purpose of draining, irrigation and warping, embanking, reclaiming and inclosing, and road-making.

3*d*, The *General Land-Drainage and Improvement Company's Act* (12th and 13th Vict., cap. 91), for the purposes of draining, irrigating and warping, embanking, reclaiming and inclosing, road-making and erecting farm-buildings.

4*th*, The *Lands Improvement Company's Act* (16th and 17th Vict., cap. 154), for the same purposes as the above with the addition of planting for shelter. This company's powers extend to Scotland.

By these acts ample provision is made for rendering the dormant capital of the country available for the improvement of its soil. To the owners of entailed estates they are peculiarly valuable, from the power which they give to them of charging the cost of draining, etc., upon the inheritance. If such owners apply their own private funds in effecting such improvements, they are enabled, through the medium of these companies, to take a rent-charge on their estates for the repayment of money which they so expend, over which they retain personal control, so that they can bequeath as they choose the rent-charge payable by their successor. Besides their direct benefits, these drainage acts have already produced some very important indirect fruits. They have led to many improvements in the manner of accomplishing the works to which they relate, to the wide and rapid dissemination of improved modes of draining, etc., and, in particular, they have had the effect of creating, or at least of greatly multiplying and accrediting, a staff of skillful and experienced draining engineers, of whose services all who are about to engage in draining and similar works will do well to avail themselves.

Section 3.—Removal of Earthfast Stones.

Newly reclaimed lands, and even those that have long been under tillage, are frequently much encumbered with earth-fast stones. This is particularly the case in many parts of Scotland. Their removal is always desirable, though necessarily accompanied with much trouble and expense. In our personal practice we have proceeded in this way. In giving the autumn furrow preparatory to a fallow crop, each ploughman carries with him a few branches of fir or beech, one of which he sticks in above each stone encountered by his plough. If the stones are numerous, particularly at certain places, two labourers, provided with a pick, a spade, and a long wooden lever shod with iron, attend upon the ploughs, and remove as many of the stones as they can, while yet partially uncovered by the recent furrow. Those thus dug up are rolled aside upon the ploughed land. When the land gets dry enough in spring, those not got out at the time of ploughing are discovered by means of the twigs and are now dug up. Such as can be lifted by one man are carted off as they are, but those of the larger class must first be reduced by a sledge hammer. They yield to the hammer more easily after a few days' exposure to drought than when attacked as soon as dug up. Before attempting to break very large boulders a brisk fire of dried gorse or brushwood is kept up over them until they are heated, after which a few smart blows from the hammer shiver them completely. Portions of otherwise good land are sometimes so full of these boulders, that to render them available, the stones must be got rid of by trenching the whole to a considerable depth. When ploughing by steam-power becomes general, a preliminary trenching of this kind will in many cases be requisite before tillage instruments thus propelled can be used with safety.

Section 4.—Paring and Burning.

Paring and Burning has, from an early period, been resorted to for the more speedy subduing of a rough uncultured surface. It is still the most approved method of dealing with such cases, as well as with any tough old sward which is again to be subjected to tillage. In setting about this operation, which is usually done in March or April, a turf, not exceeding an inch in thickness, is first peeled off in successive stripes by a paring-plough drawn by two horses, or by the breast-plough already described. These turves are first set on edge and partially dried, after which they are collected into heaps, and burned, or rather charred. The ashes are immediately spread over the surface, and ploughed in with a light furrow. By this process the matted roots of the pasture plants, the seeds of weeds, and the eggs and larvæ of innumerable insects, are at once got rid of, and a highly stimulating top-dressing is supplied to the land. A crop of turnips or rape is then drilled on the flat, and fed off by sheep, after which the land is usually in prime condition for bearing a crop of grain. This practice is unsuitable for sandy soils, which it only renders more sterile; but when clay or peat prevails, its beneficial effects are indisputable. We shall, in the sequel, give an example of its recent successful application.

Section 5.—Levelling.

Land, when subjected to the plough for the first time, abounds not unfrequently with sudden hollows and protuberances, which impede tillage operations. These can be compendiously levelled by means of a box shaped like a huge dust-pan, the front part being shod with iron, and a pair of handles attached behind. This levelling-box is drawn by a pair of horses. Being directed against a prominent part, it scoops up its fill of soil, with which it slides along sledge-fashion to the place where it is to discharge its load, which it does by canting over, on the ploughman disengaging the handles.

In all parts of Great Britain, abundance of pasture land, and often tillage land also, is to be met with lying in broad, highly raised, serpentine ridges. These seem to have originated when teams of six or eight bullocks were used in ploughing; and it has been suggested that this curvature of the ridges at first arose from its being easier to turn these long teams at the end of each land by sweeping round in a curve than by driving straight out. The very broad headlands found in connection with these curved ridges point to the same fact. A theory still lingers among our peasantry, that "water runs better in a crooked furrow than in a straight one," and has probably been handed down since the discovered awkwardness of curved ridges was first seen to need some plausible apology. These immense, wave-like ridges are certainly a great annoyance to the modern cultivator; but still the sudden levelling of them is accompanied with so much risk, that it is usually better to cut drains in the intervening hollows, and plough aslant them in straight lines, by which means a gradual approximation to a level surface is made. A field in our own occupation, which was levelled, by cleaving down the old crooked ridges, fifty years ago, still shews, by alternate curving bands of greater and less luxuriance, the exact site of the crowns and furrows of the ancient ridges.

Section 6.—*Trenching.*

But for its tediousness and costliness, trenching two or three *spits* deep by spade or fork is certainly the most effectual means for at once removing obstructions, levelling the surface, and perfecting the drainage by thoroughly loosening the subsoil. For the reasons mentioned, it is seldom resorted to on a large scale. But it is becoming a common practice, with careful farmers, to have those patches of ground in the corners, and by the fences of fields, which are missed in ploughing, gone over with the trenching-fork. The additional crop thus obtained may fail to compensate for this hand-tillage, but it is vindicated on the ground that these corners and margins are the nurseries of weeds which it is profitable to invade and abolish.

CHAPTER VI.

TILLAGE OPERATIONS.

Section 1.—*Ploughing.*

WHEN the natural green sward, or ground that has been cleared of a cultivated crop, is to be prepared for the sowing or planting of further crops, the plough leads the way in breaking up the compact surface, by cutting from it successive slices, averaging about ten inches in breadth by seven in depth, which it turns half over upon each other to the right-hand side. This turning of the slices or furrows to one side only, renders it necessary to square off the space to be ploughed into parallelograms, half the slices of which are laid the one way and the other half the other, by the going and returning of the plough. These parallel spaces are variously termed *ridges*, *stetches*, *lands*, or *feirings*, which, in practice, vary in width from a few furrows to 30 yards. When very narrow spaces are used, a waste of labour ensues, from the necessity of opening out and then re-closing an extra number of index or guiding furrows; while very wide ones involve a similar waste from the distance which the plough must go empty in traversing at the ends. The spaces thus formed by equal numbers of furrow-slices turned from opposite sides have necessarily a rounded outline, and are separated by open channels. In a moist climate and impervious soil, this ridging of the surface causes rain-water to pass off more rapidly, and keeps the soil drier than would be the case if it was kept flat. Hence the cultivated lands of Great Britain almost invariably exhibit this ridged form of surface. Until the art of under-ground draining was discovered, this was indeed the only mode of keeping cultivated ground tolerably dry. But it is at best a very defective method, and attended by many disadvantages. When land is naturally dry, or has been made so by thorough drainage, the flatter its surface is kept the better for the crops grown upon it. We are not forgetful that there are in various parts of Great Britain, clays so impervious, that probably no amount of draining or disintegration of the subsoil will render it safe to dispense with ridging. These, however, are exceptional cases, and, as a rule, such a condition of soil and subsoil should be aimed at as will admit of this rude expedient of ridging being altogether dispensed with. Unless land can absorb the whole rain which falls upon it, its full range of fertility cannot be developed; for the same showers which aggravate the coldness and sterility of impervious and already saturated soils, carry down with them, and impart to those that are pervious ever fresh supplies of genial influences. Instead, then, of this perennial source of fertility being encouraged to run off by surface channels, or to stagnate in the soil and become its bane, let provision be made for its free percolation through an open stratum several feet in thickness, and then for its escape by drains of such depth and frequency as each particular case requires. When this is attained, a flat surface will generally be preserved, as alike conducive to the welfare of the crops, and to the successful employment of machinery for sowing, weeding, and reaping them.

In all treatises on British Agriculture of a date anterior to the first quarter of the present century, we find great stress laid on the proper formation of the ridges, careful cleaning out of the separating channels, or water-furrows, and drawing and spading out of cross-cuts in all hollows, so that no water may stagnate on the surface of the field. As thorough underdraining makes progress, such directions are becoming obsolete. But whether ridging or flat work is used, the one-sided action of the plough renders it necessary, in setting about the ploughing of a field, to mark it off into parallel spaces by a series of equidistant straight lines. Supposing the line of fence, at the side at which he begins, to be straight, the ploughman takes this as his base line; and measuring from it, erects his three or more feiring poles perfectly in line, at a distance from the fence equal to half the width of the ridges or spaces in which it is proposed to plough the field. This operation—called in Scotland *feiring* the land—is usually entrusted to the most skilful ploughman on each farm, and is regarded as a post of honour. Having drawn a furrow in the exact line of his poles, which practice enables him to do with an accuracy truly admirable, he proceeds, using always the last furrow as a fresh base from which to measure the next one, until the field is all marked off. When this is done, it presents the appearance of a neatly ruled sheet of paper. Besides the poles just referred to, the ploughman is frequently furnished with a cross staff, by means of which he first of all marks off two or more lines perpendicular to the straight side at which he commences, and along these he measures with his poles, which are graduated for the purpose, in laying off his parallel lines. This feiring is only required when a process of fallowing, in preparation for green crop, has obliterated the former ridges. In breaking up clover lea or older sward, the ploughman begins at the open furrows, which afford him a sufficient guide.

In ploughing for a seed-bed the furrow-slice is usually cut about five inches deep. In the case of lea, it should be turned over unbroken, of uniform thickness, and laid quite close upon the preceding one, so as to hide all green sward. The improved wheel-plough already referred to does this work very beautifully, cutting out the slice perfectly square from the bottom of the furrow. The perfect uniformity in the width and depth of the slices cut by it, permits the harrows to act equally upon the whole surface. When the slice is cut unevenly, they draw the loosened soil from the prominences into the hollows, so that one part is scraped bare, and the other remains untouched and unbroken. This must necessarily yield a poor seed-bed, and contrasts unfavourably with the uniform tilth produced by harrowing after such work as these wheel-ploughs invariably produce. In the Lothians and west of Scotland, a form of plough is much used for ploughing lea, which cuts out the slice with an acute angle at the land side. This, when turned over, stands up with a sharp ridge, which looks particularly well, and offers a good subject for harrows to work upon. But if a few of these furrow-slices are removed, the firm earth below exhibits the same ribbed appearance as the newly ploughed surface, instead of the clear level sole on which the right-angled slice cut by the wheel-plough is laid over so as to rest upon its lower angle. This ribbing of the unstirred subsoil is exceedingly objectionable in all kinds of ploughing.

In the autumn ploughing of stubble-ground in preparation for the root-crops of the following season, a much deeper furrow is turned over than for a seed-furrow. In ordinary cases it should not be less than nine inches, while in very many, if ten or twelve can be attained, so much the better. In all deep soils this bringing up and mixing with the surface of fresh material from below, is highly beneficial. It must not, however, be practised indiscriminately. Siliceous and peaty soils need compactness, and to have the soil that has been artificially enriched kept a-top. For such deep work as we have noticed above, three or even four horses are frequently yoked to the plough. When a field slopes considerably one way, it is good practice to work the plough down the slope only, and return it to the top empty. A pair of horses working in this way will turn as deep a furrow, and get over as much ground, as three will do taking a furrow both ways, and with less fatigue to themselves and to the ploughman. After bringing a heavy furrow downhill, they get recruited in stepping briskly back with only the empty plough to draw. This mode of ploughing one furrow *down* the slope, tends less to gather the soil toward the bottom than by using a turn-wrest plough *across* the slope. It is while giving this deep autumn furrow that the subsoil plough is used. It follows in the wake of the common plough, and breaks and stirs the subsoil, but without raising it to the surface. This is a laborious operation, and engrosses too much of the horse-power of the farm to admit of large breadths being overtaken in any one season. In all indurated subsoils, however, it repays its cost; for when once thoroughly done, it diminishes the labour of ordinary ploughings for several succeeding rotations, aids the drainage, and adds to the fertility of the soil. It is in the performance of this deep autumn tillage and breaking up of the subsoil, that the steam-engine, with appropriate tackle, has begun to play an important part, and for which it will probably one day supersede all other means.

Section 2.—Harrowing, etc.

The harrow, cultivator, and roller, are all more simple in their action, and easier managed than the plough. Harrowing is most effective when the horses step briskly along. The tines are then not merely drawn through the soil, but in their combined swinging and forward movement, *strike* into it with considerable force. It is with reference to this that a single application of this implement is called a *stroke* of the harrows. Rollers are used to aid in pulverizing and cleaning the soil by bruising clods, and lumps of tangled roots and earth, which the other implements have brought a-top;

in smoothing the surface for the reception of small seeds, or the better operation of the scythe and other implements; and for consolidating soil that is too loose in its texture. Except for the latter purpose light rollers are much superior to heavy ones. When it is wanted, for example, to bruise clots of quickens, that the after harrowing may more thoroughly free the roots from the adhering earth, a light cast-iron roller, say of 5 cwt., drawn by one horse, effects this purpose as thoroughly as one double the weight drawn by a pair; and does it, moreover, in much less time, at less than half the expense, and without injuriously consolidating the free soil. These light rollers are conveniently worked in pairs; the ploughman driving one horse and leading the other. With a pair of active horses, and such rollers, a good deal more then *double* the space can be rolled in a day, than by yoking them both to one heavy one of the same length of cylinder. For mere clod-crushing, provided the clods are moist, the Norwegian harrow is superior to any roller; and for compressing a loose surface or checking wire-worm, serrated or smooth-edged discs, such as Crosskill's or Cambridge's, are better than smooth cylinders of the same weight, so that the heavy smooth roller, requiring two or more horses to draw it, is superseded by better implements for all purposes where rollers are used at all, unless it be for the rolling of the grass-lands.

As a general rule, none of these tillage operations can be performed to advantage when the soil is wet. When rain falls inopportunely there is a strong temptation to push on the field operations, before the soil has recovered the proper state of dryness. When this is done the farmer almost invariably finds in the issue that he has made more haste than good speed. Soils with a good deal of clay in their composition are peculiarly susceptible of injury in this way. Nice discrimination is needed to handle them aright. They require, moreover, a full stock of well-conditioned horses, that the work may be pushed rapidly through whenever the tide favours. To manage such soils successfully, especially when root crops are grown, tries the skill of the farmer to the utmost. So at least it has hitherto been; but with steam-power to aid him, there is now a probability that the clay-land farmer, by being able to break up his soil without treading it, and to get through with a large extent of tillage when his land is in trim for it, may find it practicable to grow root crops on equal terms with the occupier of freer soil.

Section 3.—*Fallowing.*

When, by such operations as have now been described, land has been reclaimed from its natural state, and rendered fit for the purposes of the husbandman, it is everywhere so charged with the germs of weeds, most of which possess in a remarkable degree the power of reproduction and multiplication, that it is only by the most incessant and vigorous efforts he can restrain them from encroaching upon his cultivated crops, and regaining entire possession of the soil. He can do much towards this by ordinary tillage, and by sowing his crops in rows, and hoeing in the intervals during the early stages of their growth. But if his efforts are restricted to such measures only, the battle will soon go against him. Besides this, all arable soils in which clay predominates, particularly when undrained, have such a determined tendency to become compact and soured, that under ordinary efforts they fail to yield a genial seed-bed. There is a necessity, therefore, for having recourse, from time to time, to that ameliorating process of lengthened tillage called fallowing. This process begins in autumn, immediately after the removal from the ground of the cereal crop, which had been sown upon the land newly broken up from clover lea, or natural sward, and extends either to the time for sowing turnips and analogous crops in the following spring, or is continued during the entire summer in preparation for autumn-sown wheat. We shall first describe that modification of the fallowing process by which the soil is prepared for the sowing of drilled green crops, and then the more prolonged form of it usually called *summer* or *naked* fallow.

Green Crop Fallow.

The object aimed at being the thorough disintegration and cleaning of the soil, the usual practice is to begin by ploughing as deeply as is found practicable. This first or autumn furrow is accordingly turned over to a depth of 8 or 9 inches; or by using a stronger plough drawn by three or four horses, it is carried to 12 inches in depth; and in some cases, by following with a sub-soil plough in the wake of the common one, the soil is stirred to the depth of 14 or 16 inches. All cultivators are agreed as to the importance of thus deeply and effectually disintegrating all soils that are naturally dry or thoroughly drained. In the case of undrained lands, and even of very unctuous clays, although well drained, such deep stirring of the soil in autumn does but increase its capacity of retaining the rains of winter, and of being thereby more effectually soured, and is therefore to be avoided. Assuming, however, that we have to do with soil thoroughly drained and moderately friable, it is undoubtedly beneficial to loosen it deeply and thoroughly at this stage. But before this deep ploughing is set about, it will be worth while to consider well its bearing upon the cleaning part of the process. On carefully examining the fields at the time of reaping the grain-crops, and from week to week thereafter, the roots of the couch-grass are found at first lying close to the surface; but instantly, on their getting the ground to themselves, they begin to send out fresh fibres, and to push their shoots deeply into the soil. In these circumstances, to proceed at once, according to the customary practice, to plough deeply, allows these weeds much time to increase, while this laborious and tedious operation is going on; and although, when performed, it gives some present check to their progress, by burying them under a mass of loosened soil, it not only increases the difficulty of their after removal, but places them out of the reach of frost, and in the best possible position for pervading the entire soil, on the first recurrence of mild weather. The consequence is, that fallows so treated are invariably found in spring more fully stocked with quickens than they were at the time of the autumn ploughing. The observation of this suggested the practice, now very common in England, of *cleaning fallows in autumn before giving the first deep furrow.* For this purpose, such implements as Biddle's scarifier, the broad-share paring-ploughs, or better still the common plough, divested of its mould-board and fitted with a share a foot broad, are set to work as fast as the grain-crops are reaped, and the whole surface is rapidly pared at a depth of three or four inches. This completely loosens the yet shallow-lying roots of the couch-grass, which are then freed from the adhering earth by the Norwegian and chain-harrow, raked together and burned, or carted off. This pulverizing of the surface-soil, in early autumn, is usually followed by the springing up of an abundant crop of annual weeds and of shaken grain, which are thus got rid of by the subsequent ploughing. So great and manifold are the advantages of this modern practice, that in those districts where it is most in use, other autumn work, even wheat-sowing, is comparatively neglected until it is accomplished. When the weeds have been got rid of in this summary and inexpensive manner, deep ploughing is then resorted to with unalloyed benefit. Whenever steam-power becomes fully available for tillage operations this autumn cleaning and deep stirring of fallows will be accomplished rapidly and effectually, and the teams will meanwhile be set at liberty for root-storing, wheat-sowing, and other needful work, which can be well done only when accomplished during the brief season of good weather, which usually intervenes betwixt the close of harvest and beginning of winter.

In the case of farms that have for a lengthened period been carefully cultivated, the stubbles may be found so clean as not to require their whole area to be scarified in the manner now described. Instead of this, it may suffice to have them carefully examined, and such patches or stray plants of couch-grass, or other perennial weeds, as are met with, forked out. By this means the fallows are kept clean at little expense, and when spring arrives, those repeated ploughings, and other tedious and costly operations, are wholly avoided, in performing which the condition of the soil is marred and the best seed-time often missed. When fallows are thus cleaned in autumn, it is highly advantageous to cart on to them at once, and cover in with a deep furrow, all the farm-yard dung that is on hand up to the completion of their first ploughing. From the length of time which must elapse before the land can again be touched, it is quite safe, or rather, it is highly advantageous to apply all the recently made dung, although in a very rough state. In doing this, it is necessary that a person precede each plough, and trim the rank litter into the previous furrow, that it may be properly covered up and regularly distributed. Unless this precaution is observed, the ploughs are constantly choked and impeded, the manure is drawn together into unsightly hassocks, and the whole operation is imperfectly performed. The recommendations to this practice are—*first*, An important saving of labour; for the manure being carted direct from the yards, etc., on to the land, and evenly spread over it, there is no forming, covering up and turning of dunghills, or refilling and carting in spring. This heavy work is accomplished at a season when time is less pressing than in spring, and the sowing of the crop can be proceeded with more rapidly when the time for it arrives, and while weather favours. *Second,* There is a saving of manure by burying it at once in its rough state, instead of first fermenting it in large heaps; and a large portion of the fallow-break can thus be dressed with home-made manure. *Third,* The rough dung thus ploughed in decomposes slowly, its virtues are absorbed and retained by the soil, with the whole mass of which it is thoroughly incorporated by the spring tillage, and which, in consequence, is found, after such treatment, in a peculiarly mellow and favourable condition for receiving the seed.

The advantages of autumn cleaning and manuring of land in preparation for green crops are so great that the utmost exertions should be made to secure them. Over a large portion of England the harvest is usually so early as to leave ample time for accomplishing the cleaning process before being arrested by bad weather. From the later harvest-season and more humid climate of Scotland, it is there more difficult to carry it out to the whole extent of the fallow-break; but still, with promptitude and energy, much can be done. One of her shrewd and intelligent sons, Mr. Tennant, the inventor of the grubber which bears his name, has, however, introduced a system of autumn tillage, founded upon the same principle, and accomplishing virtually the same end, but less expensive and better adapted to the climate of Scotland than that just described. So soon as the grain crops are harvested, Mr. Tennant sets his light grubbers agoing, and by working them over the whole field several times and in opposite directions, stirs the whole surface soil to the depth of six or eight inches, tears up and brings to the surface all root-weeds, where, after being knocked about and freed from adhering soil by repeated harrowings and a final grubbing, they are left for the winter. In our own practice we have latterly improved, as we suppose, on Mr. Tennant's plan by broadsharing the land before using the grubbers, and also by employing the Norwegian harrow instead of the common one. The broadsharing ensures that the whole of the couch-grass and other weeds are thoroughly loosened without being buried, and the Norwegian harrow shakes out the roots from the adhering earth better than the common harrow. When it is intended to treat a field in this way care should be taken at harvest time to reap the crop as close to the ground as possible, as rank stubble seriously encumbers the tillage implements. In setting about the grubbing of a field it is expedient also to begin with the headlands, and to work them thoroughly all round twice over, before they are trodden down by the frequent turning of the horses upon them. If this is omitted it will be found nearly impossible to have the margins of the field as well cultivated as the rest of it. A field thus treated presents for a time a singulary untidy and unpromising appearance; but the ultimate effects of the practice, as well in the cleaning as the disintegrating of the soil, are very remarkable. When roots of couch-grass, etc. are freed from the soil, and fully exposed to the vicissitudes of the weather at a season when their vital force is at the lowest point, they are unable to resist its effects, and gradually die. If placed in similar circumstances in spring, with their vital energy in full play, the merest point of a root embedded in, or even in contact with, pulverised soil, enables them to push down fresh fibres, to re-establish their connection with the soil, and to grow as lustily as ever. But so completely is the destruction of these pests secured by this simple process of winter exposure, that on the return of spring they may be ploughed in with impunity. Mr. Tennant assures us, that ever since he adopted this practice he has been enabled to dispense with the removal of these weeds. Having had an opportunity of inspecting his farm, we are enabled to testify to its cleanness and high state of fertility. On this plan, then, the cleaning of fallows is accomplished by tillage operations alone, without any outlay for raking or hand-picking, burning or carting off. Nor is this done at the expense of the pulverising part of the process. On the contrary, Mr. Tennant asserts, and we have so far verified his assertion by actual experiment, that by disintegrating the soil in autumn, as is done by this broadsharing, grubbing, and harrowing, it receives far more benefit from the alternation of frost and thaw, rain and drought, than when merely ploughed and left lying during winter in compact furrow-slices. This plan affords the same facilities as the other for autumn manuring, if the weeds are raked off at once from so much of the fallow-break as it is wished to manure before winter. When the remainder is ploughed in April following, more of it may then have the farm-yard dung applied to it in the same way. Agriculturists owe a large debt of gratitude to Mr. Tennant for the invention of his beautifully simple and efficient grubber, and for this scientific application of it to the fallowing process. Those who have been pursuing this system of tillage will be much interested in observing that it has been adopted by Mr. Smith of Woolston, who is carrying it out to perfection by means of his steam-drawn implements.

The autumn tillage of the fallows having been accomplished in one or other of the ways described, the land is left untouched till the return of spring. If it is infested by annual weeds, it is expedient, as soon as it is dry enough to bear treading with impunity, to level and stir the surface by a turn of the harrows. This slight moving of the mellowed surface-soil induces the seeds of weeds to germinate more quickly than they would otherwise do, and thus a crop of them is got rid of by the next tilling. This preliminary harrowing is useful also in affording a level course for the tillage implements. By the time that the labour connected with the sowing of spring crops is over, the fallows are usually dry enough to be stirred with safety. This point, must, however, be well seen to, as irreparable mischief is often done by going upon them too soon. And now it is, that, instead of rigidly following any customary routine of so many ploughings, harrowings, and rollings, the skilful cultivator will regulate his procedure by the actual circumstances of his soil, and the object which he has in view. What is needed for the successful growth of drilled green crops, is to have the soil free from weeds, thoroughly disintegrated to the depth of six or eight inches, and yet moist enough to ensure the ready germination of seeds deposited in it. Where such autumn cleaning and manuring as we have described have been successfully carried out, all that is needed in order to obtain a proper tilth, is to go to work with light grubbers, first in the line of the previous furrows and then across them, and then to harrow, roll, and remove any weeds that have been missed in autumn, after which the soil will be in the best possible condition for drilling. On friable soils, this method of performing the spring tillage by means of the grubber instead of the plough, is perfectly practicable, and has manifold advantages to recommend it. The saving of labour is very great, as a man and pair of horses will more easily grub four acres than plough one acre. Weeds are more easily removed, as the grubber pulls them out unbroken, whereas the plough cuts them in pieces. The soil that has been all winter subjected to the mellowing influences of the weather, and which, in consequence, is in the best possible condition to yield a genial seed-bed, is retained a-top, whereas ploughing buries it and brings up clods in its stead. And lastly, the soil being merely stirred, without having its surface reversed, its natural moisture (*or winter sap*) is retained, whereby the germinating of seeds sown in it becomes almost a certainty. The importance of this last point in the cultivation of such crops as the turnip, whose seeds must usually be sown during hot and dry weather, can scarcely be overrated. This practice is peculiarly appropriate for soils of loose texture, which are invariably injured by repeated ploughings. But it is also resorted to sucessfully on soils of the opposite extreme. Many farmers in the Lothians now grow abundant and extensive crops of turnips on strong clay soils by spreading a liberal dressing of dung on the stubble in autumn, ploughing it in with a deep furrow, leaving the land untouched until sowing-time has fully arrived, and then stirring the mellowed surface soil by the grubbers, removing weeds, and drilling and sowing at once without any ploughing. When this system is adopted on tenacious soils, it is prudent to operate upon portions of the field in detail; taking in only so much at a time as can be grubbed and drilled the same day, for if rain should intervene betwixt the grubbing and the drilling, the soil would set like mortar and the tide be lost. When once the ridglets are made up in good condition, they can withstand a fall of rain with comparative impunity; and hence the occurrence of a course of fine weather, when the season is yet too early for sowing, is sometimes taken advantage of by preparing the land and making it up into ridglets, although it should require to remain in this state weeks, or even months, before sowing takes place. In such a case, immediately before sowing the ridglets are first partially levelled by harrowing lengthwise, in order to loosen the soil and destroy annual weeds, and then again made up by using a double-breasted plough. We must here, however, insist upon the importance of having the grubbing thoroughly performed, which it cannot be unless the tines penetrate the soil as deeply as the plough has done at the autumn ploughing. It is owing to the neglect of this that the system has failed in the hands of many farmers, who first mismanage the operation, and then throw the blame upon the grubbers. To ensure success, the implement must be set so as to work at its full depth, sufficient motive power being applied by yoking three horses, if necessary, to each grubber at the first and also at the second going over, and there must be vigilant superintendence exercised lest the ploughman do the work slightly. It is sometimes objected to this system of spring-tillage, that it fails to rid the land of thistles and other tap-rooted weeds; but it is surely easier to fork these out as they appear, than to plough a whole field merely to destroy as many thistles as a man, it may be, would dig up in a day. By taking advantage of the tilth obtained by the action of the elements, instead of first ploughing down the mellowed surface, and then attempting laboriously to reduce the obdurate furrows by mechanical means, skilful and energetic farmers now succeed in preparing even tenacious soils for drilled green-crops, at little expense, and with a good measure of certainty.

On these opposite classes of soils, then—the very loose, and the tenacious—spring tillage, in preparation for root-crops, is performed to better purpose by means of the grubber than the plough. Betwixt these extremes, however, lies the most valuable class of soils—the strong fertile loams—on which the heaviest crops and best quality of Swedes are grown. With these it is usually expedient to have recourse to at least one spring ploughing, as soon, but only as soon, as the soil is dry enough to crumble freely to the very bottom of the furrow. As this usually occurs from four to six weeks before the time of sowing the crop, it is advisable to plough the entire field, and leave it so until rain falls, when a moderate use of the grubber, harrows, and light roller, usually suffices to produce a good tilth for ridging. When operations are not thus facilitated by a seasonable fall of rain, it is necessary to proceed somewhat differently. The field is lying as it was left by the plough, with a rough dried surface. If harrowed while in this state, an abundant crop of clods is brought to the surface, which quickly harden when thus fully exposed to drought. To avoid this inconvenience, the field is *first* rolled with a heavy roller, and then grubbed across the direction in which it was last ploughed. By this means the clods being partially crushed and pressed down amongst the loose earth resist the grubber, and are crumbled by it, instead of being merely raked out and left entire on the surface, as would happen but for this preliminary rolling. The grubbers are followed closely by harrows and a light roller, and these again by the grubbers; but this time with *seven* tines on instead of five, after which a sufficient tilth is usually obtained. All this is on the supposition that the land is clean when these spring operations are commenced; for should it be otherwise, it is usually better to begin with the grubber on the stale winter furrow, and to get rid of the weeds, before using the plough. If it is found necessary to plough near to the time of sowing, then the harrow and roller must keep pace with the ploughs in order to retain moisture and prevent the formation of clods. The Norwegian harrow is the proper implement to use in such cases. Let it ever be born in mind that if the soil is cleaned, and sufficiently disintegrated, the less working it gets at this stage the better.

It may be well indeed to remind the reader that although the fallowing process can most conveniently be gone about during the period which intervenes betwixt the removal of a grain crop from the ground and the sowing of the succeeding root crop, and on this account is often spoken of in a loose way as being performed "in preparation for the root-crop," it is a fallacy to regard this laborious and costly process of tillage and cleaning as undertaken solely, or mainly, for the benefit of the turnip or other root, crop then about to be sown. The other crops of the rotation benefit by it in a far greater degree, and it would be required on their account although turnips were not grown at all, as may be seen in the case of clay lands with their periodic naked fallows. It is the overlooking of this fact which has led people to charge the whole cost of this fallowing process, and of all the manure then applied to the land, against the turnip-crop, and then to represent this crop as the most costly one which the farmer grows,—one which often yields him less than it cost to produce it. Undoubtedly the cost of the fallow must be charged equally against all the crops of the rotation.

Summer or Naked Fallow.

Having thus described at length that modification of the fallowing process by which the soil is prepared for the sowing of green crops, we shall now, as proposed, speak of that prolonged form of it called a *summer* or *naked* fallow. From the facilities now afforded, by means of tile-training and portable manures, for an extended culture of green crops, this laborious and costly process, which in its day was justly regarded as the very key to good and profitable farming, is now restricted to the more obdurate clay-soils, or to cases where draining and other modern improvements are neglected. The manifold advantages of having abundant crops of turnips, or mangel-wurzel, instead of naked fallow, sometimes tempt the occupiers of clay soils to push the cultivation of these crops beyond due bounds. We know of cases where, after large expenditure in draining, the cultivation of turnips has been carried to such an extent, and conducted so injudiciously, that the land has got foul and soured, and its gross produce has been reduced below what it was while the land was undrained, and under a regular system of all but exclusive naked fallows. However thoroughly drained, clay soils retain their ticklish temper, and are so easily disconcerted by interference during unfavourable weather, that the preparing of them for the cultivation of root-crops, and still more the removing of these crops when grown, is at best a hazardous business, and requires to be conducted with peculiar tact. Judicious farmers, who know by experience the difficulties that have to be overcome in cultivating such soils, are of opinion, that all that can yet be ventured upon with safety, is to prolong the period of the naked fallow's recurrence, rather than entirely to dispense with it. After a series of alternate grain and cattle crops, it is accordingly still their practice to wind up with a summer fallow, by which they rectify unavoidable defects in the tillage of preceding years, and put their land in good humour for entering again upon a fresh course of cropping.

This process is begun by a deep ploughing in autumn, in performing which the land is gathered into ridges, that it may be kept as dry as possible during winter. When the more urgent labours of the following spring are so far disposed of as to afford leisure for it, a second ploughing is given to the fallow—usually by reversing the furrows of autumn. This is followed at intervals by two cross-ploughings, which are made to reverse each other, in order to keep the land level. As it is the nature of these soils to break into lumps, under the action of the plough, rather than to crumble down, the clods thus produced get so thoroughly parched in dry weather, that root-weeds inclosed in them are killed by sheer desiccation. To further this cheap mode of getting rid of them, the land is not rolled, but stirred by the grubber and harrow as frequently as possible, so as to expose the clods freely to the drought. We know by experience that fallows can be cleaned effectually by thus taking advantage of the tendency in clay soils to bake excessively under exposure to the hot dry weather which usually prevails in June and July. Should the season happen to be a showery one, this line of tactics must needs be abandoned, and recourse had to the judicious use of the grubber, Norwegian and common harrow, in order to free the weeds from the soil, and then clear them off by raking or hand-picking. This is more costly, and as we believe, less beneficial to the soil than the simple method first noticed, which should therefore be attempted in the first place. As in hay-making, much can here be done in a few favourable days, by keeping grubbers and harrows at work, and turning the clods frequently. When farm-yard dung is to be applied to such fallows, it is desirable that it should be carted on and ploughed in before July expires. In applying it, two methods are followed. That usually adopted is, after marking off the ridges, to put down the dung in small heaps, at regular distances, and forthwith to spread it and plough it in. In the other, the land is formed into ridglets, running diagonally across the intended line of the ridges, and the dung is enclosed in them in the manner to be hereafter described in treating of turnip culture. In either way, after the lapse of several weeks, the surface is levelled by harrowing, and the land is gathered into ridges by the last of this series of ploughings, hence called the seed-furrow. When lime is to be applied to such land, this is the stage of the rotation which is usually chosen for doing so. It is spread evenly over the surface, immediately before the last ploughing. In finishing off this fallowing process, it is necessary, on undrained lands, to be careful to clean out the ridge-furrows and cross-cuts, in anticipation of wintry rains. But if such land is worth cultivating at all, it is surely worth draining, and this operation once thoroughly performed, puts an end to all further solicitude about furrows.

CHAPTER VII.

SUCCESSION OF CROPS.

Section 1.—*Rotation necessary.*

THERE are few agricultural facts more fully ascertained than this, that the growth, year after year, on the same soil, of one kind of plants, or family of plants, and the removal from it, either of the entire produce, or at least of the ripened seeds of such plants, rapidly impairs the general fertility of that soil, and, in particular cases, unfits it for bearing further crops of the kind by which it has been exhausted. The explanation of the causes of this phenomenon belongs to the agricultural chemist, or vegetable physiologist, to whom we willingly leave the task. What we have to do with is the fact itself, and its important bearing on agricultural practice. There is no natural tendency in the soil to deterioration. If at any time, therefore, the earth fails to yield its increase for the use of man, it is owing to his own ignorance and cupidity, and not to any defect in the beneficent arrangements of the Creator. The aim, then, of the agriculturist, and the test of his skill, is to obtain from his farm abundant crops at a remunerative cost, and without impairing its future productiveness. In order to this, two conditions are indispensable; 1st, that the elements of fertility abstracted from the soil by the crops removed from it be duly and adequately restored; and, 2d, that it be kept free from weeds. The cereal grains, whose seeds constitute the staple food of the human family, are necessarily the most important and valuable of our ordinary crops. The stated removal from a farm of the grain produced on it, and its consumption elsewhere, is too severe a drain upon its productive powers to admit of these crops being grown every year on the whole, or greater part of it, without speedily impairing its fertility. Supposing, however, that this waste could be at once repaired by the annual return to the soil of manure equivalent in constituent elements to the produce removed, the length of time which grain crops occupy the soil, and their habit of growth, interpose peculiar difficulties in the way of cleaning it thoroughly, either before they are sown, or while they occupy the ground. Again, although bread-corn is the most important product of our soil, other commodities, such as butcher-meat, dairy produce, vegetables, wool, and flax, are indispensably required. The economical culture of the soil demands the employment of animal power, which, to be profitably used, must be so distributed as to fill up the year. The maintenance of the working cattle, and of other live stock, implies the stated culture of a large amount of herbage and forage. Now, these varied conditions are duly met by cultivating grain and cattle crops alternately, and in about equal proportions. In carrying out these general principles, much discrimination is required in selecting the particular plants best adapted to the soil, climate, and other circumstances, of each farm; and in arranging them in the most profitable sequences. For not only is it necessary duly to alternate grain and green crops, but in general, there is a necessity, or at least a high expediency, in so varying the species or varieties of the latter class as to prolong, as much as possible, the periodic recurrence of any one of them on the same field. In settling upon a scheme of cropping for any particular farm, regard must be had to its capabilities, to the markets available for the disposal of its products, and to the command of manure. When these things have been maturely considered, it is always beneficial to conduct the cropping of a farm upon a settled scheme. The number of men and horses required to work it is regulated chiefly by the extent of the fallow-break, which it is therefore desirable to keep as near to an average annual breadth as possible. When the lands of a farm vary much—as regards fertility, fitness for particular crops, and proximity to the homestead,—they must be so apportioned as to make the divisions allotted to each class of crops as equal as possible in all respects, taking one year with another. Unless this is done, those fluctuations in the gross produce of farms which arise from varying seasons, are needlessly, it may happen ruinously, aggravated; or such an accumulation of labour is thrown on certain years which may prove unfavourable ones as to weather, that the work is neither done well nor in due season.

No better rotation has yet been devised for friable soils of fair quality than the well known four-field or Norfolk system. By this course half the arable lands are in grain crops, and half in cattle crops, annually. It is indeed true, that, in the way in which this course has hitherto been usually worked, both turnips and clover have recurred so frequently (every fourth year) on the same fields, that they have become subject to disease, and their produce excessively precarious. But the excellence of this course is, that its main features can be retained, and yet endless variation be introduced in its details. For example, instead of a rigid one-fourth of the land being each year under turnips, barley, clover, and wheat, or oats, respectively, half only of the barley division is frequently in practice, now sown with clover seeds, and the other half cropped in the following year with beans, peas, potatoes, or vetches. On the same set of fields, coming round again to the same point, the treatment is reversed by the beans, etc., and clover, being made to change places. An interval of *eight* years is thus substituted for one of *four*, so far as these two crops are concerned. Italian rye-grass, unmixed with any other plant, is now frequently taken in lieu of clover, on part of the division usually allocated to it, and proves a grateful change both to the land and to the animals which consume it. In like manner, instead of sowing turnips unvaryingly every fourth year on each field, a portion of the annual division allotted to this crop can advantageously be cropped with mangel-wurzel, carrots, or cabbages, care being taken to change the site occupied by each when the same fields again come in turn. The same end is even so far gained by alternating Swedish with yellow or globe turnips. It is also found expedient, either systematically or occasionally, to sow a field with clover and pasture grasses immediately after turnips, without a grain crop, and to allow it to remain in pasture for four years. A corresponding extent of the other land is meanwhile kept in tillage, and two grain crops in succession are taken on a requisite portion to equalize the main divisions, both as respects amount of labour and the different staple products. A closer cover of grasses and a better pasture is obtained in this way than by first taking the customary grain crop after turnips, the land is rested and invigorated for future tillage, the outlay on clover and grass-seeds somewhat diminished, and the land better managed for the interests of all concerned than by a rigid adherence to the customary rotation.

Section 2.—Restrictive Clauses in Leases Hurtful.

It is common enough for landlords, or their agents, to tie down the tenantry over large estates to the rigid observance of some pet rotation of their own. In an unimproved state of agriculture, and for a tenantry deficient both in capital and intelligence, such trammels, kindly enforced, may be as beneficial to them as to their landlord. But, when the culture of the soil is undertaken by men of good education, who bring to the business ample capital, and skill to use it to the best advantage, such restrictions are much more likely to do harm than good to both parties. It is to be observed in regard to those restrictive clauses usually inserted in farm-leases,—such as, that two grain crops shall never be taken in immediate succession; that no hay, straw, or turnips, shall be sold from the farm; that only certain limited quantities of potatoes or flax shall be grown; that land shall be two or more years in grass, etc.; that they all proceed on the supposition that the farm is to maintain its own fertility. They obviously do not contemplate the stated purchase of large quantities of guano, bones, and similar extraneous manures, or the consumption by live stock of linseed-cake, grain, or other auxiliaries to the green crops produced on the farm. Now, not only are such clauses incompatible with such a system of farming as we have just now indicated, but their direct tendency, if inforced, is to hinder a tenant from adopting it even when disposed to do so. We hear now-a-days of tenants who are annual purchasers of these extraneous fertilising substances to the extent of 20s. to 30s. worth for every acre occupied by them. To enforce the same restriction on such men as on others who buy none at all, is obviously neither just nor politic; and we believe that any practical farmer, if he had his choice, would rather be the successor of a liberal manurer, however he may have cropped, than of one who has farmed by rule on the starving system. We are quite aware that, in regard to the first-mentioned of these restrictions (viz., that which forbids taking two grains crops in immediate succession), the contrary practice is still asserted by agricultural authorities to be necessarily bad farming. Now, we do not concur with this opinion, but believe, on the contrary, that when land is kept clean, and is as highly manured and well tilled as it must be to grow cattle-crops in perfection, the second successive crop of grain will usually be better than the first, its production nowise injurious to the land, and the practice, *in such circumstances*, not only not faulty, but an evidence of the skill and good management of the farmer. A frequent encomium applied to a particularly well-cultivated farm is, that "it is like a garden." The practice of market-gardeners is also frequently referred to as a model for farmers. Now, the point with them is to have every inch of their ground under crop of some kind at all seasons, and to carry everything to market. Under such incessant cropping, the fertility of the soil is maintained only by ample manuring and constant tillage. By these means, however, it is maintained and the practice is extolled as the perfection of management. Such a system must therefore be as true in farming as in gardening, when the like conditions are observed. Undoubtedly he is a good farmer, who, while keeping his land clean and in good heart, obtains the greatest produce from it at the least proportionate outlay; and it is no valid objection to his practice merely to say, that he is violating orthodox rotations.

Section 3.—Experiments at Rothamstead and Lois Weedon.

Some curious information has been afforded regarding the effects of growing successive crops of one kind of plant on the same field, by two examples of it that have recently attracted much attention. We refer to the experiments of Mr. Lawes at Rothamstead, and of the Rev. Mr. Smith at Lois Weedon. It is well known that Mr. Lawes has now for a number of years devoted a considerable extent of land to the prosecution of a series of interesting experiments, one field being allotted to those upon wheat, another to turnips, and another to beans. One acre in the wheat-field has now borne ten successive crops of wheat without any manure whatever. The land is annually scarified and thoroughly cleaned so soon as the crop is removed, whereupon it is ploughed and again drilled with wheat, which is then hoed in spring. Now with occasional variations due to the character of particular seasons, Mr. Lawes finds that the average annual produce of this acre is 16 bushels of grain and 16 cwt. of straw, below which he has as yet failed to reduce it by ten successive crops. His soil is a strong clay loam, resting at a depth of five or six feet upon chalk. In the case of turnips, he has found that when treated in the same way they cease after a few years to grow larger than radishes, nor can he, by the application of any amount or variety of manure which he has yet tried, obtain a second successive crop equal to the first. With the wheat, on the contrary, the addition of four cwt. of Peruvian guano at once doubles the produce. Mr. Smith's experiments, as is well known, are a revival of Jethro Tull's system of growing wheat continually on the same field, by a plan of alternate strips of wheat and bare fallow, which are made to change places annually. He has so far improved upon Tull's practice, inasmuch as his land is thoroughly drained, and his fallow spaces are deeply trenched every autumn, as well as ploughed and hoed during the growing season. The result is, that his land thus treated has yielded an average annual produce of 34 bushels per acre for eleven or twelve successive crops. Now it is not our intention to offer any opinion on this as a system of wheat-growing. We refer to it along with Mr. Lawes's, for the purpose of showing that, notwithstanding the prevalent opinion that grain crops exhaust the fertility of soils more rapidly than green crops, this is true only in a very restricted sense. Green crops judiciously interposed do undoubtedly serve a most important purpose in the means which they furnish for mantaining the fertility of a farm; but it is worthy of note, that whereas by the addition of suitable manure, thorough tillage, and diligent removal of weeds, clay soil at least will stand an indefinite succession of grain crops, the same means entirely fail to yield the same results with our most popular green crops. Our personal experience quite accords with this; for we suppose it will be admitted, that the corn crops of the country are at the present day superior, both in quality and quantity, to those of any preceding period; whereas potatoes, turnips, and clover, which we have so long regarded as our sheet anchor, have become increasingly precarious, and threaten to fail us altogether. We offer these facts for the consideration of those who out-and-out condemn the practice of sowing two white crops in immediate succession. In stating this opinion, we must, however, guard against misapprehension. Unless the land is highly manured and kept thoroughly clean, we are just as much opposed to the practice as any one can be; but when mischief is done by it, we believe that it is due rather to the presence of weeds than to the second grain crop. Neither do we plead for the absolute removal of restrictive clauses from farm leases. Human nature being what it is, men who do not see it to be for their own advantage to farm well, will, through ignorance or greed, impoverish their land unless they are restrained. Clauses as to cropping should, however, be prohibitory rather than prescriptive—have reference rather to what is removed from the farm than to what is grown upon it—and they should be contingent upon the other practices of the tenant. So long as he continues by ample manuring and careful tillage to mantain the fertility and general good condition of the farm rented by him, it can be no advantage to his landlord to hinder him from cropping it at his own discretion. It will be seen from these remarks, that we attach more importance to those general principles which should regulate the succession of crops, than to the laying down of formulæ to meet supposed cases. The man who cultivates by mere routine is unprepared for emergencies, and is sure to lag in the race of improvement; while he who studies principles is still guided by them, while altering his practice to suit changing circumstances.

CHAPTER VIII.

MANURES.

Section 1.—*Farm-yard Dung.*

In our remarks on tillage operations, and on the succession of crops, we have seen how much the practice of the husbandman is modified by the kinds and amount of manures at his disposal. In describing the crops of the farm and their culture, frequent reference will also necessarily be made to the use of various fertilizing substances; and we shall, therefore, before proceeding to that department of our subject, enumerate and briefly remark on the most important of them. In such an enumeration, the first notice is unquestionably due to farm-yard dung.

This consists of the excrements of cattle, their litter, and the refuse of their fodder; usually first trodden down in successive layers, and partially fermented in the farm-yard, and then removed to some convenient place and thrown together in heaps, where, by further fermentation and decay, it is reduced to a dark-coloured, moist, homogeneous mass, in which state it is usually applied to the land. It is thus the residuum of the whole products of the farm, *minus* the exported grain, and that portion of the other crops which being first assimilated in the bodies of the live stock, is sold in the form of butcher-meat, dairy-produce, or wool. In applying farm-yard dung to land there is thus a returning to it of what it had previously produced, *less* the above exceptions, and such waste as may occur during the process of decay by gaseous exhalation or liquid drainage. It is obvious that the value of such dung as a fertilizing agent must depend much on two circumstances; viz., 1*st*, the nature of the food consumed by the animals whose excrements are mingled with it; and 2*d*, the success with which waste from drainage and exhalation has been prevented. When cattle used during the winter months to be barely kept alive on straw and water, and were confined in an open yard, which, in addition to its own share of rain, received also the drip from the eaves of the surrounding buildings—which, after percolating the litter, flowed unchecked into the neighbouring ditch—it is needless to say that the dung resulting from such a process was all but worthless. It is much to be regretted that, from the faulty construction of farm-buildings, farmers still find it impossible to guard their dung-stores from injury and waste. When cattle-yards are slightly hollowed towards their centre, and the surrounding eaves are spouted, the litter absorbs the whole of the urine and the rain which falls upon the uncovered area, while the treading of the cattle goes far to prevent undue fermentation and escape of gases. The same remark applies still more strongly to covered boxes, the dung resulting from this mode of housing fattening cattle being of the best quality. In the case of byres and stables it is certainly desirable to have a covered depôt, into which the litter and solid excrements may be wheeled daily, and to have the urine conveyed by proper drains and distributed over this mass of solid matter. As there is usually more liquid than these can at once absorb, it is well to have a tank at the lowest part of this depôt in which to store the surplus, that it may from time to time be returned upon the adjoining mass, or conveyed to heaps in the fields. Advantage is usually taken of frosty weather to cart out to the fallow division of the farm the dung that was accumulated in yards and boxes. It is formed into large square heaps about four feet deep, in situations most convenient for ready application to the land when the season for sowing the crops arrives. It is desirable to prepare a site for these heaps by carting together and spreading down a quantity of earth (or peat, when that can be got), for the purpose of absorbing the ooze from the fermenting mass laid upon it. At the beginning of winter, the loaded dung-carts are driven on to the heaps, and their contents are spread evenly over it, layer above layer, both to equalize the quality of the dung-heap as a whole; and, by the compression thus applied, to prevent a too rapid fermentation. When the heap has attained the requisite bulk, a covering of earth or peat is spread over it to keep it moist and to prevent the escape of its ammonia. When this home-made manure was the only kind statedly at the command of the farmer, it was considered necessary, and we believe truly, to have it in an advanced state of decomposition before applying it to a turnip crop. There was a waste of manure by this practice, but unless it was in a state to supply instant nourishment and stimulus to the young turnip plants, the crop was certain to be a deficient one. The application, along with farm-yard dung, of guano, superphosphate of lime, and other portable manures, quite does away with the necessity of having the former much rotted. These concentrated manures stimulate the growth of the plants during their early stage, and put them in the best condition for making gradual use of the slowly dissolving dung. Excessive decomposition of farm-yard dung is now therefore avoided, and pains rather bestowed to improve its quality by protecting it from the weather, and retaining its ammonia and natural juice. The cheapest, and perhaps also the best, way of doing this is to cart the dung direct from the cattle-yards to the fields, and at once to plough it in.

Section 2.—Liquid Manures.

We have spoken of the importance of carefully retaining the urine of the housed live stock, by having it absorbed in the solid matter of the dung-heap, and of collecting the surplus into a suitable tank, where it may be available for moistening the heap from time to time, and especially when about to be applied to the land. A system has, however, recently attracted much notice, by which pains are taken not only to preserve every drop of urine and ooze from dung-heaps, but, as far as practicable, to apply the whole manure produced on the farm in a liquid form. It is in Ayrshire, and especially on the farm of Myremill, that this system has been carried out most fully. Our reference will be best explained by quoting at length from the "Minutes of Information" issued by the General Board of Health regarding sewage manure.

"The next farm visited was in the immediate vicinity of Glasgow, where the supply of liquid manure is derived from another source, and distributed in a different manner. The supply is from a dairy of 700 cows, attached to a large distillery: the entire drainage from the former flows in a full continuous stream into a tank containing 30,000 or 40,000 gallons, whence it is pumped up immediately by a 12-horse power engine, and forced through 4-inch iron pipes, laid about 18 inches under ground, into large vats or cisterns placed on the highest points of the land to be irrigated. From these it descends by gravitation through another system of pipes laid along the ridges of the hills, finding an outlet through stand-cocks placed at intervals, from which it is distributed through movable iron pipes fitting into each other, and laid along the surface in whatever direction the supply is required. The land thus irrigated consists of three farms lying at some distance apart, the farthest point to which the liquid is conveyed being about two miles, and the highest elevation 80 feet above the site of the tank and engine. The principal use to which the irrigation has been applied has been to preserve the fertility of the pastures, the general appearance of which was at first rather disappointing, but this was explained by the fact that they are fully stocked, and that the cows rush with avidity to those parts that have been last irrigated, and eat them down quite bare. As is the case in other instances, however, by far the most profitable application has been found to be Italian rye-grass, of which 15 (Scotch) acres were under cultivation, some with seed supplied by Mr. Dickinson, whose successful cultivation of it by similar means near London has long been known. The first cutting of this had yielded about ten tons the acre, the second nine, and the third, which was ready for cutting, was estimated at eight or nine more. Some crops of turnips and cabbages were pointed out to us in a state of vigorous growth, and with more than common promise of abundance; these were raised by a dressing of ashes and refuse (of little fertilizing value, having been purchased at 2s. 6d. a ton), conjoined with four doses of liquid, one after the preceding crop of oats had been carried, one prior to sowing, and two more at different stages of growth. The enterprising gentleman who has carried out these works at his own expense, and in spite of the discouragement arising from partial failure in his earlier attempts, though speaking cautiously, as was natural in a tenant on a nineteen years' lease, of the pecuniary results of this undertaking, imparted some facts which leave little doubt that it must have been largely remunerative. Besides maintaining, if not increasing, the fertility of the pastures, to which the solid manure from the byres was formerly devoted, at a heavy expense of cartage (the whole of which is now saved), he is enabled to sell all this manure, of which we estimated the quantity at about 3000 tons a-year, at 6s. a-load. For a good deal of the Italian rye-grass not required for his own consumption, he obtained upwards of 13s. a ton, the profit on which, taking into account the yield before stated, may easily be imagined. Thirteen carts, each containing six barrels of ten gallons each, are used to convey the milk to market, where it is sold at 5d. the Scotch pint, equal to six pints imperial measure. The income from milk would, therefore, be not less than £43 : 6 : 8 per day, or £15,816 : 13 : 4 per annum.

"The next place visited was the farm of Myremill, near Maybole, in Ayrshire, the property of Mr. Kennedy, who adopted and improved on the method of distribution just described. On this farm, about 400 imperial acres of which are laid down with pipes, some of the solid as well as the liquid manure has been applied by these means, guano and superphosphate of lime having been thus transmitted in solution, whereby their value is considerably enhanced. This is especially the case with guano, the use of which is thus rendered in great measure independent of the uncertainties of climate, and it is made capable of being applied with equal advantage in dry as in wet weather. In some respects the farm labours under peculiar disadvantages, as water for the purpose of diluting the liquid has to be raised from a depth of 70 feet, and from a distance of more than 400 yards from the tanks where it is mixed with the drainage from the byres. These tanks are four in number, of the following dimensions respectively :—48 × 14 × 12 ; 48 × 14 × 15 ; 72 × 14 × 12 ; 72 × 17 × 12. They have each a separate communication with the well from which their contents are pumped up ; which are used in different degrees of 'ripeness,' a certain amount of fermentation induced by the addition of rape-dust being considered desirable. The liquid is diluted, according to circumstances, with three or four times its bulk of water, and delivered at the rate of about 4000 gallons an hour, that being the usual proportion to an acre. The quantity to be applied is determined by a float-gauge in the tank, which warns the engineer, whose business it is to watch it, when to cut off the supply, and this is a signal to the man distributing it in the field to add another length of hose, and to commence manuring a fresh portion of land. The pumps are worked by a 12-horse power steam-engine, which performs all the usual work on the farm, thrashing, cutting chaff and turnips, crushing oil-cake, grinding, etc., and pumping. The pipes are of iron ; mains, submains, and service pipes, five, three, and two inches in diameter respectively, laid eighteen inches or two feet below the surface. At certain points are hydrants to which gutta-percha hose is attached in lengths of twenty yards, at the end of which is a sharp nozzle with an orifice ranging from one to one and a half inch, according to the pressure laid on, from which the liquid makes its exit with a jet of from twelve to fifteen yards. All the labour required is that of a man and a boy to adjust the hose and direct the distribution of the manure, and eight or ten acres may thus be watered in a day. There are now 70 acres of Italian rye-grass, and 130 of root crops on the farm. The quantity they would deliver by a jet from a pump worked by a 12-horse steam-engine, would be 40,000 gallons, or 178 tons, per diem, and the expense per ton about 2d., but a double set of men would reduce the cost. The extreme length of pipe is three-quarters of a mile, and with the hose the total extent of delivery is about 1,900,000 yards, or 400 acres. To deliver the same quantity per diem, by water-carts to the same extreme distance, would be impracticable. One field of rye-grass, sown in April, had been cut once, fed off twice with sheep, and was ready (August 20th) to be fed off again. In another, after yielding four cuttings within the year, each estimated at 9 or 10 tons per acre, the value of the aftermath for the keep of sheep was stated at 25s. an acre. Of the turnips, one lot of Swedes, dressed with 10 tons of solid farm manure, and about 2000 gallons of the liquid, having six bushels of dissolved bones along with it, was ready for hoeing 10 or 12 days earlier than another lot dressed with double the amount of solid manure without the liquid application, and were fully equal to those in a neighbour's field which had received 30 loads of farm-yard dung, together with 3 cwt. guano and 16 bushels bones per acre; the yield was estimated at 40 tons the Scotch acre, and their great luxuriance seemed to me to justify the expectation. From one field of white globe turnips sown later, and *manured solely with liquid*, from 40 to 50 tons to the Scotch acre was expected. A field of carrots, treated in the same manner as the Swedes, to which a second application of liquid was given just before thinning, promise from 20 to 25 tons the acre. Similarly favourable results have been obtained with cabbages; and that the limit of fertility by these means has not yet been reached, was clearly shewn in one part of the Italian rye-grass which had accidentally received more than its allowance of liquid, and which shewed a marked increase of luxuriance over that around it. The exact increase of produce has not been accurately determined, but the number of cattle on the farm has increased very largely, and by means of the Italian rye-grass at least *four* times as many beasts as before can be kept now on the same extent of land, *the fertility of the land being at the same time increased.* This plant, of all others, appears to receive its nourishment in this form with most gratitude, and to make the most ample returns for it; and great as are the results hitherto obtained, I believe that the maximum of productiveness is not yet reached, and that the present experiment must be carried yet further before we know the full capabilities of this manure. Of one important fact connected with this crop, I am assured, that notwithstanding the rank luxuriance of its growth, animals fed upon it not only are not scoured, but thrive more than on any other kind of grass in cultivation.

"Taking into the irrigation account the whole cost of the engine, and the whole of the fuel and wages—although half of these might have been deducted—the following appears to be the capital account and working expenses for fertilizing Myremill farm:—

"Tanks complete	£300	0	0
Steam-Engine	150	0	0
Pumps	80	0	0
Iron Pipes, laying, and hydrants . .	1000	0	0
Gutta-Percha, distributing pipes, etc. .	56	0	0
	£1586	0	0

"Annual int. on £1586, and wear and tear, at 7½ per cent	£118	19	0
Annual Wages	104	0	0
Fuel	58	0	0
	£281	19	0

This amount divided by the number of acres, is equal to the annual sum of 14s. per acre.

"I now come to the practical results of so cheap a mode of fertilizing land.

"Mr. Young informed me that in one of the fields he had himself measured the growth of Italian rye-grass, and had found it to be two inches in twenty-four hours; and that within seven months, Mr. Kennedy had cut from a field we were passing at the time 70 tons of grass per acre. Where the whole is cut, four or five heavy crops are thus taken; but upon some of the land during the last two years 20 sheep to the acre have been penned in hurdles, and moved about the same field from time to time; after each remove the fluid has been applied, and immediately followed by an abundant growth of food. There is not the slightest appearance of exhaustion in the land,—its fertility appears to increase. I was informed that, before the liquid manure was used, the land would not keep more than a bullock or five sheep to the acre; now it will maintain, if the crops are cut and carried in, five bullocks or twenty sheep to the acre. Some beans, bran, and oil-cake, are bought for the stock; but, on the other hand, one-third or more of the farm is kept in grain, notwithstanding the great number of live stock.

"*Canning Park.*—Mr. Telfer's farm, near Ayr. This is a small dairy farm of 40 acres, near the level of the sea, and about a mile and a half west of the town of Ayr. The subsoil is beach gravel with a slight admixture of clay. Water is too abundant. It lies dead within about 20 inches of the surface, and in winter nearer than that.

"No bedding or litter is used here. The cows lie on cocoa-nut mats. The ventilation is perfect; and the air sweeter than in the majority of the dwelling-houses of human beings.

"The following appears to be the cost of carrying out the system at Mr. Telfer's farm:—

"Tank	£30	0	0
Engine	60	0	0
Iron pipes and hydrants . . .	100	0	0
Distributing hose-pipe, etc.	20	0	0
	£210	0	0

"Annual interest on £210, and wear and tear, at 7½ per cent	£15 15 0
Wages and fuel	11 0 0
	£26 15 0

"In summer the cows have a quantity of oil-cake, as well as grass; and in winter they have turnips or mangel-wurzel, bean or barley meal, and cut hay or grass; the whole mess being steamed together. Miss Bell, the cousin of Mr. Telfer, manages the dairy, and said that last year the hay bought would amount to from £30 to £40, and she should think the grain to not less than £200. In general terms, the other food is produced upon the farm. As to the produce of grass, which is the chief article, the first cutting during the present year was in the latter end of March about 18 inches thick. The second was from 18 inches to 2 feet thick. The third was from 3 feet to 4 feet 6 inches thick. The fourth nearly the same. The fifth was 2 feet thick; and the sixth, in process of cutting at the time I was there, we measured at 18 inches thick. Taking the mean, where two dimensions are given for the same crop, I find the aggregate depth of grass, grown and cut off this farm within seven months, to be not less than 14 feet 3 inches. All this is, however, eaten upon the premises, and the whole marketable produce of the farm is represented by the milk and butter.

"As to the quantity and value of these, Miss Bell stated, that the previous week the butter was 114 lb. and 120 lb.—together 234 lb. sold at 1s. per pound. This, she stated, was about the average quantity and price. The amount for butter would therefore be £11 : 14s. per week, or per annum £608 : 8s. She informed me farther, that during about eight months in the year, the cold milk realises about the same amount as the butter. In the summer months, during hot weather, the market value of the milk is only about half that of the butter. From these data, the amount for milk sold per annum is £507.

"The total receipts for the two articles of milk and butter amount to £1115 : 8s. per annum.

"I only need to add that, previously to the adoption of the present system of farming, these 40 acres of land were barely sufficient to support eight or nine cows, and would have been well let at a rental of 30s. an acre."

The attention now so generally directed to this subject, and the importance attached to it in many quarters, justify this lengthened quotation, and call for some remarks upon it. We have carefully examined two of the instances referred to in this report, viz., Port-Dundas and Myremill; and some smaller experiments more cursorily. After doing so we are sorry to say that we have arrived at a very different estimate of this system of manuring from that expressed in the above quotations. We at once, and with pleasure, acknowledge that in so far as concerns the storing up and preparing of the liquid manure, its application to the land, and the production, by means of it, of crops of Italian ryegrass almost surpassing belief in their luxuriance and weight of produce, Mr. Kennedy's experiments have been crowned with complete success. The excellence of this grass as food for live stock, and their relish for it, is also indisputable. Neither do we dispute the statements of those, who tell us that manure when largely diluted with water, and properly applied in the liquid form, is more beneficial to plants, than in any other way in which it can be presented to them. Admitting all this, the question remains, Has it yet been shewn that this system can be economically applied to ordinary farms? Data are still wanting from which to answer this question conclusively, but we shall state some of the reasons which constrain us, as presently advised, to do so in the negative.

Supposing an adequate motive-power already to exist, and to be partly employed for other purposes, the capital that must be invested in providing the tanks and other apparatus necessary for carrying out this system amounts to about £4 per acre over a farm of average extent. If the system be a sound one, the great amount of this outlay cannot fairly be urged as an objection to it. The addition of a permanent rent charge of 5s. per acre to an entire farm, for a benefit which in any one year can be available to but a limited portion of it, is however a serious matter. In each case referred to in the "Minutes of Information," the whole annual

TABLE II.—*Shewing Cost, etc., of the Application of Sewerage Waters and Liquid Manures.*

Name of Place.	No. of English acres	Mode of Application.	Cost of Works and Apparatus. £	s.	d.	Annual Interest, etc., at 7½ per cent. £	s.	d.	Annual Working Expenses. £	s.	d.	Total Annual Charge per English acre. £	s.	d.	OBSERVATIONS.
Edinburgh.															
Craigentinny Meadows.	63	Steam-engine, pumps, and open gutters and panes	2000	0	0	150	0	0	117	12	0	4	4	11	Average rental upwards of £16 per English acre.
High level. Sea Meadows.	38	Gravitation, open gutters and panes,	700	0	0	52	10	0	19	17	6	1	18	1	Worthless 25 years ago, now worth about £520 per English acre.
Old Meadows.	228	Gravitation, open gutters and panes,	2700	0	0	202	10	0	119	5	0	1	8	2½	Maximum rental, £25 per English acre.
Nottinghamshire.															
The Duke of Portland. Clipstone Meadows.	300	Catchmeadow, gravitation, and open gutters	36,000	0	0	2700	0	0	150	0	0	9	10	0	Previously worth from 3s. to 5s. per acre per annum, now worth upwards of £12.
Wiltshire.															
Wiley Meadows.	150	Beadwork of ridge and furrow, gravitation and open gutters, ...	3000	0	0	225	0	0	152	10	0	1	17	0	Four heavy crops of grass per annum.
Devonshire.															
The Duke of Bedford. Tavistock Meadows.	90	Beadwork and catchmeadows, gravitation and open gutters	1183	0		88	14	6	67	10	0	1	14	8½	Land more than quadrupled in value after only 4 years irrigation.
Berkshire.															
Philip Pusey M.P. Pusey Meadows.	100	Catchmeadow, gravitation, and open gutters	445	0	0	33	7	6	37	18	4	0	14	8	Land not previously worth more than 5s. per acre, is now yielding six heavy crops of grass per annum.
Glasgow.															
Mr. Harvey's farm.	508	Steam-engine, pumps, underground iron main pipes and iron distributing pipes	1450	0	0	108	15	0	240	10	0	0	13	9	10 feet thick of grass cut from an acre in six months.
Ayrshire.															
Myremill farm.	508	Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet-pipe	1586	0	0	118	19	0	162	10	0	0	11	1	70 tons of grass cut from an acre in six months.
Canning Park farm.	50	Ditto.	210	0	0	15	15	0	11	0	0	0	10	8½	14½ feet of grass cut in seven months.
Leg or Dunduff farm.	50	Gravitation, underground iron mains, gutta-percha hose, and jet pipe ...	191	0	0	14	6	6	3	10	0	0	7	1½	12 stacks per annum previously; 80 stacks last year.
Staffordshire.															
The Duke of Sutherland. Hanchurch farm near Trentham.	83	Steam-engine, pumps, underground iron mains, gutta-percha hose, and jet pipe	520	13	4	39	1	0	18	6	0	0	13	9¾	Tanks constructed sufficient for 300 acres.
Lancashire.															
Halewood farm.	120	Ditto. Ditto.	521	12	0	39	2	5	19	15	2	0	9	9¾	One dressing of liquid equal to 25 or 30 tons of farm-yard manure per acre.
Cheshire.															
Lescard farm.	150	Ditto. Ditto.	672	1	10	50	8	0	17	11	0	0	9	8¾	A fourth crop of grass being weighed, was found equal to 10 tons per acre. It was the lightest crop cut off the same land.
Glamorganshire.															
Porth Kerry farm.	50	Gravitation, underground iron mains, gutta-percha hose and jet pipe ...	300	0	0	22	10	0	0	10	0	0	13	0	Tanks constructed sufficient for 300 acres. Between 9 and 10 feet of grass cut.

charge, whether arising from interest on capital, wear and tear of machinery, or working expenses, is divided by the whole acreage of the farm. In the first seven cases given in the tabular statement,* this móde of calculation is correct, as the whole areas do actually benefit each year by the irrigating process. But when we come to those irrigated by machinery, we find that a half or two-fifths only of the land receives the benefits of it in any one year. If the annual charge in this latter class of cases is divided by the acreage actually irrigated, it becomes evident that the expense is double that of the Pusey meadows, and equal to that of the old meadows near Edinburgh, instead of being less, as it is made to appear. Again, in estimating the profits an opposite course is followed. While the charges are made to appear less by spreading them over the whole area of the farm, the enormous produce of grass from the irrigated parts is put prominently forward, and little is said about its produce as a whole. In the dairy cases too, we are told of enormous gross profits, without being pointedly reminded that the larger portion of the keep of the cows, such as distillery offal, bean-meal, hay, and even straw and turnips, is actually purchased; that in this way a quantity of extraneous manure becomes available for the associated farm, sufficient (however applied) to maintain it in a state of fertility; and that there would be handsome profits from the dairy, irrespective of the farm altogether. In fact, town dairies usually have no land attached to them. The cows are maintained solely by purchased food, and the sale of manure, liquid and solid, forms one of the stated items of income. In Mr. Harvey's and similar cases, two separate businesses are in fact mixed up, and yet the whole is spoken of in such a way as if the profit was mainly due to the use of liquid manure. Indeed the whole of these "Minutes of Information," issued by the General Board of Health, have an air of special plead-

* See opposite page.

ing about them, which to us seriously detracts from their value.

The entire annual cost of applying manure in this manner is stated to amount to from 10s. to 14s. per acre for the whole extent of the farm. Now this would suffice to provide annually from 1 to 1½ cwt. of Peruvian guano (even at its present high price) for every acre of the farm, or from 2 to 3 cwt. per acre, if applied, as the liquid is, to the portion under green crop only. The stated application of such a dressing of guano, in separate portions, and during showery weather, will be found to yield results little inferior to those obtained by the use of liquid manure. To do this requires no costly apparatus, or permanent sinking of capital, and its application can be desisted from at any time when found unremunerative. The adoption of this plan of applying the liquid manure of the farm necessarily demands that the whole system of management be accommodated to it. In order to furnish this liquid manure, the whole green crops must, summer and winter, be conveyed to the homestead, and there consumed in such a manner as that the urine and dung of the animals fed upon it may be scoured into the tanks. It is no such easy matter to replenish these tanks as some persons seem to think. When cattle are housed in boxes or properly protected yards, the whole of the urine is absorbed by the litter, and goes to the field in the dung-cart. This is certainly a more expensive way of conveying it to the fields than by pipes. But then, as in the new system, the urine, etc., is diluted with at least three times its volume of water, there are four tons of manure to convey on the one plan for one on the other. Even where pipes are used, all the litter, and a portion at least of the dung, has still to be carted out, so that no claim of a saving of carriage can validly be put forward on behalf of this system; but its merits must be grounded solely on the superior efficacy of manure, when applied in a liquid instead of a solid form.

In the case of dry and loose soils, the consuming of the turnip crop, by folding sheep upon it, has hitherto been regarded as at once the cheapest way in which it can be converted into wool and mutton, and the land consolidated and enriched, so as to fit it for producing grain and other crops. On tenacious soils, and in a moist climate, which is quite the case at Myremill, it is certainly impracticable to pursue this system in winter. It is perhaps also the case that sheep are healthier, fatten more rapidly, and yield more wool, when fed under cover, than when folded on the open turnip field. Admitting all this, however, we are disposed to think that these benefits are better secured by Mr. Randell of Chadbury's plan of littering the pens with burnt clay, which keeps the sheep clean, and their feet in good order, and, when mingled with their urine and dung, forms a most valuable manure for any kind of land. Were this carried out by means of moveable covered pens, which could be erected and easily shifted from place to place in the turnip field, the carriage of the turnips and manure would be greatly reduced, especially if accomplished by means of the portable railway. (*See* Section 16.)

In the case of dairies near towns, where the cows are largely fed on brewery or distillery offal, and other purchased food, the circumstances are totally different from those of ordinary farms, depending solely on their own resources. The liquid manure that would otherwise run to waste, when thus applied, is so much clear gain, in so far as the value of the increased produce exceeds the cost of application. It may form a wholesome caution to some persons, to mention here that, notwithstanding all that has been written about the success of the spirited operations at Port-Dundas, we were told by Mr. Harvey, that so dubious is he still about it, that if the thing were to do again, he would rather keep his money in his pocket, and let the urine run into the canal as formerly. If there is doubt even in such a case, how much more when the manure must virtually be purchased. And this leads us to remark that we have better hopes of the ultimate success of this plan of manuring, when it is restricted to the application of the surplus liquid manure of the homestead to some piece of meadow near at hand, supplementing this supply, when necessary, by dissolving guano in water, and sending it through the pipes. These remarks apply even more strongly to the sewage from towns. The liquid, in this case, is highly charged with fertilizing ingredients of the most valuable kind, seeing that it consists largely of night-soil from a population consuming much animal food. With few exceptions, this valuable liquid, which flows in such quantities from all our towns, is not only utterly lost, but is a grievous nuisance, by polluting our streams, and generating disease. In applying it as manure, the expense lies entirely in providing and working the necessary apparatus. In such cases, then, with an unfailing supply of highly fertilizing liquid, costing nothing to begin with, there is every inducement to put into operation any plan by which it can be economically applied to field crops. The enhanced value of green forage in the vicinity of towns is an additional motive for attempting this. The profitable disposal of town sewage in a way neither injurious to the health nor offensive to the senses of the community, is, however, a problem yet remaining to be solved.

The ingenuity and enterprise displayed by Mr. Kennedy and others, in their endeavours to cheapen by this means the cost of farm produce, and the frankness and untiring patience with which they have shown and explained their proceedings to the unceasing stream of visitors, which the novelty of the operations has attracted from all parts of the kingdom, and even from foreign countries, are altogether so admirable and praiseworthy, that it requires no slight effort to speak of them otherwise than approvingly. The confidence with which various influential parties are proclaiming the complete success of this scheme of irrigation, and recommending it for general adoption, seems, however, to require that those who have examined it, and arrived at an opposite conclusion, should publicly say so.

It is unreasonable to expect that private parties are to divulge their whole business affairs; and yet, without a full *Dr.* and *Cr.* account for some ordinary arable farm treated on this system, it is impossible to arrive at a sound judgment on its merits. Until this can be done, it would be better to abstain from publishing partial statements, which tend only to mislead the public mind. We offer these remarks in no spirit of hostility to this new system of farming. We shall rejoice unfeignedly to find that our opinion of it is erroneous, and that it really warrants the sanguine expectations which some parties entertain regarding it. We simply maintain that as yet the case is "not proven," and our counsel to those who are disposed to try it is, not to embark in it to an extent that would embarrass them, if, as we fear, it should prove a failure.

Section 3.—*Guano.*

Next to farm-yard manure, which must ever be looked to as the chief means of maintaining the fertility of a farm, guano claims our notice. This substance is the dung of sea-fowl, and is found on rocky islets in parts of the world where rain seldom falls. The droppings of the myriads of birds by which such places are frequented have in many cases been permitted to accumulate during untold ages, and are now found in enormous deposits. The principal supply, both for quantity and quality, has hitherto come from the Chincha

Islands on the coast of Peru. The introduction of this powerful and exceedingly portable manure has given a prodigious impetus to agricultural improvement. It is but twenty years since a few casks of this article were brought to Liverpool from Peru, where it has been known and prized as a valuable manure from the remotest periods. No sooner had its value been discovered by our British agriculturists than the demand for it became most eager, and so greatly has the consumption already increased, that the importation during 1851 reached to 243,014 tons. The price at which it was sold at first was £20 per ton, from which, with increased supplies, it fell to £11, when the discovery in 1844 of a considerable deposit on the Island of Ichaboe on the coast of Africa at once reduced the price to £9. To shew the rate and extent of the increase in its consumption, we here give a table of imports.

The Board of Trade returns shew the quantities of guano imported into the United Kingdom from 1841 to 1860 inclusive, with the computed real value from 1854.

Table Shewing the Imports of Guano from 1841 *to* 1860.

Year.	Tons.	Year.	Tons.	Year.	Tons.	Value.
1841	2,881	1848	71,414	1854	235,111	£2,530,272
1842	20,398	1849	83,438	1855	305,061	3,137,160
1843	3,002	1850	116,925	1856	191,501	2,136,431
1844	104,251	1851	243,014	1857	288,362	3,613,074
1845	283,300	1852	129,889	1858	353,541	4,084,170
1846	89,203	1853	123,166	1859	84,122	769,333
1847	82,392			1860	141,435	1,557,895

The Chincha deposit being the property of the Peruvian Government, is sold for their behoof through the medium of one British mercantile firm, Messrs Gibbs, Bright, & Co., and is thus a close monopoly, the holders of which regulate the price and the supply to suit their own interests. The price charged for quantities of thirty tons and upwards has for several years been £12 per ton. A fuller supply of this valuable manure at a cheaper rate would be of immense importance to the British farmer. Discoveries have from time to time been made of other deposits on the Peruvian and African coast, and in Australia. The quality of both of the latter is much inferior to that from Peru. It is in a more advanced state of decay, and contains more moisture and sand. The value of that from Peru depends chiefly on the large amount of ammonia (about 18 per cent in average samples) which it contains. Even at £13 per ton, the price at which it is usually retailed, it is the cheapest form in which ammonia can be purchased. Guano is largely used as a manure for most of our field crops, but chiefly for turnips. The quantity applied per acre ranges from two to four cwt. It is most economically used in combination with other manures, as we shall have occasion to show when treating of turnip culture. The dung of birds, from its including both liquid and solid excrements, is superior as a manure to that of quadrupeds. Pigeons' dung has long been in high repute as an excellent fertilizer, and brought a high price in days when portable manures were scarcely to be had. It is now little heard of; guano, the excrement of fowls which feed upon fish, being superior, weight for weight, and available to every one. The dung of domestic poultry is usually mixed with the general dung-heap, but it could be turned to better account if kept by itself. It has been recommended to strew the floors of poultry-houses daily with sawdust or sand, and to rake this with the droppings into a heap to be kept under cover and used like guano.

Section 4.—Bones.

It is now about fifty years since ground bones began to be used by farmers in the east side of England as a manure for turnips. At first bones were roughly smashed by hammers and applied in great quantities. By and by mills were constructed for grinding them to a coarse powder, in which state they continued to be used as a dressing for turnips, at the rate of sixteen to twenty bushels per acre, in all parts of the kingdom and to a very great extent, until the admirable discovery by Baron Liebig of the mode of preparing superphosphate of lime by dissolving bones in sulphuric acid. We shall not attempt to explain on chemical principles the wonderful superiority of this substance over simple bone-dust in promoting the growth of the turnip plant. What we should do indifferently, by borrowing from others, will be found well done by an accomplished chemist in Dr. Anderson's work on Agricultural Chemistry. We can, however, testify from experience to the important fact that *one* bushel of bone-dust dissolved by a third of its weight of sulphuric acid is superior in manurial value to *four* bushels of simple bone-dust. It is not merely, or even chiefly, in the lessened cost at which an acre of turnips can be manured that this superiority lies, but especially in this, that from the extraordinary stimulus given by superphosphate of lime to newly germinated turnip-plants, they usually arrive at the stage when they are fit for thinning in from ten to fifteen days earlier than when sown over farm-yard dung or simple bone-dust, or both combined. This shortening of the critical period during which the attacks of the insignificant but dreaded turnip-beetle so often baulk the hopes of the husbandman, is an advantage not easily estimated, and one well fitted to inspire him with confidence in the science to which he owes the discovery, and with grateful respect for the eminent discoverer. This powerful effect in quickening the growth of the young turnip-plants is possessed in nearly as great a degree by Peruvian guano, when it is supplied with sufficient moisture. In climates and seasons which may be characterised as moist and cool, guano will shew best results, whereas in those which are rather hot and dry superphosphate has the advantage. Accordingly we find guano the comparative favourite in Scotland; and its rival in the drier counties of England.

Guano is believed to encourage a great expanse of foliage, and to be more especially suited for early sowings; and superphosphate to influence development of bulb, and to deserve the preference for a later seed-time. The obvious inference is that, for the turnip crop at least, these valuable fertilizers should be used in combination; and actual experiment has verified its soundness. The use of them is universal and ever on the increase. They constitute also the standard by which farmers estimate the cost and effects of other purchased manures. The extent to which they are used, their high price, and the facility with which they can be adulterated with comparatively worthless ingredients, have led to almost unparalleled frauds. The adulteration of guano has in fact become a regular trade. Had farmers only their bodily senses to aid them, the detection of this fraud would be difficult—perhaps impossible. Here, however, they can call the chemist to their aid, with the certainty of ascertaining the real character of the articles which they are invited to purchase. If purchasers of guano would but insist in every instance on getting from the seller an analysis by some competent chemist, and along with it a written warrandice that the stock is of the quality therein indicated, detection and punishment of fraud would be easy. In regard to superphosphate of lime, the prudent and economical plan is for the farmer to purchase bone-dust and sulphuric acid and prepare it himself. We have conducted this process for several years past in the following way. A trough was provided 7 feet × 3·4 × 2·10, made of $2\frac{1}{2}$-inch deal, strongly jointed, and secured at the corners by wooden pegs, as iron nails would be corroded by the acid. This holds conveniently

48 bushels of bones. The heap of bone-dust is then gone over with a barley riddle, and the small dust which passes through this is laid aside to be used as a drying material for the other portion, after it is subjected to the acid. We find that a third part of the bone-dust passes through the riddle. Three bottles, or carboys as they are called, of concentrated acid, averaging 180 lb. each, are then emptied into the trough and mixed with cold water at the rate of 1½ of water, by measure, to 1 of acid. In practice, the water is poured in first and then the acid. Into this mixture 48 bushels of bones, previously measured and laid close to the trough, are rapidly shovelled by two labourers, who will do well to be attired in clothes and shoes past spoiling. So soon as the bones begin to be thrown in, violent ebullition commences. By the time that the whole of the bones are thrown in, there will be barely liquid enough to moisten the last of them. The labourers therefore dig down at one end of the trough till they reach the bottom, and then carefully turn back and mix the whole quantity until they reach the other end. The surface is then levelled and covered with a layer of the dry riddlings two inches thick. In this state it is allowed to remain for two days, when the trough is emptied, and the same process is repeated until the whole quantity is gone over. When shovelled out of the trough the bones are found to have become a dark coloured paste, still very warm and emitting a sweetish smell. While one person throws it out, another adds to it its proportion of dry riddlings and mixes them carefully. This mass is heaped up in the corner of a shed, and augmented at each emptying of the trough, until the requisite quantity is obtained. After this the mass is carefully turned over several times, at intervals of five or six days, and is then dry enough for sowing either by hand or machine. Some prefer moistening the bones with boiling water, and then adding pure acid as they are shovelled into

the trough; but by first mixing the acid and water there is greater certainty of all the bones being equally acted upon. There is also great convenience in using the finest portion of the bone dust for drying the other, as suitable material for this purpose is sometimes difficult to procure.

We have referred to superphosphate of lime, prepared from bones. A new source of supply has, however, been discovered of late years, the extent and importance of which is becoming more apparent as investigation proceeds. We allude to those phosphoric deposits found in such abundance in the crag, and upper and lower green-sand formations in the south of England. The existence of these fossil animal remains was first pointed out by Drs. Mantel and Buckland, though it is to Professor Henslow that we are indebted for having called attention to their eminent agricultural value, and described the localities whence they may be most readily obtained. These remains consist of the fractured and rolled bones of sharks, gigantic sea-lizards, and whales, which at one period of our earth's history must have existed in myriads in our oceans and seas. Mixed with these bones are found many fish-teeth and shells of different species, and likewise immense numbers of rolled, water-worn pebbles, which at one period were imagined to be the fossilized excrements of the animals themselves, and were on this account called *coprolites* by Professor Henslow and others. Although this has since been proved a mistake, the name has been adopted and will probably be continued. These fossil bones, and so-called coprolites of the crag, are found in enormous quantities on the coast of Suffolk, Norfolk, and Essex, whence Mr. Lawes of Rothamstead obtains nearly the whole of the material which he employs in the preparation of his well known "coprolite manure," or "Lawes' superphosphate." Already, it is believed, several thousands of tons of these fossils in one form or other are annually sold for manure, with a rapidly increasing demand. Those found in the crag formation are exceedingly hard, and require to be ground by powerful machinery, and dissolved in sulphuric acid, to render the phosphate of lime available as manure. Fossils, though less abundant in the green-sand, can be reduced to the requisite fineness by simple machinery, and are then fit for agricultural purposes without any chemical preparation. They are found plentifully in the parish of Farnham, so long celebrated for the excellence and abundance of its hops, which are now discovered to be due to the presence in the soil of these fossil remains. The discovery of these *mines* of manure in various parts of our country has been made most seasonably, and may yet prove of immense national importance. When Liebig predicted that, "in the remains of an extinct animal world, England is to find the means of increasing her wealth in agricultural produce, as she has already found the great support of her manufacturing industry in fossil fuel," he was regarded by many as merely indulging a fine philosophic fancy; but enough has already been realised to convince the most sceptical of the importance of the data on which he founded his opinion. We have gleaned this information from an article "On the Phosphoric Strata of the Chalk Formation," by Messrs. Paine and May, in vol. ix. p. 56 of the *Journal of the Royal Agricultural Society of England;* and another in vol. xii. p. 91, by T. J. Herapath, on the "Fossil Bones and Pseudo-Coprolites of the Crag."

On mixing a quantity of bone-dust with its own bulk of mould or sand, and wetting the whole with the liquid which oozes from the dung-heap, violent fermentation immediately ensues, dissolving the bones, and making them more readily available for the nourishment of the turnip-crop. Many farmers are so satisfied with this preparation, that they dispense with the acid. This is not judicious, as the superphosphate of lime is a more valuable manure than bones dissolved by simple fermentation.

Bones are sometimes applied as a top-dressing to grass land with singular success. "This Cheshire practice consists in applying an extraordinary dose of bones to pasture-land. 'For pasture-land, especially the poorer kind,' says Mr. Palin, 'there is nothing equal to bone-manure, either as regards the permanancy of its effects, or the production of a sweet luxurious herbage, of which all cattle are fond. Many thousand acres of the poor clay soils have been covered with this manure during the last eight or ten years.' The average quantity used is about a ton and a half to the acre; it is therefore a landlord's improvement, on which seven or eight per cent is generally paid. Boiled bones act as long as unboiled bones, retaining the phosphorus, though not so quickly, having lost the animal matter. Boiled bones (1845) cost £3 : 10s. per ton; the outlay then was five guineas per acre, sometimes £7 or £8. 'I have known,' says a correspondent, 'many instances where the annual value of our poorest clay-lands has been increased by an outlay of from £7 to £8 an acre, at least 300 per cent; or, in other words, that the land has been much cheaper after this outlay at 30s., than in its native state at 10s. per acre; with the satisfaction of seeing a miserable covering of pink-grass, rushes, hen-gorse, and other noxious weeds, exchanged for a most luxuriant herbage of wild clover, trefoil, and other succulent grasses.' Though much of the clover and trefoil may disappear in five or ten years (sometimes they last fifteen years), an excellent herbage remains. Draining, the writer adds, '*may be carried too far* where bones are used, for boned lands suffer by a dry summer. The land should be kept cool.' I have found the same thing on water meadows. The freer the grass is growing, the more it suffers from drought; and this is natural, for a larger supply of sap is required. This writer adds, 'I have known many a poor, honest, but half-broken man, raised from poverty to comparative independence, and many a sinking family saved from inevitable ruin, by the help of this wonderful manure.' Indeed, I believe, land after boning, will keep three cows where two fed before. As to this practice, however, caution is necessary. It seems to belong to cold clays for grass in Cheshire, though on such soil it would hardly answer elsewhere, even for turnips. A Cheshire landlord told me that he had tried it vainly for grass in Suffolk. I know no case of its success out of Cheshire, unless in the bordering counties, and have heard some cases of its failure even in those. It will not do, therefore, at all to adopt it hastily. We only know it to have succeeded about Cheshire, which is on the red marls geologically, and on the rainy side of the country, and must remember that it is a costly proceeding, striking in its success, but as yet circumscribed in its practice, and therefore in the proof of its efficacy."*

Section 5.—*Rape-Cake, etc.*

Rape-cake reduced to powder forms an excellent manure for wheat and other crops. It is usually applied at the rate of from four to eight cwt. per acre. The cakes resulting after oil has been expressed from camelina, hemp, and cotton seeds, and from pistachio and castor-oil nuts, from beech and other mast, all possess considerable value as manure.

Section 6.—*Blood, etc.*

All parts of the carcases of animals form valuable manure, and are now carefully used in that way whenever they are unfit for more important uses. The blood and other refuse

* Article by Mr. Pusey. See *Journal of Royal Society of England*, vol. xi. p. 409.

from shambles and from fish-curers' yards, when mixed with earth and decomposed, make a valuable manure, and are eagerly sought after by farmers to whom such supplies are accessible. In London a company has been formed by whom the blood from the shambles is purchased, and employed instead of water in preparing superphosphate of lime, which when thus manufactured, contains an amount of ammonia which adds considerably to its efficacy as a manure. In Australia and South America it has long been the practice to slaughter immense numbers of sheep and cattle for the sake of their hides and tallow only, there being no market for them as beef and mutton. To obtain the whole tallow, the carcases are subjected to a process of boiling by steam and afterwards to pressure, and are then thrown aside in great piles. This dried flesh has recently been brought to this country and sold as a manure. A notice and analysis of it, by Dr. Anderson, appears in the *Transactions of the Highland and Agricultural Society* for October 1850, p. 367.

The refuse from glue-works; the blubber and dregs from fish-oil; animal charcoal that has been used in the process of sugar-refining; the shavings and filings of horn and bones from various manufactures; and woollen rags, are all made available for manure.

Section 7.—*Night-Soil.*

Night-Soil is a powerful manure; but owing to its offensive odour it has never been systematically used in Britain. Various plans are tried for obviating this objection, that most in repute at present being its mixture with charred peat. From the universal use of waterclosets in private dwellings, the great mass of this valuable fertilizing matter now passes into sewers, and is carried off by streams and rivers, and is for the most part totally lost as a manure. When sewage water is used for irrigation, as in the neighbourhood of Edinburgh, it is to the night-soil dissolved in it that its astonishing effects in promoting the growth of grass are chiefly due. We have already expressed our views in regard to the use of it in this diluted form of sewage water. That mode of applying it is necessarily restricted to lands in the vicinity of towns. Unfortunately it is precisely in such situations that the greatest objections exist to the use of an irrigating manure so offensive to the nostrils, and (as is supposed) so prejudicial to the health of the community. It is therefore much to be desired that a really effective process for preparing it for market in a dry, inodorous state, at a moderate price, and with its virtues unimpaired, should speedily be brought into general operation. The enormous and ever-increasing expenditure on guano, shews how unbounded will be the demand for it when it shall be thus available. Hitherto we regret to say that the numerous and costly attempts that have been made to separate the fertilizing matter from the water, in which it is contained, have proved utter failures. The most feasible plan for the utilization of night-soil that we have hitherto heard of, is that brought forward by the Rev. Henry Moule, Fordington Vicarage, Devon. In a tract addressed to cottagers he says, —"Now, my discovery is this: The earth of your garden, if dried—or dried and powdered clay—will suck up the liquid part of the privy soil; and, if applied *at once* and *carefully mixed,* will destroy all bad smell and all nasty appearance in the solid part, and will keep all the value of the manure. Three half pints of earth, or even one pint, will be enough for each time. And earth thus mixed *even once* is very good manure. But if, after mixing, you throw it into a shed and dry it, you may use it again and again; and the oftener you use it the stronger the manure will be. I have used some seven and even eight times; and yet, even after being so often mixed, there is no bad smell with the substance; and no one, if not told, would know what it is." To adapt a privy for using dried earth in this way, he says, "Let the seat be made in the common way, only without any vault beneath. Under the seat place a bucket or box, or, if you have nothing else, an old washing-pan. A bucket is the best, because it is more easily handled; only let it have a good sized bail or handle. By the side of the seat, have a box that will hold (say) a bushel of dried earth, and a scoop or old basin that will take up a pint or a pint and a half, and let that quantity of earth be thrown into the bucket or pan every time it is used. The bucket may be put in or taken out from above by having the whole cover moved with hinges: or else, through a door in front or at the back." He has also invented and patented an *earth closet*, as a substitute for the ordinary water closet, which he describes thus—"The back contains dried and sifted earth, which enters the pan through a hole at the back of it, and covers the bottom. The bottom is moved by the handle and lever; the side of the pan acts as a scraper; and all that is upon the bottom is pushed off, falling into the bucket or shaft below. The earth thus applied at once prevents fermentation, and almost all exhalation and offensive smell. The bottom returns to its place by means of a spring; and a fresh supply of the earth falls upon it from the box."*

If the premium of £1000 and the Gold Medal of the Society, recently offered by the Council of the Royal Agricultural Society to the discoverer of a manure equal to Peruvian Guano, to be sold at £5 per ton, and procurable in unlimited quantities, is won at all, it seems likely that the material will be obtained from the contents of our privies.

* "Manure for the Million," by Rev. Henry Moule, price 1d. Mr. Moule has also published a pamphlet on the same subject, entitled "National Health and Wealth."

Section 8.—*Sea-Weed.*

Along our sea-board large supplies of valuable manure are obtained in the shape of drifted sea-weed. This is either applied as a top-dressing to grass and clover, ploughed in with a light furrow, for various crops, or mixed in dung-heaps. It requires to be used in large quantities per acre—from 40 to 60 loads—and is evanescent in its effects. Grain grown on land manured with sea-weed, is generally of fine quality and is in repute as seed corn.

Section 9.—*Manure Crops.*

Crops of Buckwheat, Rape, Vetches, and *Mustard,* are sometimes ploughed in, while in a green, succulent state, to enrich the land. It is however more usual to fold sheep on such crops, and so to get the benefit of them as forage, as well as manure to the land. The leaves of turnips are frequently ploughed in after removing the bulbs, and have a powerful fertilizing effect.

Section 10.—*Lime.*

Besides manures of an animal and vegetable origin, various mineral substances are used for this purpose. The most important and extensively used of these is lime. In the drier parts of England it is not held in much esteem, whereas in the western and northern counties, and in Scotland, its use is considered indispensable to good farming. Experienced farmers in Berwickshire consider it desirable to lime the land every 12 years, at the rate of from 120 to 200 bushels of the unslacked lime per acre. It is found especially beneficial in the reclaiming of moory and boggy lands, on which neither green nor grain crops thrive until it has been applied to them. Its use is found to improve the quality of grain, and to cause it in some cases to ripen earlier. It facilitates the cleaning of land; certain weeds disappear-ing altogether for a time after a dressing of lime. It is the only known specific for the disease in turnips called "fingers and toes," on which account alone it is frequently used in circumstances which would otherwise render such an outlay unwarrantable. The practice, still frequent, of tenants at the beginning of a 19 years' lease, liming their whole farm at a cost per acre of from £3 to £5, proves conclusively the high estimation in which this manure is held. The belief—in which we fully concur—is however gaining ground, that moderate and frequent applications are preferable to these heavy doses at lengthened intervals.

When bare fallowing was in use, it was commonly towards the close of that process that lime was applied. Having been carted home and laid down in large heaps, it was, when slaked, spread evenly upon the surface and covered in by a light furrow. It is now frequently spread upon the autumn furrow preparatory to root crops, and worked in by harrowing or grubbing, and sometimes by throwing the land into shallow ridglets. Another method much used, is to form it into compost with decayed quickens, parings from road-sides, and margins of fields, etc., which, after thorough intermixture by frequent turnings, is spread evenly upon the land when in grass. A cheap and effectual way of getting a dressing of such compost thoroughly comminuted and incorporated with the surface soil, is to fold sheep upon it, and feed them there with turnips for a few days. The value of such compost is much enhanced by mixing common salt with the lime and earth at the rate of *one part* of salt by measure to *two parts* of lime. A mixture of these two substances in these proportions prepared under cover, and applied in a powdery state, is much approved as a spring top-dressing for corn-crops on light soils. In whatever way lime is applied, it is important to remember that the carbonic acid which has been expelled from it by subjecting it in the kiln to a red heat, is quickly regained from the atmosphere, to which therefore it should be as little exposed as possible before applying it to the land. A drenching from heavy rain after it is slaked is also fatal to its usefulness. Careful farmers therefore guard against these evils by laying on lime as soon as it is slaked; or when delay is unavoidable, by coating these heaps with earth, or thatching them with straw. In order to reap the full benefit of a dressing of lime it must be so applied as, while thoroughly incorporated with the soil, to be kept near the surface. This is more particularly to be attended to in laying down land to pasture. This fact is so well illustrated by an example quoted in the article "Agriculture" in the 7th edition of the Encyclopædia Britannica that we here repeat it.

"A few years after 1754," says Mr. Dawson, "having a considerable extent of outfield land in fallow, which I wished to lime previous to its being laid down to pasture, and finding that I could not obtain a sufficient quantity of lime for the whole in proper time, I was induced, from observing the effects of fine loam upon the surface of similar soil, even when covered with bent, to try a small quantity of lime on the surface of this fallow, instead of a larger quantity ploughed down in the usual manner. Accordingly, in the autumn, about twenty acres of it were well harrowed in, and then about fifty-six Winchester bushels only, of unslaked lime, were, after being slaked, carefully spread upon each English acre, and immediately well harrowed in. As many pieces of the lime, which had not been fully slaked at first, were gradually reduced to powder by the dews and moisture of the earth,—to mix these with the soil, the land was again well harrowed in three or four days thereafter. This land was sown in the spring with oats, with white and red clover and rye-grass seeds, and well harrowed without being ploughed again. The crop of oats was good, the plants of grass sufficiently numerous and healthy; and they formed a very fine pasture, which continued good until ploughed some years after for corn.

"About twelve years afterwards I took a lease of the hilly farm of Grubbet, many parts of which, though of an earthy mould tolerably deep, were too steep and elevated to be kept in tillage. As these lands had been much exhausted by cropping, and were full of couch-grass, to destroy that and procure a cover of fine grass, I fallowed them, and laid on the same quantity of lime per acre, then harrowed and sowed oats and grass-seeds in the spring, exactly as in the last-mentioned experiment. The oats were a full crop, and the plants of grass abundant. Several of these fields have been now above thirty years in pasture, and are still producing white clover and other fine grasses: no bent or fog has yet appeared upon them. It deserves particular notice, that more than *treble* the quantity of lime was laid upon fields adjoining of a similar soil, but which being fitter for occasional tillage, upon them the lime was ploughed in. These fields were also sown with oats and grass seeds. The latter throve well, and gave a fine pasture the first year; but afterwards the bent spread so fast, that in three years there was more of it than of the finer grasses."

The conclusions which Mr. Dawson draws from his extensive practice in the use of lime and dung, deserve the attention of all cultivators of similar land.

"1. That animal dung dropped upon coarse benty pastures produces little or no improvement upon them; and that, even when sheep or cattle are confined to a small space, as in the case of folding, their dung ceases to produce any beneficial effect after a few years, whether the land is continued in pasture or brought under the plough.

"2. That even when land of this description is well fallowed and dunged, but not limed, though the dung augments the produce of the subsequent crop of grain, and of grass also for two or three years, that thereafter its effects are no longer discernible either upon the one or the other.

"3. That when this land is limed, if the lime is kept upon the surface of the soil, or well mixed with it, and then laid down to pasture, the finer grasses continue in possession of the soil, even in elevated and exposed situations, for a great many years, to the exclusion of bent and fog. In the case of Grubbet-hills, it was observed, that more than thirty years have now elapsed. Besides this, the dung of the animals pastured upon such land adds every year to the luxuriance, and improves the quality of the pasture, and augments the productive powers of the soil when afterwards ploughed for grain; thus producing, upon a benty outfield soil, effects similar to what are experienced when rich infield lands have been long in pasture, and which are thereby more and more enriched.

"4. That when a large quantity of lime is laid on such land, and ploughed down deep, the same effects will not be produced, whether in respect to the permanent fineness of the pasture, its gradual amelioration by the dung of the animals depastured on it, or its fertility when afterwards in tillage. On the contrary, unless the surface is fully mixed with lime, the coarse grasses will in a few years regain possession of the soil, and the dung thereafter deposited by cattle will not enrich the land for subsequent tillage.

"*Lastly*, It also appears from what has been stated, that the four-shift husbandry is only proper for very rich land, or in situations where there is a full command of dung; that by far the greatest part of the land of this country requires to be continued in grass two, three, four, or more years, according to its natural poverty; that the objection made to this, viz., that the coarse grasses in a few years usurp possession of the soil, must be owing to the surface soil not being sufficiently mixed with lime, the lime having been covered too deep by the plough." (*Farmers' Magazine*, vol. xiii. p. 69.)

Section 11.—*Marl.*

Our remarks hitherto have had reference to carbonate of lime in that form of it to which the term *lime* is exclusively applied by farmers. But there are other substances frequently applied to land which owe their value chiefly to the presence of this mineral. The most important of these is marl, which is a mixture of carbonate of lime with clay, or with clay and sand, and other compounds. When this substance is found in the proximity of, or lying under, sandy or peaty soils, its application in considerable doses is attended with the very best effects. The fen lands of England, the mosses of Lancashire, and sandy soils in Norfolk and elsewhere, have been immensely improved in this way. In Lancashire, marl is carried on the mosses by means of portable railways at the rate of 150 tons, and at a cost of about £3 per acre. In the fens long trenches are dug, and the subjacent marl is thrown out and spread on either side at an expense of 54s. per acre. By this process, often repeated of *claying* or *marling*, as it is variously called, the appearance and character of the fen lands have been totally changed; excellent wheat being now raised where formerly only very inferior oats were produced. As the composition both of peat and of clay marl varies exceedingly, it is always prudent, either by limited experiment, or chemical analysis of both substances, to ascertain the effect of their admixture. Lime is always present in those cases which prove most successful; but an overdose does harm.

Section 12.—*Shell-Marl.*

Under some mosses and fresh water lakes extensive deposits of shell-marl are frequently found. It contains a larger percentage of lime than clay marl, and must be applied more sparingly.

Section 13.—*Chalk.*

Throughout the extensive chalk districts of England, the practice of spreading this substance over the surface of the land has prevailed from the remotest times. In the case of the Lincolnshire Wolds, once as celebrated for desolate barrenness as they now are for high culture and smiling fertility, chalking was one important means of bringing about this wonderful improvement, as it still is in maintaining it. "The soil being but a few inches in depth, and often containing a large proportion of flints, naturally possesses very little fertility—often being a light sand, not strong enough naturally to grow turnips—so that the farmers were at first obliged to *make* a soil, and must now maintain its new-born productiveness. The three principal means by which this is done, are the processes of *chalking*, and *boning*, and *manuring with sheep.* A dressing of 80 or 100 cubic yards per acre of chalk is spread upon the land, and then a crop of barley is obtained if possible, being sown with seeds for grazing. The seeds are grazed with sheep two years, the sheep being at the same time fed with oil-cake; and then the land will be capable of producing a fine crop of oats. Bones are also used frequently for the barley crop, and when they first came into use were thrown upon the land in a chopped state, neither broken nor crushed, and as much as 40 or even 50 bushels per acre. The boning and sheep-feeding are in constant operation, but chalking is required only at intervals of a few years. On the western side of the Wold district, wherever the chalk adjoins the white or blue marl, an extensive application of it is made to the surface. Thus immense quantities of earth and stone have been added by manual labour and horse-carriage to the thin covering of original soil; and, besides this, the soil is being continually deepened by deep ploughing, the chalk fragments thus brought to the surface crumbling into mould."*

In Dorsetshire "it is usual to chalk the land once in twenty years, the sour description of soil being that to which it is found most advantageous to apply it. The chalk is dug out of pits in the field to which it is applied, and it is laid on sometimes with barrows, but chiefly with the aid of donkeys. The first method costs 40s. an acre, the last 35s. when hired donkeys are used; 20s. to 25s. where the donkeys are the property of the farmer. The chalk is laid on in large lumps, which soon break down by the action of frost and exposure to the weather. Chalk is occasionally burnt and applied as lime, in which state it is preferred by many farmers, notwithstanding the additional cost of the burning."†

Section 14.—*Shell-Sand and Limestone Gravel.*

On the western shores of Great Britain and Ireland are found great quantities of sand mixed with sea-shells in minute fragments. This calcareous sand is carried inland considerable distances and applied to the land as lime is elsewhere. Limestone gravel is also found in various places and used in the same way.

* Farming of Lincolnshire, by John Algernon Clarke. *Journal of Royal Agricultural Society*, vol. xii. p. 331.

† See Caird's *English Agriculture*, 1850 and 1851, p. 61.

Section 15.—*Gypsum.*

Sulphate of Lime or Gypsum is considered an excellent top-dressing for clover and kindred plants. It is thought by some, that the failure of red clover is to be accounted for by the repeated crops of that plant having exhausted the gypsum in the soil. Its application has been followed by favourable results in some cases, but has yet quite failed in others. It is applied in a powdered state at the rate of *two* or *three* cwt. per acre when the plants are moist with rain or dew.

Section 16.—*Burnt Clay.*

About forty years ago, burnt clay was brought much into notice as a manure, and tried in various parts of the country, but again fell into disuse. It is now, however, more extensively and systematically practised than ever. Frequent reference to the practice is to be found in the volumes of the *Journal of the Royal Agricultural Society of England.* This burning of clay is accomplished in several ways. Sometimes it is burnt in large heaps or clamps containing from 80 to 100 cart-loads. A fire being kindled with some faggots or brushwood, which is covered up with the clay, taking care not to let the fire break out at any point, more fuel of the kind mentioned, or dross of coals, is added as required, and more clay heaped on. A fierce fire must be avoided, as that would make the clay into brickbats. A low, smothered combustion is what is required; and to maintain this a good deal of skill and close watching on the part of the workman is necessary. A rude kiln is sometimes used for the same purpose. Either of these plans is suitable where the ashes are wanted at a homestead for absorbing liquid manure, etc.; but for merely spreading over the land, that called clod-burning is preferable, and is thus described in volume viii. page 78 of the *Royal Agricultural Society's Journal:*—"Roll and harrow, in dry weather, till the majority of clods are about the size of a large walnut; nothing so good as the clod-crusher to forward this operation: when perfectly dry, collect them into rows about six yards apart, with iron-teethed rakes; take a quarter of a whin faggot, or less, according to size, previously cut into lengths by a man with an axe; place these pieces about four yards apart in the rows, cover them with clods, putting the finest mould upon the top of the heap, to prevent the fire too quickly escaping; observe the wind, and leave an opening accordingly; having set fire to a long branch of whin, run from opening to opening till two or three rows are lighted, secure these, and then put fire to others; keeping a man or two behind to attend to the fires and earthing up till the quantity desired may be burned, which will generally take four or five hours, say from 25 to 35 loads per acre of 30 bushels per load.

"This work is often put out to a gang of men at about 10s. per acre for labour, and the whins cost 4s. 6d. per acre, not including the carting.

"When the heaps are cold, spread and plough in. The great advantage of burning clods in these small heaps in preference to a large one, is the saving of expense in collecting and spreading; there is much less red brick earth and more black and charred; no horses or carts moving on the land whilst burning, and a large field may be all burned in a day or two, therefore less liable to be delayed by wet weather. In the heavy land part of Suffolk, the farmers purchase whins from the light land occupiers, and often cart them a distance of fourteen or sixteen miles, when there is no work pressing on the farm. These are stacked up and secured by thatching with straw, that they may be dry and fit for use when required. Bean straw is the next best fuel to whins or furze, and it is astonishing to see how small a quantity will burn the clods if they are of the proper size and dry. Observe, if the soil is at all inclined to sand, it will not burn so well. I will here mention, that I often sift and store up a few loads of the best blackened earth to drill with my turnips, instead of buying artificial manure, and find it answers remarkably well, and assists in maintaining the position that a heavy land farm in Suffolk can be farmed in the first-rate style without foreign ingredients."

Burnt clay is an admirable vehicle for absorbing liquid manure. A layer of it in the bottom of cattle boxes does good service at once, in economising manure, and yielding to the cattle a drier bed than they would otherwise have until the litter has accumulated to some depth. Valuable results have also been obtained by using it for strewing over the floors of poultry-houses, and especially of pens in which sheep are fed under cover. In the latter case, it is mixed with the excrements of the sheep as they patter over it, and forms a substance not unlike guano, nor much inferior to it as a manure. As an application to sandy or chalky soils, it is invaluable. It is mainly by this use of burnt clay, in combination with fattening of sheep under cover, that Mr. Randell of Chadbury has so astonishingly increased the productiveness of his naturally poor clay soil. A Berwickshire proprietor, himself a practical farmer, who visited Mr. Randell's farm in the summer of 1852 thus writes:—"I have visited most of the best managed farms in England, at least those that have so much of late been brought under general notice; but without exception, I never saw land in the splendid condition his is in. The beauty of the system lies in the cheap method by which he has imparted to it this fertility, and in the manner in which he keeps it up. A large part of the farm consisted, fourteen years ago, of poor clay, and was valued to him at his entry at 7s. 6d. per acre. It is now bearing magnificent crops of all kinds, the wheat being estimated to yield from 6 to 7 quarters per acre.

"Mechi has enriched Tiptree-heath, it is true; but then it is effected at a cost that will make it impossible for him to be repaid. Mr. Randell, on the other hand, has adopted a course that is nearly self-supporting, his only cost being the preparation of the clay. The great secret of his success lies in his mode of using it; and as I never heard of a similar process, I will briefly explain to you how it is done:—His heavy land not permitting him to consume the turnip and mangel crops on the ground, he carts them home, and feeds his sheep in large sheds. They do not stand on boards or straw, but on the burnt clay, which affords them a beautiful dry bed; and whenever it gets the least damp or dirty, a fresh coating is put under them. The mound rises in height; and in February when the shearlings are sold (for the sheep are only then twelve months old), the mass is from 7 to 8 feet deep. He was shearing his lambs when I was there, as he considers they thrive much better in the sheds without their fleeces. They are half bred Shropshire downs; and at the age I mention, attain the great weight of 24 lb. per quarter.

"I walked through the sheds, but of course they were then empty. I saw the enormous quantity of what he called his 'home-made guano,' the smell from it strongly indicating the ammonia it contained. He had sown his turnips, and other green crops with it, and what remained he used for the wheat in autumn. He assured me he had often tested it with other manures, and always found 10 tons of the compound quite outstrip 4 cwt. of guano, when they were applied to an acre of land separately. Burned clay I never saw used before in this manner, and I felt very much interested in the plan he pursued."

Section 17.—*Charred Peat.*

Charred peat has been excessively extolled for its value as a manure, both when applied alone, and still more in combination with night-soil, sewage water, and similar matters, which it dries and deodorises. So great were the expectations of an enormous demand for it, and of the benefits to result to Ireland by thus disposing of her bogs, that a royal charter was granted to a company by whom its manufacture was commenced on an imposing scale. This charcoal is doubtless a useful substance; but Dr. Anderson has recently proved that peat, merely dried, is a better absorber and retainer of ammonia than after it is charred. There seems much risk, therefore, of this peat-charcoal company sharing the fate of so many other schemes for benefiting Ireland.

Section 18.—*Soot.*

Soot has long been in estimation as an excellent top-dressing for cereal crops in the early stage of their growth, and for grasses and forage plants. It is applied at the rate of 15 to 30 bushels per acre. On light soils the addition of 8 or 10 bushels of salt to the above quantity of soot is said to increase materially its good effect. This mixture trenched, or deeply ploughed in, is also recommended as one of the most powerful of all manures for carrots.

In *London Labour and the London Poor* we find the following statistics as to metropolitan soot:—

	Bush. of Soot per annum.
"53,840 houses, at a yearly rental above £50, producing six bushels of soot each per annum . . .	323,040
90,002 houses, at a yearly rental above £30 and below £50, producing five bushels of soot each per annum	450,010
163,880 houses, at a yearly rental below £30, producing two bushels of soot each per annum . . .	337,760
Total number of bushels of soot annually produced throughout London . . .	1,100,810

The price of soot per bushel is but 5d., and sometimes 4½d., but 5d. may be taken as an average. Now, 1,000,000 bushels of soot at 5d. will be found to yield £20,833 : 6 : 8 per annum."*

* *Farmers' Magazine* for March 1852, p. 254.

Section 19.—*Salt.*

Common salt has often been commended as a valuable manure, but has never been used in this way with such uniform success as to induce a general recourse to it. We have already spoken of it as forming a useful compound with lime and earth. It can also be used beneficially for the destruction of slugs, for which purpose it must be sown over the surface, at the rate of *four* or *five* bushels per acre, early in the morning, or on mild, moist days, when they are seen to be abroad. It is used also to destroy grubs and wireworm, for which purpose it is sown in considerable quantity on grass land some time before it is ploughed up. It can be used safely on light soils, but when clay predominates, it causes a hurtful wetness, and subsequent incrustation of the surface. Its application in its unmixed state as a manure, is at best of doubtful benefit; but in combination with lime, soot, nitrate of soda, and perhaps also superphosphate of lime, it appears to exert a beneficial influence.

Section 20.—*Nitrate of Soda.*

Cubic Saltpetre, or Nitrate of Soda, has now become one of our staple manures. The fertilizing power of common saltpetre or nitrate of potass has been known from the earliest times, but its high price has hitherto hindered its use as a manure, except in the form in which it is obtained as refuse from the gunpowder mills. The cubic nitre is brought from Peru, where there are inexhaustible supplies of it. The principal deposits of nitrate of soda are in the plain of Tamarugal, at a distance of 18 miles from the coast. The beds are sometimes 7 or 8 feet in thickness, and from these it is quarried with perfect ease. It is not found in a perfectly pure state, but contains a mixture of several substances, chiefly common salt. To fit it for certain uses in the arts it is subjected to a process of purification by boiling and evaporation. As no fuel is to be found in that arid country, English coals are used, which are conveyed from the coast to the works on the backs of mules, and the purified nitrate is brought back in the same manner. As nitrate of soda is now invariably mixed with twice its weight of common salt before being used as a top-dressing for grain-crops, the purifying process seems altogether a redundancy, so far as its agricultural use is concerned. Were it brought to us just as it is quarried, and were it conveyed to the coast in wheel-carriages by a good road or railway, instead of miserable back-loads by mules, there seems no reason why we should not have it in abundant supplies, and at a third of the price which we have hitherto paid, viz., at from £6 to £7, instead of from £16 to £20 per ton. As cubic nitre and guano contain very nearly the same percentage of nitrogen (the element to which the fertilizing power of all manures is mainly due), it may seem surprising that the former should ever be used in preference to the latter. In practice, however, it is found that when applied as a top-dressing in spring, the former frequently yields a better profit than the latter; and hence the importance to farmers of getting it at a more reasonable price. Nitrate of soda is used as a manure for grain and forage crops. It is now extensively used in Norfolk, and elsewhere, as a top-dressing for wheat. For this purpose it is applied at the rate of 84 lb. per acre, in combination with 2 cwt. of salt. The nitre and salt are thoroughly mixed, and carefully sown, by hand, in two or three equal portions, at intervals of several weeks, beginning early in March, and finishing by the third week in April. If nitre alone is used, it has a tendency to produce over-luxuriance, and to render the crop liable to lodging and mildew. But the salt is found to correct this over-luxuriance, and a profitable increase of grain is thus obtained. Mr. Pusey*

* *Journal of Royal Agricultural Society*, vol. xiii. p. 349.

informs us that an application of 42 lb. of nitrate of soda and 84 lb. of salt per acre, applied by him to ten acres of barley that had been injured by frost, had such an effect upon the crop, that he had *seven* bushels more grain per acre, and of better quality, than on part that was left undressed for comparison. These seven bushels per acre were attained by an outlay of 6s. 4d. only. This nitre is also applied with advantage to forage crops. Mr. Hope, Fenton Barns, East Lothian, states that he finds the use of it as a top-dressing to clover, at the rate of one cwt. of nitrate and two of guano per acre, profitable. Its beneficial effects are most apparent when it is applied to light and sterile soils, or to such as have been exhausted by excessive cropping.

Section 21.—*Artificial Manures.*

Besides those substances, the most important of which we have now enumerated, which are available as manure in their natural state, there are various chemical products, such as salts of ammonia, potash, and soda, copperas, sulphuric and muriatic acid, etc., which, in combination with lime, guano, night-soil, and other substances, are employed in the preparation of manures, with a special view to the requirements of particular crops. In some cases these preparations have been eminently successful, in others but doubtfully so. Many failures are probably due to the spuriousness of the article made use of; as it is known that enormous quantities of worthless rubbish have, of late years, been sold to farmers, under high-sounding names, and at high prices, as special manures. We would recommend to those who desire information regarding the preparation and use of such compounds to study the article on Agricultural Chemistry, by Mr. Lawes of Rothamstead, in the *Journal of the Royal Agricultural Society of England* (vol. viii. p. 226); the accounts of experiments with special manures in the *Transactions of the Highland and Agricultural Society of Scotland;* articles on these topics in *Morton's Cyclopædia;* and that in Dr. Anderson's work. Those who purchase such manures ought in every instance to insist upon the seller producing an analysis of his commodity by some chemist of established character, and granting a written warranty that the article sold to them is at least equal to the value indicated by the analysis. Were all farmers to insist upon this mode of buying their manures they would at once put an end to that wholesale system of fraud by which they have been so enormously cheated of late years.

In applying these concentrated manures, those only of a slowly operating character should be used in autumn or winter, and at that season should invariably be mixed with the soil. Those in which ammonia abounds should, in spring, also be mixed with the soil when sowing the crops to which they are applied. When used for top-dressing growing crops, they should be applied only in wet weather.

CHAPTER IX.

CULTIVATED CROPS—GRAIN CROPS.

PURSUING the plan announced at the outset, we have now to speak of field crops, and shall begin with the cereal grasses, or white-corn crops, as they are usually called by farmers.

Section 1.—*Wheat.*

It is unnecessary to dwell npon the value of this grain to the farmer and to the community. It constitutes emphatically our bread-corn—our staff of life. While its increased consumption is, on the one hand, an indication of an improved style of living among the general population, its extended culture points, on the other, to an improving agriculture, as it is only on soils naturally fertile, or that have been made so by good farming, that it can be grown with success. Wheat is sown both in autumn and spring, from which circumstance attempts have been made to classify its varieties, by ranging them under these two general heads. This distinction can only serve to mislead; for while it is true that there are varieties respectively best adapted for autumn and spring sowing, it is also true that a majority of the kinds most esteemed in Britain admit of being sown at either season, and in practice are actually so treated. It is not our intention to present a list of the varieties of wheat cultivated in this country. These are very numerous already, and are constantly being augmented by the accidental discovery of new varieties, or by cross-impregnation, artificially brought about for this purpose. The kinds at present in greatest repute in Scotland are the hardier *white wheats,* among which *Hunter's* white still retains the first place. There are many kinds which, in favourable seasons, produce a finer sample; but its hardiness, productiveness, and excellent milling qualities, render it a general favourite both with farmers and millers. Its most marked characteristic is, that in rubbing out a single ear, part of the grains are found to be opaque and white, and others flinty, and reddish coloured, as if two kinds of wheat had been mixed together. Selections from Hunter's wheat have been made from time to time, and have obtained a measure of celebrity under various local names. The most esteemed of these is the *Hopeton* wheat. On very rich soils, both of these varieties have the fault of producing too much straw, and of being thereby liable to lodge. Hence, several new kinds with stiffer straw, and consequent lessened liability to this disaster, are now in request in situations where this evil is apprehended. *Fenton Wheat,* possessing this quality in an eminent degree, and being at the same time very productive, and of fair quality, is at present extensively cultivated. It has the peculiarity of producing stems of unequal height from the same root, which gives a crop of it an unpromising appearance, but has perhaps to do with its productiveness. The *red-straw-white* and *Piper's* thick-set, are in estimation for the same properties as the Fenton. Piper's is said to be the shortest and stiffest strawed wheat in cultivation. It is a yellow-grained and rather coarse variety, but exceedingly productive. It has been introduced into Scotland under the name of Protection Wheat. The red-chaff white is productive, and yields grain of beautiful quality, but it requires good seasons, as it sheds its seeds easily and sprouts quickly in damp weather. The *Chiddam, pearl, white Kent,* and *Talavera,* have each their admirers, and are all good sorts in favourable seasons; but, in Scotland at least, their culture is attended with greater risk than the kinds previously named; they require frequent change of seed from a sunnier climate, and are only adapted for dry and fertile soils with a good exposure. As red wheats usually sell at from 2s. to 4s. less per quarter than white wheats of similar quality, they are less grown than heretofore. But being more hardy and less liable to mildew and sprouting than the finer white wheats, a recurrence of unfavourable seasons always leads to an increased cultivation of them. Some of these red wheats are, however, so productive that they are preferred in the best cultivated districts of England. *Spalding's Prolific* holds a first place among these; being truly prolific, and producing grain of good quality. In Scotland, it shews a tendency to produce a rough quality of grain. The *Northumberland red* and the *golden creeping* are there in estimation; the former being well adapted for spring sowing, and the latter for poor soils and exposed situations. Three new varieties of wheat have recently been introduced by Mr. Patrick Sheriff of Haddington, formerly of Mungoswells. One is a large grained red wheat, another somewhat resembles Hunter's in colour, and the third has grain of a pearly whiteness. They have all the peculiarity of being bearded. They are all true autumn wheats; but they seem also well adapted for spring sowing, as they ripen early. A red bearded variety, usually called April wheat, from its prospering most when sown in that month, and which indeed is a true summer wheat, is sometimes grown with advantage after turnips, when the season is too advanced for other sorts. But except upon poorish clay soils, it seems only doubtfully entitled to a preference over barley in such circumstances. The list now given could easily be extended; but it comprises the best varieties at present in use, and such as are suited to the most diversified soils, seasons, and situations, in which wheat can be grown in this country. In regard to all of them it is reckoned advantageous to have recourse to frequent change of seed, and in doing this to give the preference to that which comes from a soil and climate better and earlier than those of the locality in which it is to be sown. Every farmer will find it worth his while to be at pains to find out from whence he can obtain a change of seed that takes well with his own farm; and having done so to hold to that, and even to induce his correspondent to grow such sorts as he prefers, although he should have to pay him an extra price for doing so. An experienced farmer once remarked to the writer, that by changing his seed he got it for nothing; that is, his crop was more abundant by *at least* the quantity sown, from the single circumstance of a suitable change of seed. It is proper, however, to state, that this practice of changing the seed is founded more upon mere opinion than upon well-ascertained facts, and that in those instances where it has been followed by beneficial results nothing is known of the causes to which such success is due. It is much to be desired that our Agricultural Societies should address themselves to the thorough investigation of a question of such vital importance. In fixing upon the kind of wheat which he is to sow, the farmer will do well to look rather to productiveness than to fine quality. For however it may gratify his ambition to shew the heaviest and prettiest sample in the market, and to obtain the highest price of the day, no excellence of quality can compensate for a deficiency of even a few bushels per acre in the yield. It is of importance, too, to have seed-corn free from the seeds of weeds, and from other grains, and to be true of its kind. Farmers who are systematically careful in these respects, frequently obtain an extra price for their produce, by selling it for seed-corn to others; and even millers give a preference to such clean samples.

But there are seeds which no amount of care or accuracy in dressing can remove from seed-corn—viz., those of certain parasitical fungi, which must be got rid of by a different process. The havoc caused to wheat crops by Bunt, Black-ball, or Pepper-brand (*Uredo caries* or *Tilletia caries*), before the discovery of the mode of preventing it by steeping the seed-corn in some acrid or caustic bath, was often ruinous. The plan at first most usually adopted was to immerse the seed-wheat in stale chamber-lie, and afterwards to dry it by mixture with quick-lime. This pickle, as it is called, is usually efficacious; but the lime vexes the eyes, and excoriates the hands and face of the sower, or clogs the hopper of the sowing machine, and has therefore been superseded by other substances. Blue vitrol (sulphate of copper) is as good as anything for this purpose, and is used in the following manner. A solution is prepared by dissolving powdered sulphate of copper in water, at the rate of *two* ounces to a pint for each bushel of wheat. The grain is emptied upon a floor; a little of it is shovelled to one side by one person, while another sprinkles the solution over it, and this process is continued until the whole quantity is gone over. The heap is then turned repeatedly by two persons working with shovels opposite to each other. After lying for a few minutes, the grain absorbs the moisture, and is ready for sowing either by hand or machine. The season for wheat-sowing extends from September to April, but ordinarily that succeeds best which is committed to the ground during October and November. When summer-fallows exist, the first sowings are usually made on them. It is desirable that the land neither be wet nor very dry when this takes place, so that the precise time of sowing is determined by the weather; but it is well to proceed as soon after 1st October as the land is moist enough to insure a regular germination of the seed.

Over a large portion of England, wheat is the crop usually sown after clover or one year's "seeds." In such cases the land is ploughed in the end of September, immediately harrowed, and wheat sown upon it by a drilling machine. On loose soils the land-presser is frequently used to consolidate the soil and to form a channel for the seed, which in such cases comes up in rows, although sown broad-cast. It is more usual, however, first to level the pressed furrows by harrowing, and then to use the drill; by means of which, various portable manures are frequently deposited along with the seed-corn. The sowing of wheat after clover or "seeds," as now described, is rarely practised in Scotland, where it so invariably fails as to shew that it is unsuited to our northern climate. It is here not unusual, however, to plough up such land in July or August, and to prepare it for wheat-sowing by what is called *rag-fallowing*. After the first ploughing, the land is harrowed lengthwise, so as to break and level the surface of the furrows and close the interstices without tearing up or exposing any green sward. It is then allowed to lie for ten or fourteen days to allow the herbage to die, which it soon does at this season when light is thus excluded from it. A cross ploughing is next given, followed by repeated grubbings, harrowing, and rollings, after which it is treated in all respects as a summer-fallow.

The fallow and clover leas being disposed of, the land from which potatoes, beans, peas, or vetches, have been cleared off will next demand attention. When these crops have been carefully horse and hand hoed, all that is required is to clear off the haulm, to plough and sow. If the land is not clean, recourse must be had to a short fallowing process, before sowing wheat. For this purpose the surface is loosened by the broadshare and grubber, the weeds harrowed out and raked off, after which the land is ploughed and sown. On soils well adapted for the growth of beans and wheat, viz., those in which clay predominates, any lengthened process of autumn cultivation is necessarily attended with great hazard of being caught by rain, to the loss of seed-time altogether.

Every pains should therefore be taken to have the land so cleaned beforehand, that these unseasonable efforts may be dispensed with; and to have the sowing and harrowing to follow so closely upon the ploughing, as to diminish to the utmost the risk of hindrance from wet weather. As the crops of mangel, carrots, or turnips, arrive at maturity and are either removed to the store-heap or consumed by sheep where they grow, successive sowings of wheat can be made as the ploughing is accomplished, and as the weather permits. It is to be noted, however, that it is only on soils naturally dry, or made so by thorough draining, and which are also clean, and in a high state of fertility, that wheat-sowing can be continued with advantage during the months of December and January. If the whole of these conditions do not obtain, it is wiser to refrain until February or March. When these late winter sowings are made, it is of especial importance to sow close up to the ploughs daily, as a very slight fall of rain will, at this season, unfit the land for bearing the harrows. This sowing and harrowing, in detail, is the more easily managed, that in the circumstances cross-harrowing is neither necessary nor expedient. Under the most favourable conditions as to weather and drainage, soils with even a slight admixture of clay in their composition will at this season plough up somewhat clammy, so that cross-harrowing pulls the furrows too much about, and exposes the seed, instead of covering it more perfectly. Two double turns of the harrows *lengthwise*, is as much as should be attempted at this season.

The sowing of *spring-wheat* is only expedient on dry and fertile soils with a good exposure. Unless the whole conditions are favourable, there is much risk of spring-sown wheat being too late to get properly ripened, or well harvested. On the dry and fertile soils in the valley of the Tweed, where the entire fallow-break is sown with turnips, and where consequently it is difficult to get a large breadth cleared in time for sowing wheat in autumn, it is the practice to sow it largely in February and March, and frequently with good success. Many judicious farmers are, however, of opinion that, taking the average of a twenty years' lease, barley is a more remunerative crop than spring-sown wheat, even under circumstances most favourable to the latter. When it is resolved to try it, a very full allowance of seed should be given—not less than *three* bushels per acre, and 3½ will often be better. If the plants have room they will tiller; and thus the ripening of the crop is retarded, the risk of mildew increased, and the quality of the grain deteriorated. As much seed should therefore be sown as will yield plants enough to occupy the ground fully from the first, and thus remove the temptation to tillering. By such full seeding a fortnight is frequently gained in the ripening of the crop, and this as frequently makes all the difference betwixt a remunerative crop and a losing one.

Much controversy has taken place of late years about the quantities of seed-wheat which should be used per acre. The advocates of thin-seeding have been so unguarded and extravagant in their encomiums of their favourite practice, some of them insisting that anything more than a few quarts per acre does but waste seed and lessen the produce—that many persons have been induced to depart from their usual practice to their serious cost. It is true that with land in a high state of fertility, and kept scrupulously clean by frequent hoeings, a full crop of wheat may be obtained from *half* a bushel of seed per acre, provided that it is sown in September, and deposited regularly over the surface. But what beyond a trifling saving of seed is gained by this practice? And at what cost and hazard is even this secured? It is a mere fallacy to tell us, as the advocates of excessively thin seeding so often do, that they obtain an increase of so many hundred-fold; whereas, thick seeders cannot exceed from twelve to twenty fold, when after all the gross produce of the latter may exceed that of the former by more than the quantity of seed saved, with less expense in culture, less risk from accidents and disease, an earlier harvest, and a better quality of grain. Such a crowding of the ground with plants as prevents the proper development of the ear is of course to be avoided; but the most experienced growers of wheat are convinced of the benefit of having the ground fully occupied at the time when active spring growth begins. This is secured by using two bushels per acre for the sowing made early in October, and by increasing this quantity at the rate of half a peck per week until three bushels is reached, which may be held as the maximum. Less than this should not be used from the middle of November to the end of the season. These are the quantities to be used in broad-cast sowing; when drilling or dibbling is resorted to, two-fifths less seed will suffice. In Scotland, at least, often repeated trials have shewn that larger crops are obtained by broad-casting than by drilling. The latter mode is however to be preferred wherever the land is infested by annual weeds, which can then be got rid of by hoeing. When clover and grass-seeds are sown with the grain crop it is believed also that they thrive better from the grain being sown in rows, probably because in this case light and air are less excluded from them. It is believed also that in highly-manured soils of a loose texture grain deposited somewhat deeply in rows is less liable to lodge than when sown broad-cast and shallower. When drilling and hoeing are resorted to, the latter is effected most cheaply and effectively by using Garret's horse-hoe. The mere stirring of the soil is considered by many farmers to be so beneficial to the wheat crop that they use the horse-hoe irrespective of the presence of weeds. Others are of opinion that, apart from the destruction of weeds, hoeing is injurious to grain crops, alleging that the cutting of their surface roots weakens the stems and increases their liability to fall over. Carefully conducted experiments are required to settle this point. We have no personal experience bearing upon it beyond this, that we have repeatedly seen a wheat crop much benefited by mere harrowing in spring. It is always useful to roll wheat, and indeed all cereal crops, in order to facilitate the reaping process, although no other benefit should result from it. When the plants have been loosened by severe frosts, or are suffering from the attacks of wireworms, the use of Crosskill's roller is usually of great benefit to the crop.

A plan of growing wheat year after year on the same field without the use of manure has been practised for several years past by the Rev. Mr. Smith of Lois Weedon, Northamptonshire, and detailed by him in the pages of the *Royal Agricultural Society's Journal*, and in a pamphlet which has now passed through many editions and had a very extensive circulation. His plan is to a certain extent a revival of that of Jethro Tull; but with this important difference, that whereas Tull occupied his ground with alternate double rows of wheat a foot apart, and vacant spaces five feet wide, which were carefully cultivated by ploughings and horse-hoeings repeated at intervals from the springing of the wheat until midsummer, Mr. Smith introduces two important elements in addition, viz., thorough draining, and trenching the vacant spaces in autumn, so as to bring portions of subsoil to the surface. A field treated on this system consists of alternate strips of wheat and bare fallow, which are made to exchange places year by year, so that each successive crop occupies a different site from its immediate predecessor. It has also the benefit of the fresh soil brought up by the previous autumn's double-digging, which is subsequently mellowed and pulverised by lengthened exposure to the atmosphere, and by frequent stirrings. The produce obtained by Mr. Smith from his acre thus treated was very nearly 34 bushels each year for the first five years; but as his crops have been steadily improving, his average at the end of fourteen years is fully 36 bushels. Writing in July 1861, he says, "The growing crop for 1861, notwithstanding the frost, looks strong and well, with scarcely a gap. Thus year after year gives growing confidence in the scheme." Now that steam-power is available, Mr. Smith is fully persuaded of the practicability of carrying out his system with advantage on an actual farm. At first he restricted himself to the employment of manual labour, but he has since invented a set of implements for sowing, covering in, rolling, and hoeing his crops by horse labour. We give in his own words his directions for carrying out this system, what he believes to be the advantages of it, and the cost of thus cultivating an acre.

"I suppose, at the outset, the land intended for wheat, to be wheat land; having besides a fair depth of staple, and a subsoil, as will generally, though not universally, be the case, of the same chemical composition with the surface. I suppose it dry; or drained three feet deep *at least;* well cleaned of weeds; the lands cast; and the whole tolerably level.

"1. First of all, then, plough the whole land, when dry, one inch deeper than the used staple. If it turn up cloddy, bring the clods down with the roller or the crusher. Let this be done, if possible, in August. Harrow deep; so as to get five or six inches of loose mould to admit the presser. Before sowing wait for rain. After the rain wait for a fine day or two to dry the surface. With this early commencement a week or two is of no material importance compared with that of ploughing dry and sowing wet.

"As early as possible, however, in September, get in your seed with the presser-drill; or with some implement which forms a firm-bedded channel in which to deposit the seed, grain by grain, a few inches apart. Cover over with the crusher or rough roller.

"2. When the lines of wheat appear above ground, guard against the rook, the lark, and the slug; a trite suggestion, but ever needful, especially here. And now, and at spring, and all through summer, watch for the weeds, and wage constant warfare against them. The battle may last for a year or two, or in some foul cases even more;

but, in the end, the mastery, and its fruits, without fail, will be yours.

"3. The plant being now distinctly visible, dig the intervals two spits deep; increasing the depth, year after year, till they come to twenty or twenty-four inches. Bring up at first only four, or five, or six inches, according to the nature of the subsoil, whether tenacious, or loamy, or light. To bring up more at the outset would be *a wasteful and injurious expense.*

"The digging is done thus:—Before proceeding with the work, a few cuts are made within three inches of the wheat, the back of the spade being towards the rows. A few double spits, first of all, at the required depth, are then thrown out on the headland, and there left for the present. After this, as the digging proceeds, the staple is cast to the bottom, and the subsoil thrown gently on the top. This process is carried on throughout the whole interval; at the end of which interval, just so much space is left vacant as was occupied by the soil thrown out at the beginning of it. In commencing the second interval at that finished end, the earth is thrown out as at first, not on the headland, however, but into the vacant space of the first interval. And so on all over the acre.

"4. Late in winter, and early in spring, watch your opportunity, in dry weather, before the roots of the plant are laid bare, to press them with the crusher.

"5. In the spring, and early summer, stir the spaces between the rows as often as the surface becomes crusted over; and move the settled intervals four or five inches deep with the common scarifier, set first of all about twenty-eight inches wide; reducing the width till it come by degrees to twenty-four and eighteen inches. Continue the process, if possible, at the last-named width, up to the time of flowering in June.

"These operations are indispensable to full success; and happily can be carried on at little cost. For, while the intervals of each acre can be scarified in fifty minutes, the horse-hoe implement, covering two lands at once, can stir between the rows in twenty-five.

"6. Immediately the crop is carried, clean the intervals, and move them with the scarifier in order to *sow*, without delay, the shed grains. When these vegetate and come up into plant, move the intervals again, five or six inches deep, and so destroy them. After that, level with the harrow implement, and the land is ready for the drill.

"If anything occur to prevent the sowing early in September, and to drive you to the end of October, set the drill for a thicker crop.

But, if possible, sow early. For this reason, Tillered wheat has a bad name. But that has reference only to wheat which has tillered late in the spring. And certainly, in that case, there is the fear of danger to the crop, and danger to the sample. For, supposing no mildew to fall on it, even then the plant ripens unevenly; the early stems being ready for the sickle, while the late-grown shoots have scarcely lost their verdure. But if mildew come when the stem is soft, and succulent, and porous, instead of being, as it should be at that time, glazed and case-hardened against its attacks, the enemy enters in and checks the circulating sap; and the end is, blackened straw, light ears, and shrivelled grain. Therefore, sow early. Let the plant tiller before winter. Give every stem an equal start at spring; and then, with a strict adherence to rule, there need be no alarm as to the result, subject only to those visitations from which no wheat, on any system, in the same description of soil, and under the same climate, is secure."—(See pamphlet, *Word in Season*, p. 36.)

"The advantages of the system of corn-growing which I have described are principally these. First, while one crop of wheat is growing, the unsown intervals of the acre are being fallowed and prepared for another. This the farmer well knows to be of infinite moment, meeting, as it does, one of the greatest difficulties he has to contend with. Next, upon this half-portion of the acre, tilled as I describe, there is a yield equal to average crops on a whole acre. Then, for half the portion of an acre, there is, of course, only half the labour and half the expense of an entire acre required for cultivation. And lastly, the hand-labour required finds constant employment for the poor."—(*Ibid.*, p. 17.)

"After harrowing, and cleaning, and levelling the whole, I marked out the channels for the seed with my *presser implement*, which is drawn with one horse, and presses two lands at once. My scheme of implements, to be complete, embraced a drill, which was to act immediately behind the presser-wheels, and to drop seed by seed into the hard channels. The spindle of the presser was to turn the drill-wheels, and the boxes were to be made removable. Being unable to accomplish this in time for this year's sowing, I had the seed, as heretofore, dropped by hands, and covered over by rollers.

"These rollers form the *roller implement* in the same frame, and are managed thus: the three-wheeled pressers are removed from their sockets, and in their place two rough rollers, formed of several wheels on the self-cleaning principle, are introduced, and cover over two lands at once.

"The portion of the field thus seeded will lie in this firm but rough state till spring time. Then, when the rollers have been applied again to keep the roots of the plant well in their place, they too will be removed from the frame, and light wheels and hoes will be attached; forming the *horse-hoe implement*, for hoeing and stirring between the wheat.

"There is yet one other use for the implement frame. The intervals of the wheat having been trenched in autumn, and well and frequently stirred by the common scarifier at spring, are shut out by the wide-spreading wheat-plant in June from all further processes till the crop is cut and carried. They are then to be moved and levelled by the common one-horse scarifier, for seed-time. After this will follow the harrow. The hoes will be removed from the frame, and two small harrows will be attached, to cover two lands at once; and with this implement the horse will walk on the stubble-land, between what before were the intervals; and the cycle of operations is now complete.

"In all these operations (excepting in that of scarifying) the sown lands, and lands about to be made ready for sowing, are untouched by the foot of man or horse.

"The time occupied in scarifying the land is about an hour the acre; in heavily pressing the channels for the seed, half an hour; in the other operations about 20 or 25 minutes."—(Pp. 25, 26.)

"The presser-drill, spoken of in p. 25, is completed, and I now sow the four acres in 90 minutes, timed by watch; being at the rate of 18 or 20 acres a day in a day of 8 hours, with a horse of average power and speed.

"It has been thought advisable to keep the drill in its own frame,—devoting another frame to the roller-wheels or crusher, the hoes, the scarifiers, and harrows; all of which are made removable, and which, with the exception of the spade, the hand-hoe, and the common scarifier for stirring the intervals, perform the whole cycle of operations for cultivating the land for wheat."—(Pp. 33, 34.)

"I have only to shew now, by my fresh balance-sheet, how with suitable implements, on wheat-land, the whole scheme I propose is economical, as well as easy and expeditious.

"One double digging in autumn	£1	10	0
Three stirrings with scarifier at spring (6d.) . .	0	3	0
One ditto with scarifier and harrow implement, before sowing	0	1	0
Carried forward	£1	14	0

Brought forward	£1	14	0
Two pecks of seed (5s. the bushel)	0	2	6
Pressing and drilling	0	1	0
Rough rolling	0	0	6
Four hoeings between wheat with horse-shoe implement (6d.)	0	2	0
Bird-keeping	0	2	0
All the operations from reaping to marketing .	1	2	0
Rates, taxes, and interest	0	10	0
Total amount of outlay .	£3	14	0"

"The produce, supposing it equal to that of former years, in round numbers, would be :—

"Four quarters and two bushels of wheat at (40s.) .	£8	10	0
One ton and 12 cwt. of straw (at £2 the ton). .	3	4	0
	£11	14	0
Deduct outlay .	3	14	0
Total amount of profit .	£8	0	0"

—(*Ibid.*, p. 30.)

Public attention has more recently been directed to this system of wheat culture by a lecture on Tull's husbandry, delivered by Professor Way, at a council meeting of the Royal Agricultural Society of England, and by the animated discussion which followed; when several gentlemen who had visited Mr. Smith's farm bore testimony to the continued excellence of his crops, and intimated that they and others had begun to test the system upon their own farms. If such a practice can indeed be pursued on the generality of clay-soils, then the puzzling problem of how to cultivate them with a profit is solved at once. It is impossible that practical farmers should regard otherwise than with incredulity a system which so flatly contradicts all existing theory and practice. The facts submitted to them by Mr. Smith being beyond challenge, they will, in the meantime, hold to the belief that there is some peculiarity in the soil at Lois Weedon which enables it to sustain, as yet, such heavy and continued demands on its fertility; and that the issue, there and elsewhere, must ere long be utter sterility. For our own part, believing that we have exceeding much to learn in every department of agriculture, we cannot thus summarily dispose of these facts. We simply accept them as true, and leave the exposition of them to *experience*, whose verdict we await with much interest.

But Mr. Smith is not the only person who has furnished us with information regarding the continuous growth of wheat for a series of years on the same soil. Mr. Lawes, at Rothamstead, in Herts, so well known by his interesting papers on agricultural chemistry in the *Royal Agricultural Society's Journal*, has furnished some facts in connection with the culture of wheat on clay soils, to which farmers were little prepared to give credence. Mr. Caird, who visited Rothamstead early in 1851, thus refers to this subject in his valuable work:—

"On a soil of heavy loam, on which sheep cannot be fed on turnips, 4, 5, and 6 feet above the chalk, and therefore uninfluenced by it, except in so far as it is thereby naturally drained, *ten* crops of wheat have been taken in succession, one portion always without any manure whatever, and the rest with a variety of manures, the effects of which have been carefully observed. The seed is of the red cluster variety, drilled uniformly in rows at 8 inches apart, and two bushels to the acre, hand-hoed twice in spring, and kept perfectly free from weeds. When the crop is removed the land is scarified with Bentall's skimmer, all weeds are removed, it is ploughed once, and the seed for the next crop is then drilled in. During the ten years, the land, in a natural state, without manure, has produced a uniform average of 16 bushels of wheat an acre, with 100 lb. of straw, per bushel of wheat, the actual quantity varying with the change of seasons between 14 and 20 bushels. The repetition of the crop has made no diminution or change in the uniformity of the average, and the conclusion seems to be established, that if the land is kept clean, and worked at proper seasons, it is impossible to exhaust this soil below the power of producing 16 bushels of wheat every year.

"But this natural produce may be doubled by the application of certain manures. Of these, Mr. Lawes' experiments led him to conclude that ammonia is the essential requisite. His conclusions are almost uniform, that no organic matter affects the produce of wheat, except in so far as it yields ammonia; and that the whole of the organic matter of the corn crop is taken from the atmosphere by the medium of ammonia. There is a constant loss of ammonia going on by expiration, so that a larger quantity must be supplied than is contained in the crop. For practical purposes, 5 lb. of ammonia is found to produce a bushel of wheat, and the cheapest form of ammonia at present being Peruvian guano, 1 cwt. of that substance may be calculated to give 4 bushels of wheat. The natural produce of 16 bushels an acre may therefore be doubled by an application of 4 cwt. of Peruvian guano. To this, however, there is a limit,—climate. Ammonia gives growth, but it depends on climate whether that produce is straw or corn. In a wet cold summer, a heavy application of ammonia produces an undue development of the circulating condition of the plant, the crop is laid and the farmer's hopes are disappointed. Seven of corn to ten of straw is usually the most productive crop; five to ten seldom yields well. The prudent farmer will therefore regulate his application of ammonia with a reference to the average character of the climate in which his farm is situated.

"The practical conclusion at which we arrive is this, that in the cultivation of a clay-land farm, of similar quality of soil to that of Mr. Lawes, there is no other restriction necessary than to keep the land clean. That while it is very possible to reduce the land by weeds, it is impossible to *exhaust* it (to a certain point it may be *reduced*) by cleanly cultivated corn crops. That it is an ascertained fact that wheat may be taken on soils of this description (provided they are manured) year after year with no other limit than the necessity for cleaning the land, and that may best be accomplished by an occasional green crop—turnip or mangold, as best suits—at great intervals, the straw being brought to the most rotten state, and applied in the greatest possible quantity to insure a good crop, which will clean the land well. If these conclusions are satisfactorily proved, the present mode of cultivating heavy clays may be greatly changed, and the owners and occupiers of such soils be better compensated in their cultivation than they have of late had reason to anticipate." (Caird's *English Agriculture*, in 1850 and 1851, pp. 460-462.)

It is certainly curious to observe, that the addition of four cwt. of guano brings up the produce of Mr. Lawes' acre from its average annual rate of sixteen bushels, under its reduced normal state, to very nearly the same as Rev. Mr. Smith's acre under his system of alternate strips of corn and summer fallow.

From information carefully gathered, Mr. Caird gives it as his opinion, that the average produce of wheat per acre in 26 of the 32 counties of England visited by him is $26\frac{2}{3}$ bushels, or 14 per cent higher than it was estimated at in the same counties by Arthur Young 80 years before. Were the country generally anything like as well cultivated as particular farms that are to be met with in all parts of it, we should have the present average increased by at least eight bushels per acre. 63 lbs. per bushel is a weight indicating a good quality of grain. A good crop of wheat will yield a ton of grain, and about two tons of straw per acre.

Besides its uses on the farm, wheat straw, in certain limited districts in the south of England, is an article of some value, as the raw material of a not unimportant native manufacture, namely, *Straw-Plait.* The first straws used for this purpose in this country were grown in the neighbourhood of Luton in Bedfordshire. This town is still the principal seat of the straw trade and straw bonnet manufacture, and the district around still produces the finest quality of straws; but straw-growing is now also carried on in parts of Hertfordshire, Buckinghamshire, Oxfordshire, and Berkshire. Light, rich soils are best adapted for this purpose. The kinds of wheat grown with this view are the Red Lammas, and the Chiddam. A bright, clean, tough straw being required, it is necessary to begin reaping before the flag of the straw falls. If the straw is exposed to rain it becomes rusted or spotted; if to very hot and dry weather it gets sunburnt and brittle. The utmost care and energy must therefore be used to get the crop dried, carried, and stacked as quickly as possible. In favourable seasons an acre of wheat will yield (besides the grain) from 15 cwt. to a ton of cut straws, of the value of £6 to £8 per ton, clear of all expenses. The farmer sells his straw to a class of men called straw-factors, who draw and cut the straws in his barn. The drawing and cutting off of the ears being there performed, the factors remove the straw to their own premises. There it undergoes a farther cutting, is exposed to the fumes of sulphur, assorted into proper lengths, and made up into marketable bunches of various sizes and qualities. These bunches are disposed of to the plaiters at the various markets of the district. About 50,000 females and boys are engaged in plaiting. No plait is made in factories, the work being performed by the wives and children of agricultural labourers in their own cottages, where it is carried on all the year except in harvest. The straw trade, in its various departments, is of considerable importance and is steadily increasing. The gross returns are supposed not to fall short of £1,250,000 per annum.

There is now also a small demand for wheat straw for the manufacture of paper.

Section 2.—*Barley.*

In Great Britain, barley is the grain crop which ranks next in importance to wheat, both in an agricultural and social point of view. Its use as bread-corn is confined to portions of the lowlands of Scotland, where unleavened cakes, or "bannocks o' barley meal," still constitute the daily bread of the peasantry. It is more largely used in preparing the "barley broth" so much relished by all classes in Scotland. To fit the grain for this purpose, it is prepared by a peculiar kind of mill, originally introduced from Holland by Fletcher of Saltoun, in which a thick cylinder of gritty sandstone is made to revolve rapidly within a case of perforated sheet-iron. The barley is introduced betwixt the stone and its case, and there subjected to violent rubbing, until first its husk, and then its outer coatings are removed. It is, however, in the production of malt liquor and ardent spirits, and in the fattening of live stock, that our barley crops are chiefly consumed. We have no doubt that it would be better for the whole community if this grain were more largely used in the form of butcher-meat, and greatly less in that of beer or whisky. It has been customary for farmers to look upon distillation as beneficial to them from the ready market which it affords for barley, and more especially for the lighter qualities of this and other grain crops. But this is a very short-sighted view of the matter; for careful calculation shews that, when the labouring man spends a shilling in the dram-shop, not more than a penny of it goes for the agricultural produce (barley), from which the gin or whisky is made; whereas, when he spends the same sum with the butcher or baker, nearly the whole amount goes for the raw material, and only a fraction for the tradesman's profits. And not only so, but the man who spends a part of his wages upon strong drink, diminishes, both directly and indirectly, his ability to buy wholesome food and good clothing; so that, apart from the moral and social bearings of this question, it can abundantly be shewn that whisky or beer is the very worst form for the farmer in which his grain can be consumed. Were the £50,000,000 at present annually spent in Great Britain upon ardent spirits (not to speak of beer), employed in purchasing bread, meat, dairy produce, vegetables, woollen and linen clothing, farmers would, on the one hand, be relieved from oppressive rates, and, on the other, have such an increased demand for their staple products, as would far more than compensate for the closing of what is, at present, the chief outlet for their barley.

There are many varieties of barley in cultivation, and some of them are known by different names in different districts. Those most esteemed at present in Berwickshire and neighbouring counties, are the *Chevalier*, the *Annat*, and the *common-early long-eared.* The chevalier produces the finest and heaviest grain, weighing usually from 54 lbs. to 56 lbs. per bushel, and is in high estimation with maltsters. It is also tall and stout in the straw, which is less liable to lodge than that of the common barley; and when this accident does happen, it has the valuable property of not producing aftershoots or greens. It requires about fourteen days longer than the common-early to reach maturity, but as it admits of being sown earlier than the latter sort, this is in practice no drawback to it. The Annat barley resembles the chevalier in its leading features, but is yellower in its complexion, and not quite so round in the grain. It ripens a few days earlier than the chevalier, and in our own experience is more productive. The common-early is more liable than those just noticed to suffer from over luxuriance. It is generally used for the latest sowings, on those portions of land from which the turnip crop has been longest in being removed.

In the elevated or northern parts of the kingdom four-rowed barley, usually called *Bere* or *Bigg*, is cultivated, as it is more hardy, and ripens earlier than the two-rowed varieties. A new variety, called Victoria Bere, is said to be so productive, and to yield such a heavy sample, as to be worthy of cultivation even in lowland districts.

Barley delights in a warm, friable soil, and thrives best when the seed is deposited rather deeply in a tilthy bed. Being the grain crop best adapted for succeeding turnips that have been consumed by sheep-folding, advantage must be taken of favouring weather to plough up the land in successive portions, as the sheep-fold is shifted. So much of it as is ploughed before 1st February will usually get so mellowed by the weather as to be easily brought into suitable condition for receiving the seed. In Scotland, the usual practice is to sow broadcast on this stale furrow, and to cover the seed by simple harrowing. A better way is first to level the surface by a stroke of the harrows, and then to form it into ribs *twelve* inches apart, by such an implement as has been described, when speaking of Tennant's grubber. Over this corrugated surface the seed is sown broadcast, and covered by another turn of the harrows. The ribbing loosens the soil, gives the seed a uniform and sufficient covering, and deposits it in rows. The only advantage of such ribbing over drilling is, that the soil is better stirred, and the seed deposited more deeply, and less crowded than is done by the ordinary drills. It is certainly of great advantage to have the seed-corn deposited in narrow lines, so far as the working of the horse-hoe is concerned; but we are convinced that stiffer stems, larger ears, a more abundant yield, and a brighter sample, are likely to be obtained when the seed is loosely scattered in a channel three or four inches wide than when crowded into a narrow line. This grain is now sown considerably earlier than heretofore. When the soil is enriched by plentiful manuring, its temperature raised by thorough draining, and the climate and exposure favourable, it should be sown as early in March as possible, and will often do remarkably well although sown in February. This early sowing counteracts that tendency to over-luxuriance, by which the crop is so often ruined in fertile soils. It is chiefly owing to this early sowing (although aided by the use of hummelling machinery) that the average weight of barley is so much greater now than it was twenty years ago. From 53 lbs. to 54 lbs. per bushel, is now about the average weight in well-cultivated districts; while 57 lbs. and 58 lbs. is by no means rare. The produce per acre ranges from 30 to 60 bushels; 36 bushels being about the average. The quantity of seed used per acre is from 2½ to 3 bushels, for broad-cast sowing, and about a third less when drilled. As already remarked in regard to wheat, it is well, as the season advances, to avoid, by a fuller allowance of seed, the temptation to excessive tillering, and consequent unequal and later ripening. A good crop of barley yields about one ton each per acre of grain and straw.

Section 3.—*Oats.*

Over a large portion of England oats are grown only as provender for horses, for which purpose they are fully ascertained to be superior to all other grains. Except, therefore, on fen-lands, and recently-reclaimed muiry soils, the cultivation of oats in south Britain bears a small proportion to the other cereals. It is in Scotland, "the land o' cakes," that this grain is most esteemed, and most extensively cultivated. Considerably more than half of the annual grain crops of Scotland consist in fact of oats. The important item which oatmeal porridge forms in the diet of her peasantry, and of the children of her other classes, has something to do with this extensive culture of the oat; but it arises mainly from its peculiar adaptation to her humid climate. As with the other cereals, there are very numerous varieties of the oat in cultivation. In Messrs. Lawson's *Synopsis of the Vegetable Products of Scotland*, it is said (Div. i. p. 80), "Our collection comprises nearly sixty varieties, about thirty of which are grown in Scotland; but of these not more than twelve are in general cultivation. These twelve varieties, enumerated in the order of their general cultivation, are, the Potato, Hopetoun, Sandy, Early-Angus, Late-Angus, Grey-Angus, Blainslie, Berlie, Dun, Friesland, Black Tartarian, and Barbachlaw." The first four kinds in this list are those chiefly cultivated on the best class of soils. It is to the produce of these that the highest market prices usually have reference. The weight per bushel of these sorts usually runs from 42 lb. to 46 lb. From 50 to 60 bushels per acre is a usual yield of oats. The two last-named kinds are chiefly esteemed for their large produce, and adaptation to inferior soils; but being of coarse quality, they are chiefly used for provender. A variety which stands the winter is now frequently grown in England, for the double purpose of first yielding a seasonable supply of green food to ewes and lambs in early spring, and afterwards producing a crop of grain. It has already been stated that, in Scotland, wheat does not prosper when sown after clover or pasture; but with the oat it is quite the reverse, as it never grows better than on land newly broken up from grass. It is, accordingly, almost invariably sown at this stage of the rotation. The land is ploughed in December or January, beginning with the strongest soil, or that which has lain longest in grass, that it may have the longest exposure to the mellowing influences of wintry weather. In March or April, the oats are sown broad-cast on this first ploughing, and covered in by repeated harrowings. These are given lengthwise until the furrows are well broken down, for if the harrows are worked across the ridges before this is effected, they catch hold of the edges of the slices, and partially lifting them, permit the seed-corn to fall to the bottom, where it is lost altogether. As it is only when a free tilth is obtained that the crop can be expected to prosper, care must be taken to plough early and somewhat deeply, laying the furrows over with a rectangular shoulder, to sow when the land is in that state of dryness that admits of its crumbling readily when trode upon, and then to use the harrows until they move smoothly and freely in the loose soil, two or three inches deep. The Norwegian harrow is an important auxiliary to the common ones in obtaining this result. When wild mustard and other annual weeds abound, it is advisable to drill the crop and to use the horse-hoe. When the land is clean, the general belief in Scotland is that the largest crops are obtained by sowing broad-cast. When the latter plan of sowing is adopted, from 4 to 6 bushels per acre is the quantity of seed used. The latter quantity is required in the case of the Hopetoun and other large-grained varieties. The condition of the soil as to richness and friability must also been taken into account in determining the quantity of seed to be used. When it is in high heart and likely to harrow kindly, a less quantity will suffice than under opposite conditions. In breaking up a tough old sward, even six bushels per acre may be too little to sow. The following very interesting experiment bearing on this point was recently made in Fifeshire. "Mr. Gulland, Wemyss, offered a sweepstakes in 1850, that 4 bushels of oats, sown per Scotch acre, in poor land, would yield a better produce than 8 bushels sown under similar conditions. The late Mr. Hill, maintaining the contrary, accepted the sweepstakes, and a number of others took up the same. Experiments were made by Mr. Dingwall, Ramornie, and Mr. Buist, Hattonhill. . . . :—

"In Mr. Buist's experiments,

"4 bush. sown yielded 28 bush. per acre, 34 lb. per bush.
8 bush. sown yielded 36 " " 34¼ lb. "

"In Mr. Dingwall's experiments,

"4 bush. sown yielded 45 bush. per acre, 38½ lb. per bush.
8 bush. sown yielded 49 " " 39 lb. " "*

The advocates for thin seeding will of course regard even the least of these quantities as foolishly redundant. It is quite true, that if the land is in good heart, the crop will ultimately stand close on the ground from a very small seeding; but it will take two or three weeks longer to do this than if the land had been fully stocked with plants from the first, by giving it seed enough. In our precarious climate, where a late harvest and bad crops usually go together, it is of the

* *Agricultural Gazette*, 20th November 1852.

utmost importance to secure early, uniform, and perfect ripening; and as liberal seeding tends directly to promote such a result, practical farmers will do well to take care how they omit such a simple means of attaining so important an end. We believe that it is on the principle now indicated that the superior result, both as respects quantity and quality of produce, in the double-seeded lots in the experiments now cited, is to be explained.

As with wheat, the vigour and productiveness of the oat is much enhanced by frequent change of seed. Our agricultural authorities usually assert that the change should, if possible, always be from an earlier climate and better soil. This is undoubtedly true as regards high-lying districts; but with a good soil and climate, we have always seen the best results with seed from a later district.

On poor hard soils it is usually remunerative to apply a cwt. of guano per acre to the oat crop; sowing it broadcast, and harrowing it in, along with the seed. As much additional produce is thus ordinarily obtained as more than pays for the manure, and the land is, in all respects, left in better condition for the succeeding green crop. In the case both of very light and strong clay soils, we have obtained excellent results by applying a liberal dressing of farm-yard dung, in autumn, to grass-land about to be broken up for oats. By using, in this way, the dung produced during the summer months, we have obtained abundant crops of oats from portions of land which, but for this, would have yielded poorly; and, at the same time, by applying the bulky manure at this stage of the rotation, instead of directly for the succeeding green crop, an important saving of time and labour has been effected, as we shall have occasion to notice when treating of turnip-culture.

When the young oat plants have pushed their second leaf, it is always beneficial to use the roller, as it helps to protect the crop from the evil effects of drought, and facilitates the reaping of it. The oat frequently suffers much from a disease called "segging" or "tulip root," which appears to be caused by the presence of a maggot in the pith of the stems close to the ground. On land which is subject to this disease, it is advisable not to sow early. A dressing of lime is also believed to be serviceable as a preventative. On muiry soils, this crop is also not unfrequently lost by what is called "*slaying.*" This seems to result from the occurrence of frosty nights late in spring when the crop is in its young stage, and which, when grown on such soils, it cannot withstand. The application of large dressings of lime to light muiry soils greatly aggravates this tendency to *slaying* in the oat crop. The only effectual remedy is to improve the texture of the soil by a good coating of clay. Oats yield about one ton of grain, and one and a half tons of straw, per acre.

Section 4.—*Rye.*

The extensive cultivation of this grain in any country being alike indicative of a low state of agriculture, and of a poor style of living among its peasantry, it must be regarded as a happy circumstance, that it has become nearly obsolete in Great Britain. It is still occasionally met with in some of our poorest sandy soils, and patches are occasionally grown elsewhere for the sake of the straw, which is in estimation for thatching—for making bee-hives, and for stuffing horse-collars. Its cultivation as a catch crop, to furnish early food for sheep in spring, is on the increase.

Section 5.—Leguminous Crops—*Beans.*

The only members of this family statedly cultivated for their grain are beans and pease. Before the introduction of clover and turnips these legumes occupied a more important place in the estimation of the husbandman than they have done since. Indeed, in many districts naturally well adapted for the culture of turnips, that of beans and pease was for a time all but abandoned. Recently, however, increasing precariousness in the growth of clover, and even of turnips, where they have been sown on the same ground every fourth year for a lengthened period, has compelled farmers to return to the culture of beans and pease for the mere purpose of prolonging the intervals in the periodic recurrence of the former crops. But it is found, in regard to the bean itself, in districts where it has long occupied a stated place in rotations of six or seven years, that its average produce gradually diminishes. We have thus an additional illustration of the importance of introducing as great a variety of crops as possible into our field culture. It is on this principle that beans and pease are now again extensively cultivated on dry friable soils. Winter beans, or pease of some early variety, are generally preferred in such cases. The grain of these legumes, though partially used for human food, is chiefly consumed by horses and by fattening cattle and sheep. Being highly nutritious, they are well adapted for this purpose. By growing beans on a limited portion of the land assigned to cattle crops, a larger weight of beef and mutton can be produced from a given number of acres, than by occupying them wholly with roots, forage, and pasturage. Several varieties of field beans are cultivated in Great Britain; such as the *common horse bean*, the *tick*, the *Heligoland*, and the *winter bean*. The latter was introduced into England about the year 1825, and there rises steadily in estimation. It has been tried in many parts of Scotland and proves quite hardy, but is objected to from the exceeding shortness of its straw. But for this, it is a valuable acquisition, as it ripens so much earlier than the spring-sown varieties. Beans should never be sown on land that is foul.

By diligent horse and hand hoeing, land that is clean to begin with can be kept so under beans, and left in fine condition for carrying a white corn crop; but in opposite circumstances it is sure to get into utter confusion. It is found advisable therefore to take beans after the white crop that has succeeded roots or a bare fallow. In Berwickshire, where a five-years' course, consisting of turnips, wheat, or barley, two years seeds, and oats, has long prevailed, beans are now not unfrequently introduced by substituting them for the second year's grass. A four-years' course with beans instead of a portion of the seeds is certainly preferable. In cultivating this crop, the land is ploughed with a deep furrow in autumn, a dressing of dung being first spread over the surface and turned in by the plough. As early in March as the state of the soil admits, it is stirred by the grubber and harrowed. The seeds are then deposited either in narrow rows 14 inches, or in wider rows 27 inches apart. The latter width has long been preferred in Scotland, because of its admitting of the free use of the plough and the drill-grubber, in addition to the hoe, during the early stages of the plant's growth, and also from a belief that the free entrance of light and air, of which the wide rows admits, increases the productiveness of the crop. We shall describe both modes of culture, and then state the grounds upon which, after long sharing in the opinion just noted, and following that practice, we now give a decided preference to sowing in narrow rows. In sowing at the wider intervals the soil, having been prepared as already stated, is formed, by a single turn of the common plough, into shallow drills 27 inches apart. Ten or twelve such drills being formed to begin with, the seed is scattered broad-cast, at the rate of 3 bushels per acre, by a sower who takes in six of these drills at a time, and gives them a double cast, or by a drilling machine, which sows three rows at once. The beans either roll into the hollows as they fall, or are turned in by the ploughs, which now proceed to open, each a fresh drill, in going down the one side of the working interval, and to cover in a seeded one in returning on the other side. If tares are cultivated on the farm, it is usual to sow a small quantity (say a peck per acre) amongst the beans, on which they are borne up and so ripen their seeds better, and yield more abundantly, than when trailing on the ground. When the crop comes to be thrashed, the tares are easily separated from the beans by sifting. Ten days or so after sowing, the drills are partially levelled by a turn of the chain harrow; and, if the land is cloddy, it is smoothed by a light roller. If showers occur when the bean plants are appearing above ground, or shortly after, the common harrows may be used again with the best effect in pulverising the soil and destroying newly-sprung weeds. A horse and hand hoeing is then given, and is repeated if weeds again appear. When the plants have got about 6 inches high, it is beneficial to stir the soil deeply betwixt the rows by using Tennant's grubber, drawn by a pair of horses. For this purpose the tines are set so close together as to clear the rows of beans, and the horses are yoked to it by a main tree, long enough to allow the horses to work abreast in the rows, on either side of the one operated upon. The soil is thus worked thoroughly to the depth of 6 or 8 inches, without reversing the surface and exposing it to drought, or risk of throwing it upon the plants. Just before the blooms appear, some farmers pass a bulking-plough betwixt the rows, working it very shallow, and so as merely to move the surface-soil towards the plants. This may do good; but a deep earthing up is hurtful. When the blooms open, all operations should cease, as otherwise much mischief may be done. Such an amount of culture as has now been described may be thought needlessly costly and laborious; but unless a bean crop is kept clean, it had better not be sown. And it is to be remembered that the benefit of this careful tillage is not confined to it, but will be equally shared in by the wheat crop that follows. The culture of winter beans differs only in this, that they require to be sown as early in autumn as the removal of the preceding grain crop admits of. When it is determined to sow in 14 inch rows, the seeds are deposited by any of the corn-drilling machines in common use, set for the specified width of rows, or—which we prefer—the soil is formed into narrow ribs or drills by means of the one-horse plough, the seeds are scattered broadcast by hand or machine over this corrugated surface, and they are covered by a double turn of the common harrows, and rolled by a light roller. As soon as the bean plants appear, care must be taken to keep down weeds by diligent hoeing. Two good hoeings will usually suffice, for by the time that the second is accomplished, the crop will speedily so close in, as to render any further hoeing impracticable and unnecessary. After repeated trials of these two modes of cultivation, made along side of each other, we have found that the produce from the narrow rows, has been at the rate of from 4 to 6 bushels more per acre, than that from the wide rows, and that the soil has been left decidedly cleaner, after the former than after the latter mode. It is certainly somewhat startling to find results so opposed as these are to preconceived opinion and approved practice. And yet when the matter is well considered, it becomes obvious enough why it should be so. The wide rows admit of a most effective process of tillage and hoeing up to the time when the beans come into bloom, when, however, it must wholly cease. But when farther culture is precluded, the need for it by no means ceases, seeing that the rows of bean plants usually remain sufficiently apart to admit of the continued growth of weeds during the long period which intervenes betwixt the blooming and the ripening of the crop. And hence it happens—especially if the spring prove cold and parching—

that although the wide-rowed beans have been kept scrupulously clean up to the time of blooming, their upright habit of growth renders it impossible that they can so close in upon the wide space betwixt the rows as to preoccupy and overshadow the ground sufficiently to keep it clean during the long period that the crop must necessarily be left to its own resources. By sowing in narrow rows the crop is soon in a condition to defend itself against weeds and drought, and hence the saving of labour, the more bulky crops, and the cleaner stubbles, which result from sowing beans at 14 rather than 27 inch intervals.

In Scotland the haulm of beans is esteemed an excellent fodder for horses and other live stock; whereas in England it is thought unfit for such a use. The reason of this appears to be, that in the southern counties beans are allowed to stand until the leaf is gone, and the stems blackened before reaping; whereas in Scotland they are reaped so soon as the eye of the grain gets black. When well got, the juices of the plant are thus, to some extent, retained in the haulm, which in consequence is much relished by live stock, and yields a wholesome and nutritious fodder. A good crop of beans yields about one ton of grain and one and a half tons of straw per acre.

Section 6.—*Pease.*

Pease are sown in circumstances similar to those just detailed; but they are better adapted than beans to light soils. They too are best cultivated in rows of such a width as to admit of horse-hoeing. The early stage at which they fall over, and forbid further culture, renders it even more needful than in the case of beans to sow them only on land already clean. If annual weeds can be kept in check until the pease once get a close cover, they then occupy the ground so completely, that nothing else can live under them; and the ground, after their removal, is found in the choicest condition. A thin crop of pease should never be allowed to stand, as the land is sure to get perfectly wild. The difficulty of getting this crop well harvested renders it peculiarly advisable to sow only the early varieties.

Section 7.—*Other Crops.*

The cereals and legumes now enumerated, constitute the staple grain-crops of Great Britain. Others are grown occasionally, but more for curiosity than profit. Zealous attempts were made by the late William Cobbet to introduce *maize* or *Indian corn* as one of our regular crops. It has been conclusively proved that none of its varieties, yet tried, can be ripened in the ordinary seasons of this country. It has indeed been suggested that it might form a useful addition to our garden vegetables—using it, as it is done in America, by cooking the unripe cobs; and also that we might grow it beneficially as a forage crop. *Lentiles* have recently been grown in different parts of the country; but both of these grains can be imported of better quality, and at less cost, than they can be grown at home.

There is great inducement to agriculturists to endeavour more earnestly to obtain improved varieties of grain by cross-impregnation of existing ones. Something has already been accomplished in this direction; but only enough to shew what encouragement there is to persevere. Whenever the same skill and perseverance are directed to the improvement of field crops, that our gardeners are constantly exerting, with such astonishing results, on fruits, flowers, and vegetables, we may anticipate a great increase of produce, not only from the discovery of more fruitful varieties, but of such as possess a special adaption to every diversity in the soil and climate of our territory.

Section 8.—Harvesting of Grain Crops, and preparing them for Market.

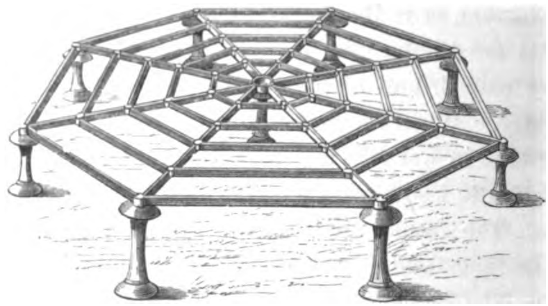
Several distinct modes of reaping grain are in use. The most ancient, and still the most common, is by the sickle or reaping-hook, which is used either with a smooth or serrated edge. The latter was at one time preferred, as by it the work was performed most accurately. The smooth-edged instrument is, however, now the favourite, as it requires less exertion to use it, and the reaper can, in consequence, get through more work in a day; and also, because in using it the stalks are less compressed, and consequently dry faster when made into sheaves. In some parts of England the crops are reaped in a method called *fagging* or *bagging*. The cutting instrument used is heavier, straighter, and broader in the blade than the common reaping-hook. The workman uses it with a slashing stroke, and gathers the cut corn as he proceeds by means of a hooked stick held in his left hand. It is a similar process to the mode of reaping with the Hainault scythe—an instrument which has been tried in this country, but never adopted to any extent. The common scythe, especially with that form of handle known as the Aberdeen handle or *sned*, is very extensively used for reaping grain in all parts of the kingdom. Indeed the practice of mowing grain has been increasing of late years, and would extend more rapidly but for the greater difficulty of finding good mowers than good reapers. A greater amount of dexterity is required to cut grain well by the scythe than by the sickle. The difficulty lies not in making smooth and clean stubble, but in so laying the swathe as to admit of the corn being sheaved accurately. When the mower lays his swathe at right angles to his line of progress, and the gatherer is skilful and careful, corn may be handled as neatly in reaping by the scythe as by the sickle. When the crops are not much laid or twisted, mowing is somewhat the cheapest of these modes of reaping. Its chief recommendation, however, is that mown sheaves dry most quickly, and suffer least from a drenching rain. This arises from the stalks being less handled, and so forming an open sheaf, through which the wind penetrates freely. Tightly bound sheaves are always difficult to dry. It is one of the advantages of reaping by machinery that grain cut down in that way has this property of drying rapidly.

In Berwickshire and adjoining counties, the reaping of the crops has hitherto been accomplished by employing, at day's wages, such a number of reapers as suffices to cut down the crops on each farm in from twelve to twenty days. The rate of wages paid to reapers for a number of years has ranged from 2s. 6d. to 3s. 6d. each *per diem*, with victuals in addition, costing about *eightpence* for each person. In marshalling the band, two reapers are placed on each ridge of 15 or 18 feet in breadth, with a binder to each *four* reapers, and a steward, or the farmer in person, to superintend the whole. When the crop is of average bulk, and lies favourably for reaping, each *bandwin*, or set of *four* reapers and a binder, clear *two* acres in a day of *ten* hours; but 1¼ to 1½ acres only, if it is bulky and lodged. The cost of reaping by this method is therefore from 10s. to 15s. per acre. With a reaping-machine cutting say eight acres *per diem*, and requiring in all ten persons (five men and five women or stout lads), to attend to and clear up after it, at an average wage, including victuals, of 3s. each; and allowing 3s. *per diem* to cover tear and wear, and interest on its prime cost, there seems a reasonable prospect of a goodly portion of our future crops being reaped for about 5s. per acre. The labour of the horses employed in working the reaper is not included in this estimate, as at this season they would otherwise be idle, and yet eating nearly as much food as when at work. There would thus be a saving in actual outlay of about 5s. per acre. But this is the least important view of the matter. On a Berwickshire farm producing 200 acres of crop, there are usually at least six pairs of horses kept, with a resident population, sufficient to yield about thirty persons (including women and youths) available for harvest labour. The stated forces of such a farm will therefore suffice to man *two* reaping-machines, and leave ten persons still available for opening up fields, clearing corners, and reaping such portions as the machines cannot deal with. In unfavourable seasons, one machine only might be able to work with twenty persons using the scythe or sickle. In either way the crop could be cut down in from ten to fifteen days with little or no extraneous aid; whereas, to accomplish it in the same time by hand labour only, from fifty to sixty persons are required. The rapidity and accuracy with which the sowing of grain is now accomplished, frequently issues in the whole crops of a wide district being simultaneously ready for the sickle. The consequence is, that the supply of labourers proves insufficient —there is a scramble to get them—the rate of wages becomes exorbitant, employers are fain to submit to much sauciness and turbulence; and all the while the crops are suffering from over-ripening and are exposed to shaking winds. Great then will be the boon to farmers, if, by means of this invention, they can bring their own heavy cavalry into the field,—dispense with the services of mercenaries,—reduce their actual outlay, and yet shorten the period and lessen the risk of the harvesting process. The call for reaping-machines is now, therefore, more urgent than ever. Perhaps we might add, it is only now that our agriculture has made sufficient progress in other respects to be ready to gear on to such machinery when presented to us.

It is now agreed on all hands that grain should be reaped before it becomes what is called *dead* ripe. In the case of wheat and oats, when the grains have ceased to yield a milky fluid on being pressed under the thumb-nail, and when the ears and a few inches of the stem immediately under them have become yellow, the sooner they are reaped the better. Barley requires to be somewhat more matured. Unless the pink stripes on the husk have disappeared, and the grain has acquired a firm substance, it will shrink in drying, and be deficient both in weight and colour. When allowed to stand till it gets curved in the neck, the straw of barley becomes so brittle that many ears break short off in the reaping; and it suffers even more than other grain-crops under a shaking wind.

It is of great consequence to see that corn is dry when it is tied up in sheaves; that these are not too tightly bound, and that every sheaf is kept constantly on foot. From the increased demand for harvest labourers, and the rapidity with which operations must be carried forward, stooking is not now performed with the same accuracy that it was wont to be. There is therefore the greater need for employing a person to review the stooks daily and keep every sheaf erect. It was formerly the practice in Scotland to set up oats and barley in full stooks of twelve sheaves each, viz., five pairs and two hood-sheaves. These hood-sheaves are an excellent defence when wet weather sets in, but they retard the drying of the corn in fine weather, and there are now few binders who can set them up so as to stand securely. It is better, therefore, to aim at rapid drying, and for this purpose, to have the sheaves small individually, and to set but *four* or *six* of them together. Large sheaves are worse to dry than small ones, not only from their greater bulk, but from their being almost inevitably tighter bound. The utmost vigilance is required on the part of farmers to avoid this fault. Beans and pease are reaped by the sickle. The former are usually not bound into sheaves at once, but left prostrate in handfuls for a few days until they have withered a little. But it is on the whole safer to stook them as they are reaped. They are then sheaved and bound with ties of twisted straw, which must be provided beforehand. In stacking beans, the tops of the sheaves are kept outwards, as by this means fewer pods are exposed to the weather, or to the depredations of fowls, etc., than when the butts are to the outside. Pease are rolled into wisps as they are reaped, and afterwards turned daily until they are fit to carry. When stacked, they must instantly be thatched, as they take in wet like a sponge. It requires no little discrimination to know when sheaves are dry enough to keep in a stack. The farmer finds it for his profit to consult his most intelligent and experienced labourers on this point. On thrusting the hand into a sheaf sufficiently dried, there is a lightness and kindliness to the touch not easily mistaken when once understood. Whenever this is ascertained, the crop is carried with the utmost possible dispatch. This is best accomplished by using one-horse carts, and by building the sheaves into round stacks of *ten* or *twelve* loads each. Very large stacks are for ostentation, not for profit. The labour of pitching up the sheaves to them is needlessly great; corn is much sooner in a state to keep in small stacks than in large ones, and sooner gets into condition for market; the crop is more accessible for thrashing in *ten*-load quantities than in huge ricks, and the crop of different fields and kinds of grain more easily kept separate.

It is always desirable to have the stacks built upon frames or stools elevated 18 or 20 inches from the ground. Besides the security from vermin thus attained, there is a free admission of air to every part, particularly when aided by a triangle of rough timber in the centre, which speedily insures thorough dryness in the whole stack. When stacks are built upon the ground with a mere bedding of straw under them, the grain from the basement tiers of sheaves is often lighter by several pounds per bushel, than that from the rest of it. A farmer who has his rick-yard fully furnished with these frames can often carry his crop without risk,—when, if built on the ground, it would inevitably heat,—and have the grain in condition for market earlier by months than in the latter case.



YOUNG'S STACK-STOOL.

We have elsewhere noticed a recent, but perhaps, too costly improvement upon these stack-frames, viz., to have them mounted on wheels and set on rails, so that such stacks can be moved entire to the barn-door, when about to be thrashed. As the stacks are built, they are thatched without delay. For this purpose, careful farmers provide beforehand ample stores of thatch and straw ropes. The thatch is not elaborately drawn, but merely straightened a little as it falls from the thrashing-mill, tied into large bundles, and built up into stacks, where it gets compressed, and so lies more evenly than if used direct from the mill. A good coating of such thatch secured by straw ropes, interlacing each other in chequers, forms a secure and cheap covering, easily put on by ordinary farm labourers, and possesses, with all its roughness, an air of unpretending rustic neatness, which harmonises well with surrounding objects, and which we greatly prefer to the elaborate ricks of the southern counties with their shaved sides, combed thatch, and weather-cock a-peak. Apart from its cost, the shaving of stacks is objectionable, as they then suffer more from a beating rain or snow-drift, than when the natural roughness is left upon them, on the same principle that a coarse, shaggy topcoat shoots off wet better than a smooth broadcloth.

With proper machinery propelled by steam or water, the thrashing and dressing of grain is a simple and inexpensive process. As grain is now universally sold with a reference to its weight per bushel, its relative value depends much upon its dryness and thorough freedom from chaff, dust, light grain, and seeds of weeds. Farmers who are systematically careful in the cultivation, harvesting, thrashing, and dressing of their crops, can always command the best prices of the day. In preparing a parcel of grain for market, it is a good plan to measure a few sacks very carefully, ascertain the average weight of these, and then fill every remaining sack to that weight exactly.

CHAPTER X.

CULTIVATED CROPS—ROOT CROPS.

Section 1.—*Potato.*

THE events of late years render it necessary to regard this root somewhat differently than was warranted by its previous history. Its value, as an article of food, relished alike by prince and peasant, its easy culture, its adaptation to a very wide diversity of soil and climate, and the largeness of its produce, justly entitled it to the high esteem in which it was universally held. Like many other good gifts, it was, however, grossly abused, and diverted from its legitimate use. From an agreeable, wholesome addition to the daily food of the community, advantage was taken of its amazing productive powers, to put it in place of "the staff of life." In Ireland, and the Highlands of Scotland, the people already in a painfully degraded condition, and contented to exist with potatoes as their sole food from year's end to year's end, took occasion, from its very productiveness, under the rudest culture, to subdivide their lands, and marry prematurely, with reckless improvidence, and amid an ever-deepening degradation. We know now, from the utter prostration and helplessness into which this wretched population was at once thrown by the memorable potato disease, the terrible penalty which this abuse of "a good gift" has brought directly on the miserable sufferers, and indirectly on the whole community. It will be well if the stern lesson, enforced by famine and pestilence, have the effect of leading to a better social condition. Viewed in this light, the potato disease may yet prove a blessing to the nation. Its continued prevalence, although in a mitigated form, cannot well be regarded otherwise, when we remember the frantic eagerness with which the Irish peasantry replanted their favourite root on the first indication of its returning vigour, and the desperate energy with which they cling to it under repeated disappointments. Apart from this specialty, the precarious health of this important esculent is much to be regretted. It seems contrary to analogy to suppose that it is likely either to be entirely lost or to manifest a permanent liability to this disease. It seems more natural to suppose that, by and by, this disease will disappear, or that some efficient remedy for it will be discovered. Railways now afford great facilities for transporting this bulky commodity at little expense to great distances, and thus render the market for it available to a wider district, and would, but for the disease, insure its more extended cultivation. This enlarged cultivation of a crop which, to be grown successfully, requires a soil rich in fertilizing matters, has moreover been rendered practicable by the opportunity which the farmer now has of obtaining guano and other portable manures.

The varieties of the potato, whether for garden or field culture, are exceedingly numerous, and admit of endless increase by propagating from seeds. It would serve no useful purpose to enumerate here even a selection from the sorts in use in different parts of the country. In Messrs. Lawson's *Synopsis of the Vegetable Products of Scotland*, a description of 175 kinds is given, to which the reader is referred for particulars. When the crop is grown for cattle food, bulk of produce will be the primary consideration; but for sale or family use, flavour, keeping quality, and handsome appearance, as well as good yield, will be particularly attended to. Exemption from disease is now a momentous consideration, whatever the use for which it is grown. There is this difficulty, however, connected with selections on the score of healthiness, that while in each season since the disease broke out, certain varieties have escaped, it is observed from year to year, that the exempted list varies; certain kinds that had been previously healthy becoming as obnoxious to disease as any, and others in a great measure escaping that had suffered much before. Indeed, certain parties, from observing that diseased tubers left in the ground have produced healthy plants in the following season, have been induced purposely to plant diseased potatoes, and with good results. This, however, is probably due to the mere fact of their being kept in the earth.

In field culture the potato is frequently grown on a portion of the fallow break; but its appropriate place in the rotation is that usually assigned to beans, with which, in an agricultural point of view, it has many features in common, and in lieu of which it may with advantage be cultivated. As the potato requires to be planted as early in spring as the weather will admit of, thus leaving little opportunity for cleaning the land, and as its mode of growth forbids any effective removal of root-weeds by after culture, it is peculiarly necessary to have the land devoted to this crop cleaned in autumn. Winter dunging facilitates the planting, and is otherwise beneficial to the crop by producing that loose and mellow condition of the soil in which the potato delights. The quality of the crop is also believed to be better when the dung is thoroughly incorporated with the soil, than when it is applied in the drill at the time of planting. A liberal application of manure is necessary if a full crop is expected. The rank growth thus induced renders it, however, more obnoxious to the murrain, and hence at present it is more prudent to aim rather at a sound crop than an abundant one, and for this purpose to stint the manure. When it is applied at the time of planting, the mode of procedure is the same as that which will presently be described in the section on turnip culture. The potato sets are prepared a few days before they are expected to be needed. Tubers about the size of an egg do well to be planted whole; and it is a good plan to select these when harvesting the crop, and to store them by themselves, that they may be ready for use without further labour. The larger tubers are cut into pieces having at least one sound eye in each, although two are better. It is of great consequence to have seed-potatoes stored in a cool and dry pit, so that if possible they may be prepared for planting before they have begun to shoot. If there has been any heating in the pit, the potatoes are found to be covered by a rank crop of shoots, which are necessarily rubbed off, and thus the most vigorous eyes are lost, and much of the substance which should have nourished the young plant is utterly wasted. A sufficient number of dormant eyes are no doubt left, but from the comparatively exhausted state of the tubers, these produce stems of a weaker and more watery character and more liable to disease than those first protruded. To avoid these evils, gardeners are at pains to invigorate their seed potatoes and husband their whole powers for early and vigorous growth by *greening* them in autumn, storing them in a cool place with a current of air passing through it, and then in early spring exposing them to light on a floor, whence they are carefully removed and planted with their short, thick *green* shoots unbroken.* Neither the *greening* nor the sprouting under cover and in the light, can ordinarily be practised on the scale on which the field culture of the potato is conducted. But the important feature in it, viz., so treating potatoes intended for seed that the crop shall be produced from the first and most vigorous shoots, and that these shall obtain the

* See a pamphlet *On the Cultivation of the Potato* by Mr. James Cuthill, Market-Gardener, Camberwell, London, which should be studied by every grower of potatoes.

full benefit of the natural pabulum stored up for their use in the parent tuber, should be carefully considered and imitated if possible in field culture.

The report of the meeting of the Edinburgh Botanical Society, on 8th January 1852, bears that "Professor Simpson communicated the results of some experiments made by himself and Mr. Stewart relative to the growth of alpine plants after having been kept artificially covered with snow in an ice-house for many months. Seeds and plants when kept in this way during winter, and then brought into the warm air of summer, germinate and grow with great rapidity. Mr. Stewart had also made experiments with animals, and he found that the chrysalis so treated produced a moth in eleven days after being brought into the atmosphere, while other chrysalis of the same moth did not do so for three or four months after. In arctic regions the rapid growth of plants during the short summer was well known. Professor Simpson alluded to the importance of similar experiments being made on the different kinds of grain. He referred to the rapidity of harvest in Canada and other countries where the cold lasted for many months, and he was disposed to think that if grain was kept in ice-houses during the winter, and sown in spring, there might be an acceleration of the harvest."*

This suggestion for the treatment of seed corn is certainly deserving of trial. But the known difficulty of hindering the premature germination of potato sets in the ordinary method of storing them, seems to point to them as the peculiarly appropriate subjects of such an experiment.

Potato drills should not be less than 30 inches wide, nor the sets less than 10 or 12 inches apart in the rows. The usual practice is to take the sets to the field in sacks, which are set down at convenient distances for replenishing the baskets or aprons of the planters. When a large breadth is to

* *Gardeners' Chronicle*, 31st January 1852.

be planted, a better way is to have the sets in carts, one of which is moved slowly along in front of the planters. A person is seated in the cart, who has by him several spare baskets which he keeps ready filled, and which are handed to the planters in exchange for empty ones as often as required. This greatly economises the time of the planters, and admits of a greater amount of work being accomplished by them in a day. Single-bout drills are quite sufficient, so far as the success of the crop is concerned. Where neatness is much studied, a double-bout certainly makes a nicer finish, but as the drills should be partially levelled by a turn of the chain-harrows about ten or fourteen days after planting, as weather admits, very short time is allowed for admiring the trigness of the work, and the extra labour thus expended can certainly be more profitably employed at this busy season. So soon as the young potato plants are fairly above ground, the drill-grubber should be set to work and followed up without delay by hand-hoeing. Mr. Wallace, North-Berwick-Mains, a most successful cultivator of potatoes, has for many years taken off all the shoots, save one, from the potato sets as they appear above ground, and the prunings are used in filling up blanks; the result has been, that the produce of the solitary stem is both larger and of more equal size and quality than when the shoots are all left. A turn of the horse-hoe and another hand-hoeing after a short interval are usually required, after which the common practice is to earth up the rows by the double mould-board ploughs. There is reason to believe that this latter practice usually does harm rather than good. It no doubt prevents the uppermost tubers from getting greened by exposure to the light, but it is believed that the injury inflicted on the roots which spread into the intervals betwixt the rows far more than counterbalances any benefits that result, or have been supposed to result, from this earthing up. After the plants are a foot high, a slight stirring of the surface to keep down weeds is all the culture that is admissible consistently with the well-doing of the crop.

When the crop is matured, which is known by the decay of the tops, and the firmness of the epidermis when the tubers are forcibly rubbed by the thumb, advantage is taken of every dry day in harvesting the crop. For small plots, the fork is certainly the most efficient implement for raising the tubers; but on the large scale, when expedition is of such consequence, they are always unearthed by the double mould-board plough. Alternate rows are split open in the first instance, and then the intervening ones, as the produce of the first is gathered. When a convenient breadth has thus been cleared, a turn of the harrows is given to uncover such tubers as have been hid from the gleaners at the first going over. This work is now very generally accomplished by means of a bulking-plough divested of its wings, and having attached to its sole a piece of iron terminating in radiating prongs. This being worked directly under the row of potato plants, unearths the tubers, and spreads them on the surface by one operation. The potatoes are gathered into baskets from which they are emptied into carts and conveyed at once to some dry piece of ground, where they are piled up in long narrow heaps and immediately thatched with straw. The base of the heaps should not exceed a yard in width, and should be raised above the surface level rather than sunk below it, as is very usually done. As the dangers to be guarded against are *heating* and *frost*, measures must be taken with an eye to both. The crop being put together in as dry and clean a state as possible, a good covering of straw is put on and coated over two or three inches thick with earth, care being taken to leave a chimney every two yards along the ridge. By thus keeping the heaps dry and secure from frost, it is usually possible, even yet, to preserve potatoes in good condition till spring. Such diseased ones as have been picked out at the gathering of the crop can be used for feeding cattle or pigs. The fact that pigs fatten, apparently, as well on diseased potatoes when cooked by steaming or boiling, as on sound ones, is certainly a very important mitigation of this dreaded calamity. There are several varieties of the potato, such as "yams," "lumpers," "mangel-wurzel potato," etc., which, although unfit for human food, are much relished by cattle, and which from their abundant produce, healthiness, and great fattening quality, are well deserving of being more generally cultivated for the purpose of being used in combination with turnips and other substances in the fattening of cattle. The turnip crop of recent years has been nearly as much diseased as the potato crop, and as one remedy against "fingers and toes" in the former, is to let longer intervals of time intervene before their recurrence in the same field, and as it has been ascertained that an acre each of beans, potatoes, and turnips, will produce more beef than three acres of turnips alone, it is worthy the consideration of those concerned, whether it would not be prudent to substitute a crop of these coarser potatoes for a portion of their turnip crop on fields or parts of fields that have borne diseased turnips in previous rotations. Eight tons per acre is a good crop of potatoes.

Section 2.—*Turnips.*

The introduction of turnips as a field crop constitutes one of the most marked epochs in British agriculture. To the present day no better criterion exists by which to estimate its state in any district, or the skill of individual farmers, than the measure of success with which this or other root crops is cultivated. We have already, in our section upon fallowing, described in detail the process of preparing the soil for drilled green crops. Referring the reader to what is there said, we now proceed with our description of turnip culture.

Previous to the introduction of bone-dust and guano, farm-yard dung formed, in the majority of cases, the only available manure for the turnip crop. It was almost invariably formed into heaps in the field to which it was to be applied, and repeatedly turned, as great stress was laid on having it well rotted. The introduction of these invaluable portable manures has, however, not only immensely extended the culture of the turnip, but has materially modified the course of procedure. On the first introduction of bone-dust, the practice was to use the fold-yard dung as far as it would go, and to apply bone-dust alone, in quantities of from sixteen to twenty bushels per acre, to the remainder of the crop. Guano, too, for a time, was used to some extent on the same principle; but now it is most satisfactorily proved, that whereas very good crops of turnips can be obtained by manuring either with dung alone, at the rate of from fifteen to twenty tons per acre, or bones alone, at the rate of sixteen to twenty bushels, or guano alone, at the rate of three to four cwt., much *better* crops can be obtained by applying to each acre its proportion of each of these kinds and quantities of manures. A portion of the bones is now usually applied in the form of superphosphate of lime; and as this substance, and also guano, have a remarkable power of stimulating the growth of the turnip in its earliest stage, forcing it to the state fit for thinning from ten to fourteen days earlier than heretofore, there is now no occasion for the dung being in the advanced state of decomposition that was formerly found necessary. When farm-yard dung alone was used, it behoved to be in a soluble state, ready to furnish nourishment to the plant from the beginning. But in bringing it to that state, a considerable loss is sustained by fermentation, and its bulk is so much reduced, that it becomes difficult to distribute evenly the allowance which would be available for each acre, in order to give the whole crop a share of it. This, however, it is most desirable to do, as good farm-yard manure contains in itself the whole elements required by the crop. And hence an additional reason for the plans of applying farm-yard dung, which have already been noticed. If that made during the previous summer has been applied in autumn to the lea before ploughing for oats, as far as it will go, and another portion of the contemplated turnip break dunged before the winter furrow, with all that has been made up to that time, and the future accumulations up to April formed into heaps, to be applied in the drills for the latest sowings, the manure produced on the farm may be made to go over nearly the whole breadth under root crops.

In proceeding to sow those portions that were dunged before the oat crop, and on the stubble, all that is required is to form the drills, and apply the guano or bones, or mixture of both, by hand. In doing this, ten or twelve drills are set out the evening before, that all may be ready for a good start. The light manure is taken to the field in carts, which are unyoked at convenient distances for replenishing the aprons of the young persons (one for each plough) or the machine by which it is distributed along the drills. The sowers of the manure being started on the outside drills, the ploughmen proceed to open fresh ones inside in going, and to cover in the manure by reversing the first formed ridglets as they return. The seed machine, sowing two rows at a time, follows close up to the ploughs, and thus the work goes rapidly on, each plough getting over from 2½ to 3 acres a-day. When farm-yard dung is applied at the time of sowing, the process is the same, except that the drills must be opened somewhat deeper, and that the dung-carts, followed by an adequate number of spreaders, precede the sowers of the light manures. In filling the dung-carts, one able-bodied labourer is required for each plough employed in drilling; and where these amount to three, six spreaders are required to distribute it evenly along the drills. In some districts the double-breasted plough is used in forming the drills and covering in the dung. In the hands of a skilful ploughman, that implement does certainly make neater work to look at; but so far as the success of the crop is concerned, the common swing-plough is preferable, for in covering in with it the earth is made to run over the top of the ridglet, by which means the clods fall into the hollow, and the finest of the mould is left on the top, where the seed is to be deposited. With the double mould-board this cannot so well be done, and the consequence is, that a groove is formed on the top of the ridglet, in which the small dry clods, carried up by the tail of the mould-board, are left, forming the worst possible bed for the seed. In parching weather it is usual to pass a light roller over the drills immediately after sowing, to retain the moisture, and insure germination. The seed is deposited near the surface, half an inch of mould being a sufficient covering. The quantity sown is 2 lbs. per acre of globe or yellow turnip seeds, and 3 to 4 lbs. of Swedes. Care must be taken that the seed is fresh, so as to have a vigorous and thick plant. Thick sowing increases the difficulty of thinning out the plants, but it hastens their growth, and diminishes the risk of failure from the depredations of the turnip beetle. The time of sowing in the south of Scotland extends from the middle to the end of May for Swedes, and thence to the middle of June for yellows and globes. A partial sowing of yellow or globe is however made by careful stockmasters before sowing the Swedes, to be ready for use by the end of August or beginning of September, when pasturage fails. Sowings of early varieties, such as the stubble turnip and certain yellow kinds, are also made after winter tares or other catch crops, until the middle of July; but later than this they cannot be sown in Scotland with advantage, unless for the production of a crop of seed. The average weight per acre of Swedes may be stated at 18 tons, and of turnips at 22 tons, although double these rates have occasionally been obtained. Recent experiments go to shew that with liberal manuring and early sowing, the weight of the crop is considerably increased by thinning out the plants at wider intervals than has hitherto been customary. The usual practice in Scotland has been to sow in ridglets 27 inches apart, with 9 or 10 inches betwixt the plants. Recent experiments establish the fact that with 15 inches from plant to plant, much larger bulbs and a greater acreable produce are obtained. As it is ascertained that in the case of Swedes the largest bulbs are also the best in quality, it is of the greater consequence to allow them ample room.

The thinning is commenced as soon as the rough leaf is fairly developed. Previous to this operation the horse-hoe is worked betwixt the rows for the double purpose of destroying weeds and facilitating the operation of thinning. This operation is sometimes still farther facilitated by using Huckvale's machine, which slaps out the rows so as to leave tufts of plants at regular distances apart. The *singling* of the plants is performed by the hand-hoe. The young persons by whom this work is usually performed advance in *echelon* with their backs to the untouched work, the steadiest and most expert worker leading the band. This arrangement insures a uniform rate of progress, saves the finished work from being trodden upon, and keeps the workers closely under the eye of the steward. This thinning of the rows so as to leave single plants at regular intervals of 12 to 15 inches apart is accomplished by an alternate thrusting and drawing motion of the hoe, which a little practice enables the workers to perform with such precision that very rarely do they either make a gap or leave double plants, and still more rarely do they require to stoop down to disentangle them with their fingers. Three of these workers can usually thin an acre in a day. With ordinary care on the part of the overseer there is no great difficulty in getting the plants left single at proper intervals; but it is very difficult to get the hoers trained to select and leave only the stoutest plants. And yet, so important is this, that,—all other things being equal,—a difference of two to three tons per acre in the rate of produce has been ascertained to result on comparing rows that had been thinned by a person who took pains to select and leave the best plants, with others on which they had been left indiscriminately. When the plants have rallied after the thinning, and begun to grow rapidly, the usual practice has been to turn a furrow from either side of them into the middle of the interval by a one-horse plough, and then to level this down by a turn of the horse-hoe. A great improvement on this practice is to use Tennant's grubber instead, adjusted for drill work in the manner already described. By thus using a strong implement drawn by two horses, the soil in the intervals betwixt the rows can be stirred a foot deep if required, without any risk of hurting the young plants, and this too is accomplished by a single operation. A second hand-hoeing is then given, which usually completes the after culture. It was formerly the invariable practice to finish off by passing a double mould-board plough betwixt the rows, which was called *setting up*. On dry soils this is not only useless, but positively hurtful to the crop; and those so wet as to require it are unfit for the profitable cultivation of turnips at all.

The nature of the soil will usually determine the mode of consuming the crop. On all loose, dry soils, feeding off by sheep is the most profitable plan; whereas on deep, strong loams it is advisable to withdraw the whole and eat them by cattle, as, unless in very favourable weather, when even a fourth is fed off by sheep, the extra manuring does not compensate to the after crops for the injury which they usually sustain from the treading and poaching. On the poorest class of light soils, the whole crop should if possible be consumed where it grows by sheep; but on those of a better description, a third, a half, or two-thirds may be withdrawn for the feeding of cattle, according to circumstances. Whatever the proportion left on the ground, care is taken to regulate the intervals so as to distribute the treading and droppings of the sheep as equally as possible over the field.

The management of the turnip crop, so as that it may be supplied to the live stock in the best possible condition during the entire season, is a point of the greatest importance. The portion that is to be used as cattle food is removed from the ground as soon as the crop has sufficiently matured, and before the time when drenching rains and severe frosts may ordinarily be looked for. The best way of preserving them is by storing in broad flat heaps, not exceeding 20 inches deep, on some dry and sheltered situation, open to the sun, and covering them with a good coating of straw. It takes less labour to put them together in this way, and less straw to cover them; and being less exposed to frost and parching winds they retain their juices much better than when stored in long, narrow heaps. The pulling of Swedes preparatory to storing is much facilitated by passing under them a sharp share and so cutting across the tap roots without displacing the bulbs. The thatch of the corn-stacks that are thrashed in autumn is usually reserved for covering turnip heaps. After 1st November it is well to make diligent use of every favourable hour in thus securing the turnip crop.

The difference both to the cattle and to the land betwixt the plan of having turnips stored in dry weather without poaching the fields and securing clean and fresh food in all weathers, and the other of bringing in only a few days' supply at a time, and so being often compelled to go upon the land when soaked with rain or bound with frost, and feeding the cattle with miry or frozen turnips, can scarcely be computed. The careful farmer will never feel at ease until his winter's provision is safe in the store-heap. The portion to be fed off by sheep must necessarily be treated in a different manner. What is to be used after Christmas can be very readily defended against frost, by earthing up in the drills with the common plough. But as what is to be consumed by the young sheep must be pulled and trimmed at any rate, in order to be sliced, the best way is to throw the turnips into heaps at regular distances, and cover them with a thin coating of earth. By this means the turnips are kept from running to stems, and the sheep get them clean and fresh, whatever the state of the weather.* The same end is secured by opening a trench by a bout of the common plough, into which the turnips from two drills on either side are laid in regular order with their tops uppermost, and the earth turned over upon them by reversing the course of the plough. When wanted for use, they are again unearthed by means of the plough. The feeding qualities of turnips are so seriously impaired by exposure to frost, even when they escape actual destruction, that the expense of securing them by one or other of these methods, is always amply repaid. In very mild winters again, storing is equally effective in preventing the virtues both of the turnips and the soil from being wasted by the pushing of the seed stems. Such precautions are so usually omitted, and the loss thereby sustained is so serious, that it would be well for all who question the utility of the practice to satisfy themselves regarding it in some such way as this. Let two portions of a turnip field, as equal in all respects as possible, be selected, and let the crop from one of them be in December put into small store heaps or buried in the earth,

* During the unusually wet winter of 1852-3, we stored a large quantity of turnips and Swedes intended for cattle food in this way The trimming and storing was carried on every dry day, and the carting postponed until the occurrence of frost or drought admitted of its being done without injury to the land.

and let the other remain on the ground untouched till the middle of March. Let a lot of sheep which have received the same previous treatment be then equally divided and fed respectively on these several portions for three or four weeks, and their weights ascertained before and after the trial. Let both portions be afterwards sown with barley under like circumstances, and the produce accurately ascertained. Assuming that an average amount of frost occurs, and that the unstored turnips have begun to push their seed stems when the sheep are put upon them, our personal experience warrants us in anticipating a difference of at least *six* bushels of barley per acre, and *two* lb. of mutton per sheep in favour of the portion on which the turnips are stored.

The turnip is liable in the early stages of its growth to the attacks of various insects. The most formidable of these enemies is the *turnip beetle*, which frequently settles upon the plants so soon as they appear above ground, in such numbers as totally to destroy the whole of them. The best way of guarding against these nimble adversaries, is to endeavour, by careful preparation of the soil, liberal manuring, and thick seeding, to secure a thick plant and rapid growth; for whenever the rough leaf is expanded, the risk from this quarter is over. From time to time the young turnip plants are assailed by the larvæ of certain butterflies and moths, which sometimes appear in such numbers as to cause serious alarm, but ordinarily their attacks occasion but a slight check to the growth of the crop.

A far more formidable evil is the disease called "fingers and toes," which, although long known, seems to be steadily extending, and has been wider spread and more virulent since 1851 than in previous years. This truly formidable disease sometimes shews itself by the time that the plants are ready for thinning, but more usually it is about the stage when the second hoeing is given that unmistakeable indications of its presence are observed. The crop appears in high health, and is making rapid growth, when suddenly, under hot sunshine, numbers of the plants are seen to droop with flaccid leaves; and examination being made, it is found that the disease has already made serious progress. In some cases it is chiefly confined to the tap-root, which is distorted with knobby excrescences. In others, the roots present a thickened, palmated appearance, giving rise to the popular name for the disease, "fingers and toes," while in others the lateral roots expand into glandular-looking tubers, which frequently appear partially above ground at distances of several inches from the central stem. For a time all these forms of the excrescences present a smooth healthy looking skin, yielding no trace of the presence of insects of any kind, either externally or internally. By and by the skin cracks over the excrescences, which speedily assume a gangrenous appearance. Indeed, the whole symptoms present a striking analogy to cancer in the animal system. By the time that the healthy plants are approaching near to maturity, the most diseased ones have usually lost all resemblance to turnips, and there remains on the land a substance like rotten fungus. In very bad cases, whole acres together are found in this state, with here and there a sickly distorted turnip still shewing a few green leaves. At other times a few only of the plants are wholly destroyed; the field, to a casual observer, looking not much amiss, though a closer inspection proves that the general crop is of stunted growth, with few plants entirely free from the disease. Such partially diseased roots are not absolutely rejected by sheep, but they are evidently unpalatable and innutritious, while the crop as a whole is more speedily consumed than its general appearance would lead one to expect. When this disease appears on farms that have previously been exempt from it, it is usually confined for a year or two to small patches, which, however, in the absence of remedial measures, steadily and rapidly extend, not only on the recurrence of a turnip crop on the same fields, but over the other parts of the farm. Indeed, there are not wanting indications of its being propagated by contagion; as, for instance, when tainted roots are carted into pastures, and the disease shews itself most in those places where they have been consumed, when, in course of rotation, the field comes afterwards to bear a turnip crop. When they are consumed by cattle in fold-yards, the dung may be the medium of contamination, on the supposition that this conjecture is well-founded. Ploughing land in a wet state evidently aggravates the disease. We know of one instance where a strip down the middle of a field was ploughed in autumn while soaked by rain, on which wet ploughed portion the turnips were evidently more diseased than over the rest of the field. In another instance which came under our personal observation, a ditch running along part of the top of a field, of upwards of 50 acres, was scoured in spring, and the mud spread back over the headland. The whole field was, in the same season, sown with turnips, which proved an excellent crop, entirely free from "fingers and toes," with the exception of that portion of headland on which the mud was spread, where every plant was diseased. Although wholly in the dark as to the nature and propagation of this disease, it is well to know that the judicious application of lime is a certain remedy. In order, however, to its efficacy, it must be applied in a *powdery state* after the autumn ploughing, and immediately incorporated with the soil by harrowing; or else, as a compost with earth, spread on the lea, before breaking up for oats. We know from experience, that a very moderate dose (say four tons of unslaked shells), applied in this way will suffice as a prevention of this disease. It is on light soils that its ravages are most frequently experienced, and to these heavy doses of lime are unsuitable. Indeed, whether for promoting the general fertility of soils, or for warding off the attacks of this disease, moderate applications of lime every *twelve* years or so, seem preferable to heavier dressings at longer intervals. The name "fingers and toes" is not unfrequently applied to a distinct disease to which the turnip, in common with the cabbage and other cole-worts, is liable, namely Anbury or Club-root. When the knobby excrescence which is found on plants affected by Anbury is broken up, it is found to encase a white maggot, whose presence is the obvious cause of the mischief. We have seen young cabbages which had begun to droop from clubbing, when pulled up, freed from the parasite, and replanted, regain healthy growth and come to prosperous maturity. In the case of the "finger and toe," the most careful investigation, aided by the microscope, has hitherto failed to detect any insect cause for this disastrous malady.

Section 3.—*Mangel-Wurzel.*

This root has been steadily rising in estimation of late years. It is peculiarly adapted for those southern parts of England where the climate is too hot and dry for the successful cultivation of the turnip. A competent authority declares that it is there easier to obtain thirty tons of mangel than twenty tons of Swedes, and that it is not at all unusual to find individual roots upwards of twenty lb. in weight. In Scotland it is just the reverse, it being comparatively easy to grow a good crop of Swedes, but very difficult to obtain twenty tons of mangel. This plant is very susceptible of injury from frost, and hence in the short summer of Scotland it cannot be sown so early nor be left in the ground so late as would be requisite for its mature growth. These difficulties may possibly be got over, either by the selection of hardier varieties or by more skilful cultivation. Its feeding quality is said to be nearly equal to that of the Swede, it is much relished by live stock—pigs especially doing remarkably well upon it—and it has the very important property of keeping in good condition till midsummer if required. Indeed, it is only after it has been some months in the store heap that it becomes a palatable and safe food for cattle. It is moreover exempt from the attacks of the turnip beetle. On all these accounts, therefore, it is peculiarly valuable in those parts of Great Britain whose summers are usually hot and dry—conditions of climate which are favourable to the mangel and peculiarly unfavourable to the turnip.

Up to the act of depositing the seed, the processes of preparation for mangel are identical with those described for the turnip; winter dunging being even more appropriate for the former than for the latter. The ridglets being formed 28 inches apart, and charged with a liberal allowance of dung and guano, the seeds are deposited along the top, at the rate of about 4 lb. per acre. The common drilling machines are easily fitted for sowing its large rough seeds. The after culture is also identical with that of the turnip. The plants are thinned out at distances of not less than 15 inches apart. Transplanting can be used for the filling up of gaps with more certainty of success than in the case of Swedes. But we find it much more economical to fill up such gaps by sowing a little turnip seed in them than by transplanting mangel. Several varieties of the plant are cultivated—those in best repute being the *orange-globe*, the *long yellow*, and the *long red.* This crop requires a heavier dressing of manure than the turnip to grow it in perfection, and is much benefited by having salt mixed with the manure at the rate of two or three cwts. per acre. The crop requires to be secured in store heaps as early in autumn as possible, as it is easily injured by frost. The following graphic description of this process by Mr. Morton of Whitfield, appeared in the *Agricultural Gazette* of 8th November 1851:—

"The mode of harvesting our root crop which we have adopted for several years is this; we let the lifting—cutting off the leaves and the roots, and putting the roots into the cart—at so much per acre, accordding to the weight of the crop, to one man, who gets other men to join with him in the work and share in the profits; and the arrangement I require to be adopted is, that the one-horse carts, which I employ to haul the roots, shall be constantly employed, and I require from 16 to 20 loads, or tons of roots, to be filled hourly. The number of carts required is according to the distance of the field from the store; thus the distance from the middle of the field to the store being 15 chains, four carts are required; 22 chains require five carts; and 30 chains require seven carts.

"*The mode of lifting the roots.*—Five men are employed to pull up the roots; each man pulls up two rows; standing between the rows, he takes with his left hand a root from the row on his left side, and with his right hand a root from the row on his right side, and pulling both up at the same time, places them side by side, across the row where he pulled up the roots with his right hand, so as to have the tops lying in the space between the two rows he has pulled up; the next man takes the two rows at the right hand of the last two rows we have just described, and he, with each of his hands, pulls up a row, and places them on the line of the row which he has pulled up with his left hand, with the root end lying towards the root end of the first row, so that we have now four rows of roots lying close together in two rows, side by side, with their leaves on the outside of each of these rows, and the roots of each row nearly touching each other; and every four rows, when growing, are thus, when pulled, laid in two rows, root to root, occupying not more than 27 inches. Now, as the next four rows are lifted in the same way, and placed in like manner, we have a space unoccupied of three times 27 inches, or 6 feet 9 inches between each double row of roots, for the cart to go between them (viz., this double row of bulbs after they have had the leaves and roots cut off), to carry off the bulbs to the store. After the five men, who are pulling the roots, there follow ten women or boys with knives, made of pieces of old scythes, who, with repeated blows, cut off the leaves and roots, without ever moving one of them with their hands; this is constant, but not hard work, and it requires ten active women or boys to keep up with the five men pulling.

"Immediately on the heels of the cutters follow the carts between the two double rows of bulbs as they lie, having their leaves and roots cut off; and a man, one of the principals of the gang, and nine young active boys and girls throw up the bulbs as fast as they can into the cart, the man speaking to the horse to move forward, or stop, as they clear the ground; when one cart is full, an empty one has been brought by one of the boys who drive the carts, and placed immediately behind the full one; so that, as he moves off with the full cart, the man calls the horse with the empty cart to move forward, and they proceed to throw the roots into the cart as fast as they did into the one that has just gone off the field.

"The pulling of the roots and the filling of the carts being the principal work, one of the leaders is in each of these departments of the work; so that, by his example, he shews those with him how he wishes them to work, and thus the work proceeds with the utmost regularity and despatch; 20 cart-loads are hourly filled in the fields and delivered in the store; 180 to 182 loads of 22 cwt. and 23 cwt. each in a day of nine hours; thus a cart-load is filled every three minutes by 10 pairs of hands, which are pulled by five pairs of hands, and the leaves and roots cut off by 10 pairs of hands—in all 25 pairs of hands, men, women, and boys; this has been repeatedly done in a day.

"The stores are made of posts and rails, enclosing a space 9 feet apart and 4½ feet high, and of any length, if the space will admit, and as near to where they are to be consumed as possible. The posts are 5 feet apart, let into the ground 18 inches, and 4½ feet above, with five rails above, 4 or 5 inches wide, nailed to the inside of the posts; and each of these stores is 3 feet apart. I have 14 of them about 70 feet long each, which is sufficient to store from 1000 to 1200 tons of bulbs."

The heaps are carefully thatched, and the spaces betwixt them filled with straw to keep out frost. The expense, exclusive of the carting, Mr. Morton shews to be 3s. 6d. per acre.

It is believed that in many cases crops of turnip and mangel could be more cheaply stored by means of the portable railway than by carts, and with less injury to the land. This is especially the case with clay soils, and in such seasons as the autumn of 1852. In using it, eight drills of roots are trimmed and laid in two rows, as Mr. Morton describes; the rails are shifted betwixt each of these pairs of rows; the roots pitched into light trucks, which a man pushes before him to the headland, where the contents are discharged by tipping. Being there heaped up and thatched, the roots are carted to the homestead as required.

Section 4.—Carrot.

This root, though so deservedly esteemed and universally grown in gardens, has not hitherto attained to general cultivation as a field crop. This is owing chiefly to certain practical difficulties attending its culture on a larger scale. Its light feathery seeds cannot easily be sown, so as to secure their regular germination; the tardy growth of the young plants, and the difficulty of discriminating betwixt them and weeds makes the thinning a troublesome affair; the harvesting of the crop is comparatively expensive; and it is only on sandy and light loamy soils, or those of a peaty character, that it can be grown successfully. The increasing precariousness in the growth of potatoes, turnips, and clover, and the consequent necessity for a greater variety of green crops, entitle the carrot to increased attention as a field crop. Its intrinsic qualities are, however, very valuable, especially since the introduction of the white Belgian variety. On light soils it is alleged that larger crops of carrots than of turnips can be obtained, and with less exhaustion of their fertility, which is explained as arising from the greater depth to which the carrots descend for their nourishment. This root is eaten with avidity by all kinds of farm stock. Horses, in particular, are very fond of it, and can be kept in working condition with a considerably smaller ration of oats when 20 lb. of carrots are given to them daily. It can also be readily kept to an advanced period of spring when stored with ordinary care.

The mode of culture is very similar to that already described for mangel-wurzel. A usual practice is to prepare the seed for sowing, by mixing it with moist sand, and turning the mass repeatedly for several days until germination begins, when it is sown by hand at the rate of 6 lb. per acre of the dry seeds, in a seam opened by the coulters of the corn or turnip drill, according as it is wished to have it on the flat or on ridglets. Some prefer merely to rub the mixture of seeds and sand or mould betwixt the palms, until the seeds are thoroughly separated from each other, and so divested of their hairs as, when mixed with sand, to run from a drilling machine. It is of the utmost importance to secure seeds of the previous year's growth, as if older their germination cannot be depended upon. Much care is also needed in saving the seed only from selected roots, as carrots have a decided tendency to degenerate. The white Belgian variety is certainly the best for farm use, not only from the weight of crop, but from its growing more rapidly in its earliest stage than other approved sorts, and shewing a broader and deeper coloured leaf which can more easily be discriminated from weeds, and thus admitting of the earlier use of the hoe. When the sowing and first hoeing and thinning of the crop are got over successfully, the after culture of the crop is very simple; all that is needed being the occasional use of the horse and hand-hoe to keep down weeds. The fork must be used in lifting the crop. The greens are then cut off and given to young stock or cows, and the roots stored in long narrow heaps, exactly as mangel. Fifteen tons per acre is an average crop, although on suitable soils, with liberal manuring and skilful cultivation, double the weight is sometimes obtained. Those who intend to cultivate this crop statedly, will do well to raise their own seeds from carefully selected roots. Unless genuine and fresh seed is sown, failure and disappointments can scarcely be avoided.

Section 5.—*Parsnip.*

This plant bears so close a resemblance to the carrot, and its culture and uses are so similar, that they need not be repeated. It can, however, be cultivated successfully over a much wider range of soils than the carrot, and, unlike it, rather affects those in which clay predominates. It is grown extensively, and with great success, in the Channel Islands. The cows there, fed on parsnips and hay, yield butter little inferior, either in colour or flavour, to that produced from pasture. About 10 lb. of seed are required per acre. It requires, like that of the carrot, to be steeped before sowing, to hasten germination, and the same care is needed to have it fresh and genuine. It should be sown in April. The roots, when matured, are stored like carrots.

Section 6.—*Jerusalem Artichoke.*

This root, although decidedly inferior to the potato in flavour, is yet deserving of cultivation. It grows freely in inferior soils, is easily propagated from the tubers, and requires little attention in its cultivation. When once established in the soil, it will produce abundant crops for successive years on the same spot. It is sometimes planted in woods to yield shelter for game, for which purpose it is admirably fitted, as it grows freely under the shade of trees, and yields both food and covert. In properly fenced woods it might yield abundant and suitable food for hogs, which might there root it at their pleasure, without damage to anything. Where they had mast along with these juicy tubers, they would undoubtedly thrive apace. After they had grubbed up what they could get, enough would be left to reproduce a crop for successive seasons. Such a use of this esculent seems well deserving of careful trial.

CROPS ANALOGOUS TO DRILLED ROOT CROPS.

(Sections 7, 8, 9.)

There are several crops which, under a strict classification, should be noticed among forage crops rather than here, but which, in an agricultural point of view, are so closely analogous to drilled root-crops, that we regard this as the suitable place in which to notice them.

Section 7.—Cabbage.

On strong rich soils, large crops of very nutritious food for sheep or cattle, and of a kind very acceptable to them, are obtained from the field culture of the Drumhead cabbage. A seed-bed is prepared in a garden, orchard, or other sheltered situation, about the second week in August, either by sowing in rows 12 inches apart, and thinning the plants about 3 inches in the rows, or broadcast in beds. As early in spring as the land on which the crop is to be grown is dry enough for being worked, let it be thoroughly and deeply stirred by one or more turns of the grubber. Assuming that a liberal dressing of dung has been put into it at the autumn ploughing, three or four cwt. of guano are now scattered evenly over the surface and ploughed in by a deep square furrow. A lot of plants being brought from the seed-bed, a band of planters, each provided with a dibble and a piece of rod 27 inches long, proceed to insert a row of plants the length of the rods apart in each third plough-seam, the result of which is that the plants stand in regular rows 27 inches apart every way, and can afterwards be kept clean by horse and hand hoeing like any other drilled green crop. Cabbages are much in repute with breeders of rams and prize sheep, which fatten rapidly on this food. Cabbages are usually drawn off and given to sheep on their pastures, or to cattle in byres and yards; but they are also fed off, where they grow, by sheep, in the same way as turnips. It is an exhausting crop when wholly drawn off, and is sometimes grown with advantage on this account on spots greatly enriched by irrigation with sewage or otherwise, and where the succeeding grain crop is expected to suffer from over-luxuriance, the cabbages being grown, as the phrase goes, to "take the shine out of it." In favourable circumstances, from 30 to 40 tons per acre of this nutritious crop may be obtained. From what has been said it is evidently not adapted for extensive field culture; but on most farms a few acres might be grown annually with great advantage. It is a peculiarly suitable food for either sheep or cattle during the autumnal transition from grass to turnips.

Section 8.—*Rape.*

This plant is peculiarly adapted for peaty soils, and is accordingly a favourite crop in the fen lands of England, and on recently reclaimed mosses and moors elsewhere. Its growth is greatly stimulated by the ashes resulting from the practice of paring and burning. In these cases it is sown broad-cast; but when such soils are brought into a regular course of tillage, it is drilled, and otherwise treated in the same manner as turnips. As we have described its culture under the head of "Oil-producing plants" (chap. xii. sec. 5), we shall only say further here, that its highly nutritious leaves and stems are usually consumed by folding sheep upon it where it grows, and that there is no green food upon which they fatten faster. Occasionally it is carried to the homestead, and used with other forage in carrying out the system of soiling cattle.

Section 9.—*Kohl-Rabi.*

This plant has been frequently recommended to the notice of farmers of late years. Like mangel, it is better adapted for strong soils, and dry and warm climates, than the turnip. It may either be sown on drills in the same manner as the turnip, or in a seed-bed and afterwards transplanted. The latter plan is expensive, if it is desired to cultivate the crops to any extent; but is commendable for providing a supply of plants to make good deficiencies in the rows of other crops, or when a small quantity only is wanted. By sowing a plot of ground in March in some sheltered corner, and transplanting the crop early in May, it is more likely to prosper than in any other way. Cattle and sheep are fond of it, and it is said not to impart any unpleasant flavour to milk. We have seen a few trials of it in Scotland as a field crop; but, from whatever cause, the weight of food produced per acre was greatly less than from the mangel and Swedes growing alongside of it. For further information about this plant, the reader is referred to the *Book of the Farm*, vol. ii. p. 87; Hewit Davis' *Farming Essays*, p. 90; Lawson's *Synopsis of the Vegetable Products of Scotland*, Div. ii. p. 109. Lawson says that the pulp or flesh of kohl has the same taste as the leaves of the cabbage, and hence its adaptation as food for milch cows.

CHAPTER XI.

CULTIVATED CROPS.—HERBAGE AND FORAGE CROPS.

Section 1.—*Grasses, etc.*

UNDER this general heading, we propose to include what we have to say concerning the grasses, whether natural or cultivated, and those other crops which are grown expressly for the sake of the cattle food yielded by their leaves and stems. This kind of farm-produce is either consumed where it grows, by depasturing with live stock, or mown and given to them in a green state under cover, or dried and stored for after use. It thus embraces the cultivation of these crops, and their disposal, whether by grazing, soiling, or haymaking. Following this method, we shall first of all briefly describe the cultivation of those pasture and forage crops which are of best repute in British husbandry.

Tillage lands are now everywhere cropped according to some settled rotation, in which the well-recognised principles of the alternate husbandry are carried out according to the actual circumstances of each locality. With rare exceptions, such lands at stated intervals bear a crop of the clovers or cultivated grasses. As these are usually sown in mixture, especially when intended for pasturage, the resulting crop is technically called "seeds." As it is of importance to have the land clean, and in good heart, when such crops are sown, they usually follow the grain crop which immediately succeeds the fallowing process. Being for the most part of a lower habit of growth than white corn crops, thay can be sown and grow together without mutual injury. When the latter are harvested, the former being already established in the soil, at once occupy it, and grow apace. By this arrangement there is therefore secured an important saving both of time and tillage. Barley being the crop amongst which the seeds of the clovers and grasses are most frequently sown, and amongst which, upon the whole, they thrive best, it is customary to sow these small seeds at the same time as the barley, and to cover them in with a single stroke of the common harrows. This is erroneous practice, both as regards the time and manner of sowing these small seeds. We have already mentioned, in the proper place, that barley should be sown as early in March as possible. Now, if the clovers, etc., are sown as early as this, they are almost certain to get so forward as both to rob the barley of its due share of nourishment, and, when it is reaped, to bulk so largely in the sheaves, as to retard their drying, and aggravate the risk of their being ill harvested. It is found, moreover, that if there be but plants enough, the clovers stand the winter better, and ultimately yield a better crop, when but puny looking, than when very strong, at the reaping of the grain crop. It is better, therefore, to delay the sowing of the small seeds until the end of April or beginning of May. As to the manner of covering them in, we have to remark that the smallness of these seeds, and their manner of germinating, alike requires that they receive only the very slightest covering of soil. This important fact is so well illustrated in the following table, which exhibits the results of some carefully conducted experiments, reported to the Highland Society by Mr. Stirling of Glenbervie, that we shall here quote it:—

"Column I. contains the scientific names.
Column II. contains the average weight of the seeds per bushel in pounds.
Column III. contains the average number of seeds in one ounce.
Column IV. shews, in inches, the depth of cover at which the greatest number of seeds brairded.

Column V. shews, in inches, the depth of cover at which only about half the number of seeds brairded.

Column VI. shews, in inches, the least depth of cover at which none of the seeds brairded.

I.	II.	III.	IV.	V.	VI.
Agrostis stolonifera	13	500,000	0 to ¼	½ to ¾	1
vulgaris	12	425,000	...	...	...
Aira cæspitosa	14	132,000	0 to ½	¾ to 1	2¼
Alopecurus pratensis	5	76,000	0 to ½	1 to 1¼	2¼
Anthoxanthum odoratum	6	71,000	0 to ½	1 to 1¼	2
Arrhenatherum avenaceum	7	21,000	½ to ¾	1½ to 1¾	4
Brachypodium sylvaticum	10	15,500	0 to ¼	½ to ¾	2
Cynosurus cristatus	26	28,000	...	...	...
Dactylis glomerata	12	40,000	0 to ¼	¾ to 1	2¼
glomerata *gigantea*	10	34,000	...	...	...
Elymus arenarius	11	2,320	1 to 1½	2 to 2½	5
geniculatus	12	2,300	...	...	...
Festuca duriuscula	10	39,000	0 to ¼	¾ to 1	2¼
elatior	14	20,500	0 to ¼	1 to 1¼	2¾
elatior *gigantea*	13	17,500	0 to ¼	1¼ to 1½	3
heterophylla	12	33,000	0 to ¼	1 to 1¼	2¼
gigantea	16	8,600	...	...	...
ovina	14	64,000	0 to ¼	¾ to 1	2
ovina *tenuifolia*	15	80,000	...	...	...
pratensis	14	26,000	0 to ½	¾ to 1	2½
pratensis *loliacea*	15	24,700	...	...	...
rubra	10	39,000	...	...	...
Glyceria aquatica	13	58,000	¼ to ½	¾ to 1	2¼
fluitans	15	33,000	...	...	...
Holcus lanatus	7	95,000	¼ to ½	¾ to 1	2½
mollis	6	85,000	...	...	...
Lolium italicum	15	27,000	0 to ¼	1 to 1¼	3¼
perenne	18 to 30	15,000	¼ to ½	1½ to 1¾	3½
Milium effusum	25	80,000	¼ to ½	1 to ¼	2¾
Phalaris arundinacea	48	42,000	...	...	...
Phleum pratense	44	74,000	0 to ¼	¾ to 1	2
Poa nemoralis	15	173,000	...	...	...
nemoralis *sempervirens*	15¼	133,000	0 to ¼	¼ to ½	1
pratensis	13	243,000	...	...	...
trivialis	15	217,000	0 to ¼	½ to ¾	1½
Psamma arundinacea	15	10,000	½ to 1	1½ to 1¾	4
Trisetum flavescens	5¼	118,000	0 to ¼	¾ to 1	2
Achillea Millefolium	30	200,000	¼ to ½	½ to ¾	1½
Cichorium Intybus (chicory)	32	21,000	...	...	...
Lotus corniculatus	62	28,000	0 to ¼	¼ to ½	1½
major	64	51,000	...	...	...
Medicago lupulina	63	16,000	0 to ¼	¾ to 1	1½
sativa	60	12,600	...	...	...
Onobrychis sativa	26	1,280	¾ to 1	2 to 2¼	4¼
Petrosalinum sativum	41	12,800	...	...	...
Plantago lanceolata	52	15,600	¼ to ½	1¼ to 1½	2½
Poterium Sanquisorba (burnet)	25	3,320	½ to ¾	1½ to 1¾	4
Trifolium filiforme	65	54,000	0 to ¼	¼ to ½	1¼
hybridum	63	45,000	0 to ¼	½ to ¾	1¼
pratense	64	16,000	0 to ½	1¼ to 1½	2
pratense *perenne*	64	16,000	0 to ½	1¼ to 1½	2
repens	65	32,000	0 to ¼	½ to ¾	1½

"The results in the three last columns of the preceding table were obtained by sowing the seed in finely sifted dark loam, which was kept moist throughout the process of germination, to which is attributable the circumstance of so many of the sorts vegetating best—as shewn in Column IV.—without covering, and under full exposure to the light. The combination of such favourable circumstances of soil and moisture, can, however, seldom be calculated upon in field sowing, therefore a covering of mould for the seeds, however slight, is always advisable. But it will be seen, by the results in Column VI., that a great number of seeds must be inevitably lost from overdepth of covering, unless the ground be in all cases carefully prepared and pulverised before sowing either the *natural* or *artificial* grasses."*

From this it is evident that to scatter these tiny seeds over a cloddy surface, and then to harrow it, may more aptly be called burying than sowing them. The following is a more rational mode of proceeding. When these seeds are to be sown among winter wheat, it is expedient to begin by using the horse-hoe (supposing the wheat to have been drilled), as well to loosen the surface and produce a kindly bed for the seeds, as to destroy weeds. In the case of broad-casted wheat, a turn of the harrows secures the same end. In the case of the more recently-sown barley, all that is needed is to smooth the surface with the one-horse roller. Over the ground thus prepared, the small seeds are distributed by a broad-cast sowing machine, which covers at once a ridge of 15 or 18 feet in width. The covering is then effected by simply rolling with the smooth roller, or by dragging over the surface the chain-harrow, which may either be attached to the sowing machine, or to a separate frame; or by using Cambridge's or Crosskill's roller, with a hurdle interlaced with bushes tethered to it. On clay soils the chain-web is to be preferred; but on loose soils Crosskill's roller imparts a beneficial firmness, and, with its tail-piece of bushes to fill up the indentations, gives an accuracy of finish which rivals the neatness of a newly-

* Morton's *Cyclopædia of Agriculture*—article "Grasses," vol. i. p. 999.

raked garden plot. We have long regarded this covering in of grass seeds as the most important use to which Crosskill's valuable implement is put. The only drawback to it is, that it makes a heavy demand on the horse-power of the farm at a pressing season. As it can only be worked in dry weather, it is advisable, when the land is in trim, to work it double tides by means of a relay of horses. This mode of procedure is alike applicable to the sowing of mixed clovers and grasses, and to that of the clovers alone, and is the course usually pursued in sowing for one or two years' "seeds."

When it is intended to lay down arable land to grass for several years, or to restore it to permanent pasture or meadow, it is always advisable to sow the seeds without a corn crop. This doubtless involves an additional cost at the outset, but it is usually more than repaid by the enhanced value of the pasture thus obtained. To grow the grasses well, the soil should be pulverised to the depth of 3 or 4 inches only, and be full of manure near the surface. There is no better way of securing these conditions, than by first consuming a crop of turnips on the ground by sheep folding, and then to pulverize the surface by means of the grubber, harrow, and roller, *without ploughing it.*

Much diversity of practice exists in regard to the kinds and quantities of seeds used in sowing down with a grain crop. In Scotland from 2 to 4 pecks of ryegrass seeds, with from 10 to 14 lb. of those of red, white, and yellow clovers, in about equal proportions, is a common allowance for an acre. A pound or two of field parsley is occasionally added, or rather substituted, for an equal weight of clover seeds. The natural grasses are seldom sown, and only when the land is to be laid to permanent pasture. In England ryegrass is in much less repute than in Scotland, the clovers being there very generally sown unmixed, and always in larger quantities than we have just named—20 lb. per acre being a common allowance. There can be little doubt that both of these plans are faulty.

When a good natural pasture is carefully examined, it is found to consist of an amazing number of different grasses and other plants. We once plucked *seventeen* distinct species in an old pasture, taking only those that could be reached without stirring a foot; and as it was only those that were in flower at the time, or which had escaped the browsing of the cattle that could be discriminated, we have no doubt that the list was far from complete. Not only does a natural pasture contain a great variety of herbage at any one time, but it has its plants which replace each other at different seasons; and some also which are prominent only in wet years and others in dry ones. The provision thus made for affording, at all times, such a variety of food as is at once grateful and wholesome to the animals which browse it, and for keeping the ground fully occupied under every diversity of seasons and weather, is truly admirable, and the study of it well fitted to interest and instruct the husbandman. The importance of this subject is beginning to be appreciated by agriculturists; as one proof of which we now see our leading seedsmen regularly advertising for sale a numerous list of grasses and other pasture plants. Most of them also, for the guidance of their customers, point out the kinds and quantities per acre, which are appropriate for diversity of soils and other circumstances. We refer, as an example of this, to the manual of Messrs. Lawson of Edinburgh, who have devoted much attention to this subject.

The following Tables are from another source:—

"I.—For Alternate-Husbandry.

	For 1 year's Hay.	For 1 year's Hay and 1 year's Pasture.	For 1 year's Hay and 2 years' Pasture.
	lbs.	lbs.	lbs.
"Lolium italicum . . .	9	9	9
perenne	18	18	18
Dactylis glomerata . . .	...	2	2
Phelum pratense . .	1	2	2
Medicago lupulina .	...	1	1
Trifolium hybridum . . .	1	2	2
pratense . . .	8	4	2
pratense perenne .	...	2	4
repens	2	4	4
	39	44	44

"For sheep pastures, it will often be found advantageous to add from two to four lb. per acre of *parsley* seed to the above mixtures; and for pastures in certain upland districts, established practice will justify the introduction of an additional lb. or two of yellow clover (*Medicago lupulina*), together with from two to three lb. of ribgrass (*Plantago lanceolata*). And for very heavy, as well as for peaty soils, one to one-and-a-half lb. of *Phleum pratense* may be added advantageously, both for hay and pasture.

"II.—For Permanent Pasture, No. I.

	lbs.
"Alopecurus pratensis	2
Dactylis glomerata	6
Festuca duriuscula . . .	2
elatior . . .	2
pratensis	2
Lolium italicum	6
perenne	8
Phleum pratense	2
Poa nemoralis sempervirens . . .	2
trivialis	3
Medicago lupulina	1
Trifolium pratense	1
perenne	3
repens	6
	46

"In certain cases, the following additions to Table II. may be made, namely one to two lb. each of *Festuca rubra* and *Poa pratensis* on dry sandy soils; one lb. of *Achillea Millefolium*, and one to two lb. of *Petrosalinum sativum* in sheep pastures; two lb. chicory (*Cichorium Intybus*) in cattle pastures, six or ten lb. of *Onobrychis sativa* and four to six lb. of *Poterium Sanguisorba* (burnet) in dry calcareous soils. When a crop of hay is taken the first year, both the ryegrasses (*Lolium*) may be increased by a third; and two lb. of *Trifolium pratense* added. Also one-half to one lb. per acre of *Anthoxanthum odoratum* when occasional crops of hay are to be taken."*

When land has been thus sown for a permanent pasture, care should be taken not to allow a sheep to set foot upon it for the first two years, for if these industrious nibblers are allowed to crop the tender clover seedlings before they are fully established in the soil, they are certain to remove the crown from most of them, and thus ruin the pasture at the very outset. Innumerable instances of failure in the attempt to obtain good permanent pastures are entirely owing to this premature grazing by sheep. The first growth should therefore be mown, care being taken to do so before any of the grasses have flowered. Then roll repeatedly, and stock with young cattle only, until the second season is over.

Having described the means to be used for obtaining good pastures, let us now consider how to use them profitably. To the uninitiated the management of grass land may seem much easier than that of arable land, although the reverse is the case. After a lengthened practice, we, at least, find it so in our own experience. Nothing, indeed, can be more simple than to turn a quantity of live stock into a pasture in spring, and leave them there to shift for themselves until autumn; but such a procedure is *simple* in more than one acceptation.

The art of grazing embraces the practical solution of two important problems, viz., 1*st*, How to obtain the greatest

* Morton's *Cyclopædia of Agriculture*—article "Grasses," vol. i. p. 1000.

amount and best quality of herbage from any given pasture; and, 2*d*, How to consume this herbage by live stock so as to make the most of it. The grazier has ever to keep in view what is best for his land and what is best for his stock; and must take his measures throughout the entire season with an eye to both these objects. As regards the first of them, experience yields the following maxims for his guidance:—

Never to stock his pastures in spring until genial weather is fairly established.

Never to allow the grasses to run to seed, nor parts of a field to be eaten bare, and others to get rank and coarse.

Duly to spread about the droppings of the cattle; to remove stagnant water, and to extirpate tall weeds.

Some time about midsummer to make a point of having the pasture eaten so close that no dead herbage or "foggage" shall be left on any part of it.

In what more immediately concerns the welfare of the live stock he is in like manner taught in stocking his pastures,—

To adapt the stock as regards breed, size, condition, and numbers, to the actual capabilities of the pasturage.

To secure to the stock at all times a full bite of clean, fresh grown, succulent herbage.

In moving stock from field to field to take care that it be a change to better fare—not to worse.

Pasturage consists either of natural herbage or of "seeds." In the south-eastern counties of Scotland there is little good old grass: all the really fertile soils being employed in arable husbandry, with the exception of small portions around the mansions of land-owners. The pasturage consists, therefore, for the most part, of the cultivated clovers and grasses. Comparatively few cattle are there fattened on grass; the object of graziers being rather to stock their pastures with young and growing animals, and to get them into forward condition for being afterwards fattened upon turnips. The grazing season is there also much shorter than in England: old grass seldom affording a full bite for a well-conditioned bullock before the middle of May, or later than the middle of September. It is quite otherwise in England, various parts of which abound with old grass lands of the very richest description, on which oxen of the largest class can be fattened rapidly. These, in many cases, admit of being stocked towards the end of April, and under judicious management continue to yield excellent pasturage for half the year. When stocked with cattle in fresh condition, two sets or "runs" are not unfrequently fattened, in such pastures, in the same season. These grass-fed cattle begin to come to market early in July, and for four or five months thereafter constitute the chief supplies of beef in our markets.

Cattle already well-fleshed are alone suitable for turning into these rich old pastures. When this is attended to, and care taken not to over-stock the pastures until they yield a full bite, the progress of the oxen will usually be very rapid. It is now customary to hasten this progress by giving about four lbs. of oil-cake to each beast daily. The dust and crumbs being sifted out, the bits of cake are strewn upon the clean sward, from whence they are quickly and carefully gleaned by the cattle. This is usually a profitable practice. It brings the beasts forward rapidly, improves their appearance and handling, and, besides enriching the land, admits of about *twelve* per cent more numbers being fed upon a given acreage. These choice old pastures are usually occupied in combination with others of inferior quality. The most forward lot of cattle having been fattened and sold off from the former, they are ready to receive a fresh stock. If it is contemplated to get them also fattened before the expiry of the season, they are not put on the best land instantly on the first lot being sold; but a crowd of sheep or store-beasts being turned upon it for a few days, the existing herbage is cleared off, and the pasture (*Anglice*) "laid in" or (*Scottice*) "hained," until a fresh clean growth fits it for receiving a suitable number of the best cattle from the other pastures. It is inexpedient to graze sheep promiscuously with cattle on these best lands, as they pick out the sweetest of the herbage, and so retard the fattening of the oxen. Neither do we approve of having horses among such cattle; not so much from their interfering with their pasturage, as from the disturbance which they usually cause by galloping about. This does not apply to the draught-horses of a farm, which are usually too tired and hungry when turned out from the yoke to mind anything but food and rest; but it is better thrift to soil *them;* and frolicsome, mischievous colts are unsuitable companions for sedate, portly oxen. In favourable seasons, the grass often grows more rapidly than an ordinary stocking of cattle can consume it, in which case they select the best places and allow the herbage on some parts to get rank and coarse. If these rank places are neglected until the herbage gets dry and withered, the finer plants die out, the coarser-growing grasses usurp the ground, and the pasturage is injured for future years. To check this evil in time, these neglected places should be mown, and the grass either brought to the homestead for soiling, or left to dry where it grew; in which state the cattle will eat up most of it, and be the better for it, especially if their bowels are unduly relaxed by the succulence of the growing herbage. The remarks now made apply equally to all old pastures employed for the fattening of cattle, although not of the first quality. All that is required is, to observe a due proportion betwixt the capabilities of the pasturage and the breed and size of the cattle. A pasture that will fatten a fifty-stone ox may be quite inadequate for one of seventy, and the hardy Galloway or West Highlander will thrive apace where the heavier and daintier short-horn could barely subsist.

With the exception of the best class of rich old pastures, grass is usually consumed to greater profit by a mixed stock of sheep and store cattle, than by one kind of animals only. This holds true both as regards the natural herbage of pastures, or water meadows, and cultivated grasses, clovers, or sainfoin. When old pastures and mixed "seeds" are grazed chiefly by sheep, the same rules apply that have already been noticed in connection with cattle. The herbage should if possible be fully established in a growing state, and so far advanced as to afford a full bite, before the pasture is stocked in spring. If the sheep are turned into it prematurely, their close nibbling hinders the plants from ever getting into a state of rapid growth and productiveness, and the necessity imposed upon the stock of roaming over the whole field, and keeping long afoot before they can glean enough to appease their appetite, is prejudicial alike to them and to their pasture. The prudent grazier endeavours to avoid these evils by having his stores of Swedes or mangels to last until the full time at which he may reckon on having good pasturage. In distributing the flocks to different fields, the best pasturage is allotted to those that are in most forward condition. It is advantageous to have the pastures so subdivided that one portion may be double stocked while another is rested. By frequently removing the stock from the one portion to the other the herbage of each by turns gets time to grow and freshen, and is more relished by the sheep than when the whole is tainted by their uninterrupted occupation of it. In the case of clover, trefoil, sainfoin, and water-meadows, this principle is yet more fully carried out by folding the flock and giving them a fresh piece daily. The crop is thus eaten close off at once in daily portions, and the plants being immediately thereafter left undisturbed, and receiving over the whole area their due share of the excrements of the flock, grow again more rapidly than when subjected to constant browsing under a system of promiscuous grazing. This plan of folding sheep upon such crops has the same advantages to recommend it as soiling, only that it is cheaper to shift the fold daily than to mow and cart home the forage and carry back the manure. In the case of water-meadows it is the practice to irrigate them afresh as each crop of grass is fed off. This is attended with considerable risk of the sheep getting tainted with rot, which must be guarded against as much as possible. In the first place it is well to give them a daily allowance of bran, beans, or cake, and salt; and besides this to put on this land only such sheep as are nearly ready for the butcher. They will thus fatten very rapidly, and be slaughtered before there is time for harm to ensue.

The modes of grazing which we have now described are appropriate for sheep in forward condition. The poorer pastures are usually stocked with nursing ewes and lean sheep bought in from higher grazings. Lambs, both before and after weaning, require clean pastures, and of course frequent changes. If kept on tainted pastures they are certain to become subject to diarrhœa, to be stinted in their growth, and to have their constitution so weakened that many of them will die when afterwards put upon turnips. To avoid these evils they must be frequently moved from field to field. A sufficient number of store-cattle must be grazed along with them to eat up the tall herbage and rank places avoided by the sheep. After the lambs are weaned, the ewes require to fare rather poorly for a time, and can thus be made use of to eat up the worst pasturage, and the leavings of the young and fattening sheep. When the latter, with the approach of autumn, are put upon aftermath, clover-stubbles, rape, cabbages, or turnips, their previous pastures should in succession be thickly stocked by the ewes and other store stock, so as to be eaten bare and then get leave to freshen and get ready for the ewes by rutting time, when they require better food. In depasturing sheep on poor soils it is usually highly advantageous to give them a daily allowance of grain or cake in troughs, which must be shifted daily, so as to distribute the manure regularly over the land. By means of this auxiliary food sheep can be fattened on land, the herbage of which would not alone suffice to do this. It admits also of a larger number of sheep being kept per acre, and of the pasturage being fed off more closely than could otherwise be done. The produce of poor siliceous soils, both in grass and after crops, is much increased by the additional manuring and treading which the consumption of such extraneous food upon them occasions.

It is always advantageous to have pastures provided with a shed under which the stock can find shelter from sudden storms, or from the attacks of insects, and the scorching rays of the summer's sun. When such sheds are regularly strewed with dried peat or burnt clay, much valuable compost for top-dressing the pasture can be obtained. The dung of the cattle thus secured and applied, benefits the pastures more than that which is dropped upon it by the animals. Such clots require to be spread about from time to time.

To carry out successfully the various details now referred to, which constitute the art of grazing, there is required much foresight, accurate observation, sound judgment, and constant superintendence. Without all this it is impossible to make the most of any given amount of live stock and pasturage, and hence the extraordinary disparity in the results obtained by different graziers from similar materials.

The temperate climate of Britain is so peculiarly favourable to the growth of the grasses and other pasture plants, and to the keeping of live stock with safety in the open fields for a large part of the year, that the practice of consuming these crops by depasturing, as already described, has hitherto been decidedly preferred to soiling. One consequence of this is, that forage crops have been comparatively neglected. There is now, however, a growing conviction among agriculturists that it is more convenient to keep neat-cattle and horses, during summer, in yards or loose boxes, and to feed them with succulent forage, mown and brought to them daily as it is needed, than to turn them adrift to browse in the fields. The pasturing plan is preferred by many because it involves the least labour, and is alleged to be more healthful to the animals. In behalf of the soiling plan, it is urged that a given space of ground under green crop keeps nearly twice as much stock, when its produce is mown and consumed elsewhere, than when it is constantly nibbled and trodden upon; that housed cattle being exempted from the vicissitudes of the weather, the attacks of insects, mutual disturbance, and the labour of gathering their food, eat less and yet fatten more rapidly than they do at pasture; that more good is gotten of their excrements when mixed with litter, and trodden down under cover, than when dropped about in the open fields; and that land from which a green crop has been mown, when ploughed up, is freer of weeds and (other things being equal) bears a better corn-crop than that which has been pastured. It is a further recommendation to the soiling plan that it admits of oil-cake or meal being administered along with green food with a precision and economy that is unattainable in the pasture fields. There being so many, and such cogent reasons in favour of the practice of soiling, we may warrantably anticipate that it will in future be much more generally adopted. It is proper, however, to notice that the success of this system is absolutely dependent on the following conditions. The green food must be mown and brought home at least *twice* a-day, owing to the rapidity with which it ferments when put together; it must be given to the stock not less than *four* times daily, and only in such quantity at each feed as they can eat clean up in the interval betwixt meals; they must have constant and ample supplies of pure water and of fresh litter; and, in particular, matters must be so arranged that there shall be an unfailing supply of green forage of the best quality through the entire season. This is accomplished either by successive cuttings of one kind of crop from the same ground—as of irrigated meadow, or Italian ryegrass—or by a combination of such crops as naturally come to maturity in succession, or are made to do so by a sequence of sowings. From what has been said, it is obvious that soiling can only be carried out successfully with a moderately good soil and climate, a liberal use of manure, and skill and foresight on the part of the farmer. With these, however, its results will usually be highly satisfactory. It is peculiarly adapted for clay soils, on which the culture of root crops is attended with much difficulty, and where there is, therefore, abundance of litter for use in summer, and much need for the soiling system to get it converted into good manure.

Section 2.—*Natural Meadow Grass.*

In proceeding to notice the crops most usually cultivated in Britain for green forage, we shall begin with *Natural Meadow Grass.* In the south-western parts of England abundant crops of grass are obtained by irrigation with simple water. Our remarks shall here, however, be restricted to those situations where sewage from towns or villages is available. Wherever a few scores of human families are congregated together, and have their dwellings properly drained and supplied with water, there is an opportunity for manuring a considerable extent of meadow with the sewage-water accruing from them throughout the year. The celebrated meadows in the environs of Edinburgh are interesting illustrations of the value of such water for irrigating purposes, and of the astonishing bulk of rich herbage which can be obtained in the course of a year from an acre of land thus treated. From the thickness of the crop in these meadows, and the rank luxuriance of its growth, the grass must be cut before it exceeds *ten* inches in height, as otherwise the bottom gets blanched, and the grass rots out. The mowing begins usually in April, and continues till November, so that by fitly proportioning the head of stock to the extent of meadow, and having the latter arranged in plots to be mown in regular succession, soiling can be practised throughout the season by means of the produce of the meadow alone. This practice is necessarily limited to situations where sewage water is available. The following excerpt from the *Minutes of Information to the General Board of Health, collected in the practical application of Sewer Water and Town Manures to Agricultural Production*, p. 65, will explain the system here referred to, and exhibit its results :—

"Craigentinny Meadows, situate about one mile and a half south-east of Edinburgh, have been put under irrigation at various times, the most recent addition being nearly 50 acres laid out in the course of last year (1850) and the year previous, which lying above the level of the rest are irrigated by means of a steam-engine. The meadows first laid out are watered by contour channels following the inequalities of the ground, after the fashion commonly adopted in Devonshire; but in the more recent parts the ground is disposed in 'panes' of half an acre, served by their respective feeders, a plan which, though somewhat more expensive at the outset, is found preferable in practice. The whole 260 acres take about fourteen days to irrigate; the men charged with the duty of shifting the water from one pane to another give to each plot about two hours' irrigation at a time; and the engine serves its 50 acres in ten days, working day and night, and employing one man at the engine and another to shift the water. The produce of the meadows is sold by auction on the ground, 'rouped' as it is termed, to the cowfeeders of Edinburgh, the purchaser cutting and carrying off all he can during the course of the letting, which extends from about the middle of April to October, when the meadows are shut up, but the irrigation is continued through the winter. The lettings average somewhat over £20 the acre; the highest last year having brought £31, and the lowest £9; these last were of very limited extent, on land recently denuded in laying out the ground, and consequently much below its natural level of productiveness. There are four cuttings in the year, and the collective weight of grass cut in parts was stated at the extraordinary amount of eighty tons the imperial acre. The only cost of maintaining these meadows, except those to which the water is pumped by the engine, consists in the employment of two hands to turn in and off the water, and in the expense of clearing out the channels, which was contracted for last year at £29, and the value of the refuse obtained was considered fully equal to that sum, being applied in manuring parts of the land for a crop of turnips, which, with only this dressing in addition to irrigation with the sewage-water, presented the most luxuriant appearance. The crop, from present indications, was estimated at from thirty to forty tons the acre, and was expected to realise 15s. the ton, sold on the land. From calculations made on the spot, we estimated the produce of the meadows during the eight months of cutting, at the keep of ten cows per acre, exclusive of the distillery refuse they consume in addition, at a cost of 1s. to 1s. 6d. per head per week. The sea-meadows present a particularly striking example of the effects of the irrigation; these, comprising between 20 and 30 acres skirting the shore between Leith and Musselburgh, were laid down in 1826 at a cost of about £700; the land consisted formerly of a bare sandy tract, yielding almost absolutely nothing; it is now covered with luxuriant vegetation, extending close down to high-water mark, and lets at an average of £20 per acre at least. From the above statement it will be seen how enormously profitable has been the application in this case of town refuse in the liquid form; and I have no hesitation in stating, that, great as its advantages have been, they might be extended four or five fold by greater dilution of the fluid."

Section 3.—Italian Ryegrass.

Italian Ryegrass can, however, be cultivated over as wide a range of soils and climate as any forage crop which we possess, and its value for soiling is every day getting to be more generally appreciated. When first introduced, and indeed until very recently, it was chiefly sown in mixture with other grasses and clovers for pasturage, a purpose to which it is well adapted from its early and rapid growth in spring. Its true function, however, is to produce green food for soiling, for which purpose it is probably unrivalled. It is in connection with the system of irrigation with liquid manure, as practised at Myremill and elsewhere, that its astonishing powers have been most fully developed. When grown for this purpose it is sown in April, on land that has borne a grain crop after turnips or summer fallow. If sown *with* a grain crop and as thickly as is requisite, it gets nearly as tall as the grain, and both are injured. A liberal dressing of farm-yard dung is spread upon the stubble in autumn, and immediately ploughed in. In the end of March or beginning of April the land is prepared for the seed by being stirred with the grubber and then well harrowed. The seed, at the rate of four bushels per acre, is then sown in the way already described for clover and grass seeds. When the liquid manure system is practised, the crop is watered as soon as the young plants are about an inch high, and so rapid is its growth in favourable circumstances that a cutting of ten tons per acre has in some cases been obtained six weeks after sowing. When there is no provision for supplying liquid manure, a top-dressing of guano, nitrate of soda, soot, or the first two articles mixed, is applied by hand-sowing, taking care to give this dressing when rain seems at hand, or has just fallen. A similar top-dressing is repeated after each cutting, by which means three cuttings are ordinarily obtained from the same space in one season. A very great quantity of stock can thus be supported from a very limited extent of ground. This grass is also found to be very grateful to the palates of horses, cattle, and sheep, which all thrive upon it. Though so very succulent, it does not produce purging in the animals fed upon it. It is peculiarly suitable feeding for milch cows, as appears from the published account at Canning Park. Such results as those obtained by Mr. Kennedy and others are not to be expected unless under similar conditions; but on good loams, clean and in good heart, and under such treatment as is described at the beginning of this section, as large crops of this grass with at least equal feeding powers to red clover may be reckoned on, and with a degree of certainty which the farmer cannot now entertain in regard to the latter crop. If regularly mown when the ear begins to shew, taking care never to allow the seed to form, it is fully ascertained that this grass will grow abundantly for a second year, with the advantage of being ready for use very much earlier than in its first season. It is sometimes sown in autumn, but those who have had the fullest experience in its cultivation give a decided preference to spring sowing, either after a grain crop which has followed a green crop or fallow, or at once after turnips. It is of great importance to get fresh and genuine seed. That directly imported from Italy yields the best crop when otherwise good. As a proof of the fondness of sheep for this grass, it has been observed that when it had been sown in mixture with red clover and cut for hay, sheep, on being turned into the aftermath, eat down the Italian rye-grass in preference to the clover.

Section 4.—Crimson Clover.

Crimson Clover, though not hardy enough to withstand the climate of Scotland in ordinary winters, is a most valuable forage crop in England. It is sown as quickly as possible after the removal of a grain crop at the rate of 18 lbs. to 20 lbs. per acre. It is found to succeed better when only the surface of the soil is stirred by the scarifier and harrow, than when a ploughing is given. It grows rapidly in spring, and yields an abundant crop of green food, peculiarly palatable to live stock. It is also suitable for making into hay. Only one cutting, however, can be obtained, as it does not shoot again after being mown.

Section 5.—Red Clover.

This plant, either sown alone or in mixture with ryegrass, has for a long time formed the staple crop for soiling, and so long as it grew freely, its power of shooting up again after repeated mowings, the bulk of crop thus obtained, its palatableness to stock and feeding qualities, the great range of soils and climate in which it grows, and its fitness either for pasturage or soiling, well entitled it to this preference. Except on certain rich calcareous clay soils, it has now, however, become an exceedingly precarious crop. The seed, when genuine, which unfortunately is very often not the case, germinates as freely as ever, and no greater difficulty than heretofore is experienced in having a full plant during autumn and the greater part of winter; but over most part of the country, the farmer, after having his hopes raised by seeing a thick cover of vigorous-looking clover plants over his field, by March or April finds, to his dismay, that they have either entirely disappeared, or are found only in capricious patches here and there over the field. No satisfactory explanation of this clover failure has yet been given, nor any certain remedy, of a kind to be applied to the soil, discovered. One important fact is, however, now well established, viz., that, when the cropping of the land is so managed as that clover does not recur at shorter intervals than eight years, it grows with much of its pristine vigour. The knowledge of this fact now determines many farmers in varying their rotation so as to secure this important end. At one time there was a somewhat prevalent belief that the introduction of beans into the rotation had a specific influence of a beneficial kind on the clover when it came next to be sown; but the true explanation seems to be, that the beans operate favourably only by the incidental circumstance of almost necessarily lengthening the interval betwixt the recurrences of clover. When the four-course rotation is followed, no better plan of managing this process has been yet suggested than to sow beans, pease, potatoes, or tares, instead of clover, for one round, making the rotation one of eight years instead of four. The mechanical condition of the soil seems to have something to do with the success or failure of the clover crop. We have often noticed that head-lands or the converging line of wheel tracks near a gateway at which the preceding root crop had been carted from a field, have had a good take of clover when on the field generally it had failed. In the same way a field that has been much poached by sheep while consuming turnips upon it, and which has afterwards been ploughed up in an unkindly state, will have the clover prosper upon it, when it fails in other cases where the soil appears in far better condition. If red clover can be again made a safe crop, it will be a boon indeed to agriculture. Its seeds are usually sown along with a grain crop any time from 1st February to May, at the rate of 12 lbs. to 20 lbs. per acre when not combined with other clovers or grasses.

Italian ryegrass and red clover are now frequently sown in mixture for soiling, and succeed admirably. It is, however, a wiser course to sow them separately, as by substituting the Italian ryegrass for clover, for a single rotation, the farmer not only gets a crop of forage as valuable in all respects, but is enabled, if he choose, to prolong the intervals betwixt the sowings of clover to twelve years, by sowing, as already recommended, pulse the first round, Italian ryegrass the second, and clover the third.

These two crops, then, are those on which the arable-land farmer mainly relies for green forage. To have them good, he must be prepared to make a liberal application of manure. Good farm-yard dung may be applied with advantage either in autumn or spring, taking care to cart it upon the land only when it is dry enough to admit of this being done without injury. It must also be spread very evenly so soon as emptied from the carts. But it is usually more expedient to use either guano, nitrate of soda, or soot, for this purpose, at the rates respectively of 2 cwt., 1 cwt., and 20 bushels. If two or more of these substances are used, the quantities of each will be altered in proportion. They are best also to be applied in two or three portions, at intervals of fourteen to twenty days, beginning towards the end of December, and only when rain seems imminent or has just fallen.

When manure is broad-cast over a young clover field, and presently after washed in by rain, the effect is identical with that of first dissolving it in water, and then distributing the dilution over the surface, with this difference, namely, that the first plan costs only the price of the guano, etc., and is available at any time and to every one, whereas the latter implies the construction of tanks and costly machinery.

Section 6.—*Vetches.*

Vetches are another very valuable forage crop. Being indigenous to Britain, and not fastidious in regard to soil, they can be cultivated successfully under a great diversity of circumstances, and are well adapted for poor soils. By combining the winter and spring varieties, and making several sowings of each in their season, at intervals of two or three weeks, it is practicable to have them fit for use from May till October, and thus to carry out a system of soiling by means of vetches alone. But it is usually more expedient to use them in combination with grass and clover, beginning with the first cutting of the latter in May, taking the winter vetches in June, recurring to the Italian ryegrass or clover, as the second cutting is ready, and afterwards bringing the spring vetches into play. Each crop can thus be used when in its best state for cattle food, and so as gratefully to vary their dietary.

Winter Vetches.—There is no botanical difference betwixt winter and spring vetches, and the seeds being identical in appearance, caution is required in purchasing seed to get it of the right sort. Seed grown in England is found the most suitable for sowing in Scotland, as it vegetates more quickly, and produces a more vigorous plant than that which is home-grown. As the great inducement to cultivate this crop is the obtaining of a supply of nutritious green food which shall be ready for use about the 1st May, and so as to fill up the gap which is apt to occur betwixt the root crops of the previous autumn, and the ordinary summer food, whether for grazing or soiling, it is of the utmost importance to treat it in such a way, that it may be ready for use by the time mentioned. To secure this, winter tares should be sown in August if possible, but always as soon as the land can be cleared of the preceding crop. They may yield a good crop though sown in October, but, in this case, will probably be very little in advance of early-sown spring vetches, and possess little, if any, advantage over them in any respect. The land on which they are sown should be dry and well sheltered, clean, and in good heart, and be farther enriched by ploughing into it from 12 to 15 loads of farm-yard manure. Not less than 3½ bushels of seed per acre should be sown, to which some think it beneficial to add half a bushel of wheat. Rye is frequently used for this purpose, but it gets reedy in the stems, and is rejected by the stock. Winter beans are better than either. The land having been ploughed rather deeply and well harrowed, it is found advantageous to deposit the seed in rows, either by a drilling-machine, or by ribbing. The latter is the best practice, and the ribs should be at least a foot apart and rather deep, that the roots may be well developed before top-growth takes place. As soon in spring as the state of the land and weather admits of it, the crop should be hoed betwixt the drills, a top-dressing at the rate of 40 bushels of soot, or 2 cwt. of guano per acre applied by sowing broad-cast; and the roller then used for the double purpose of smoothing the surface, so as to admit of the free use of the scythe, and of pressing down the plants which may have been loosened by frost. It is thus by early sowing, thick seeding, and liberal manuring, that this crop is to be forced to an early and abundant maturity. May and June are the months in which winter vetches are used to advantage. A second growth will be produced from the roots if the crop is allowed to stand; but it is much better practice to plough up the land as the crop is cleared, and to sow turnips upon it. After a full crop of vetches, land is usually in a good state for a succeeding crop. When the whole process has been well managed, the gross amount of cattle food yielded by a crop of winter vetches, and the turnip crop by which it is followed in the same summer, will be found considerably to exceed what could be obtained from the fullest crop of turnips alone, grown on similar soil, and with the same quantity of manure.

Spring Vetches, if sown about the first of March, will be ready for use by 1st July, when the winter vetches are just cleared off. To obtain the full benefit of this crop, the land on which it is sown must be clean, and to keep it so, a much fuller allowance of seed is required than is usually given in Scotland. When the crop is as thick set as it should be, the tendrils intertwine, and the ground is covered by a solid mass of herbage, under which no weed can live. To secure this, not less than four bushels of seed per acre should be used, if sown broad-cast, or three bushels if in drills. The latter plan, if followed by hoeing, is certainly the best; for if the weeds are kept in check until the crop is fairly established, they have no chance of getting up afterwards. With a thin crop of vetches, on the other hand, the land is so certain to get foul, that they should at once be ploughed down, and something else put in their place. As vetches are in the best state for use when the seeds begin to form in the pods, repeated sowings are made at intervals of three weeks, beginning by the end of February, or as early in March as the season admits, and continuing till May. With *two* sowings in autumn, and *four* in spring, a supply of this valuable food can be had in good condition from May till October, so that by means of vetches alone, if well managed, the interval betwixt the old and new crops of roots can be filled up. There are, as we have seen, other forage crops well worthy the attention of the farmer, but the vetch is less fastidious in regard to soil and climate than any of them, and can be grown successfully on very poor soils. The usual practice in Scotland has been to sow vetches on part of the oat break, once ploughed from lea. Sometimes this does very well, but a far better plan is to omit sowing clover and grass-seeds on part of the land occupied by wheat or barley after turnips, and having ploughed that portion in autumn to occupy it with vetches, putting them *instead of* "*seeds*" for one revolution of the course.

When vetches are grown on poor soils, the most profitable way of using them is by folding sheep upon them, a practice very suitable also for clays, upon which a root crop cannot safely be consumed in this way. A different course must, however, be adopted than when turnips are so disposed of. When sheep are turned in upon a piece of tares, a large portion of the food is trodden down and wasted. Cutting the vetches and putting them into racks does not much mend the matter, as much is still pulled out and wasted, and the manure unequally distributed over the land. To avoid those evils, hurdles with vertical spars, betwixt which the sheep can reach with head and neck, are now used. These are set close up to the growing crop along a considerable stretch, and shifted forward as the sheep eat up what is within their reach. This requires the constant attention of the shepherd, but the labour is repaid by the saving of the food, which being always fresh and clean, does the sheep more good. A modification of this plan is to use the same kind of hurdles, but, instead of shifting them as just described, to mow a swathe parallel to them, and fork this forward within reach of the sheep as required, repeating this as often during the day as is found necessary, and at night moving them close up to the growing crop, so that the sheep may lie for the next twenty-four hours on the space which has yielded food for the past day. During the night they have such pickings as have been left on the recently-mown space, and so much of the growing crop as they can get at through the spars. There is less labour by this last mode than the other, and in practice it has been found to do well. This folding upon vetches is suitable either for finishing off for market sheep that are in forward condition, or for recently weaned lambs, which after five or six weeks' folding on this clean, nutritious herbage, are found to take on more readily to eat turnips, and to thrive better upon them, than if they had been kept upon the pastures all the autumn. Sheep folded upon vetches must have water always at command, otherwise they will not prosper.

As spring-sown vetches are in perfection at the season when pastures usually get dry and scanty, a common practice is to cart them on to grass land and spread them out in wisps, to be eaten by the sheep or cattle. It is, however, much better either to have them eaten by sheep where they grow, or to cart them to the homestead.

Section 7.—Mustard.

After a crop of vetches has been consumed, if the season is too far advanced to admit of turnips being sown, it is not unusual to take a crop of white mustard or *crimson clover*.

By means of the crops now enumerated, the practice of soiling can be carried out in all cases where it is practicable.

There are other valuable crops of this kind, several of which we shall now describe; but their culture is either limited by their requirements in regard to soil and climate, or attended with too great expense to admit of their competing with those already described.

Section 8.—Sainfoin.

This very important forage plant would be well entitled to a more prominent place in our list, but for the circumstance that it is only on dry calcareous soils that its excellences are fully developed; and to these accordingly its culture may be said to be confined. In all the chalk districts of England, sainfoin occupies an important place in the rotation of crops. Referring to the chalky downs round Ilsley in Berks, Mr. Caird says:—"About a tenth part of the land is kept under sainfoin, in which it remains for four years, being each year cut for hay, of which it gives an excellent crop. A farmer having forty acres of sainfoin, sows out ten acres and breaks up ten acres annually. This goes regularly over the whole farm, the sainfoin not returning on the same field for considerable intervals, and when its turn comes round the field receives a rest of four years from the routine of cultivation. It is then ploughed up in spring, and sown with oats on one furrow, the crop of which is generally excellent, as much as eighty bushels an acre not being uncommon."* The seed, at the rate of four bushels per acre, is drilled in immediately after barley or oats has been sown, working the drill at right angles to its course when it deposited the grain. It is frequently pastured for one or more years before being mown either for green forage or for hay. It is sometimes allowed to stand for

* *Caird's English Agriculture*, p. 114.

eight or ten years, but the plan described in the above quotation is the more approved one. A variety called *giant-sainfoin* has been introduced by Mr. Hart of Ashwell, Herts. As compared with the common sort it is more rapid in its growth in spring, and still more so after the first and second cuttings. Three cuttings for hay, and one of these ripening the seed, have been yielded by it in one year, and a good eddish after all. The yield from it in the first year, after sowing, is large in comparison with the common sainfoin, from its attaining maturity much sooner; but for the same reason it is thought judicious to break it up after three years, while still in vigour.

Section 9.—*Lucerne.*

Lucerne is much cultivated as a forage crop in France and other parts of the continent of Europe, but has never come into general use in Britain. It is, however, frequently met with in small patches in districts where the soil is very light, with *a dry subsoil.* Its thick tap-roots penetrate very deeply into the soil; and if a good cover is once obtained, the plants will continue to yield abundant cuttings of herbage for eight or ten years, provided they are statedly top-dressed, and kept free from perennial weeds. In cultivating lucerne, the ground must first be thoroughly cleaned, and put into good heart by consuming a turnip crop upon it with sheep. In March or April, the surface-soil having first been brought to a fine tilth, the seed, at the rate of 10 lb. per acre, is sown in rows at 15 to 18 inches apart. So soon as the plants appear, they must be freed from weeds by careful hoeing and hand-weeding, repeated as occasion requires. Little produce is obtained from them the first season, and not a very heavy cutting the second; but by the third year it will yield two or more abundant crops of herbage peculiarly suitable for horse-feed. It is the slow growth of the plants at first, and the difficulty of keeping them free from weeds on those dry soils which alone are adapted for growing lucerne, that have deterred farmers from growing it more extensively than has hitherto been done. We have grown it successfully in Berwickshire on a muiry soil, resting on sandstone rock, in an exposed situation, at an elevation of 400 feet. The time to cut it is, as with clover and sainfoin, when it is in full flower.

Section 10.—*Chicory, etc.*

Chicory, burnet, cow-parsnip, and *prickley comfrey,* all known to be palatable to cattle, and yielding a large bulk of produce, have probably been less carefully experimented with than their merits deserve. Although they have long figured in such notices as the present, or in occasional paragraphs in agricultural periodicals, they have never yet, that we are aware of, been subjected to such a trial as either conclusively to establish their claim to more extended culture, or to justify the neglect which they have hitherto experienced.

Section 11.—*Gorse or Whin.*

Notwithstanding its formidable spines, the young shoots of this hardy evergreen yield a palatable and nutritious winter forage for horses and cattle. To fit it for this purpose it must be chopped and bruised to destroy the spines. This is sometimes done in a primitive and laborious way by laying the gorse upon a block of wood, and beating it with a mallet flat at one end, and armed with crossed knife-edges at the other, by the alternate use of which it is bruised and chopped. There are now a variety of machines by which this is done rapidly and efficiently, and which are in use where this kind of forage is used to any extent. The agricultural value of this plant has often been over-rated by theoretical writers.

In the case of very poor, dry soils, it does however yield much valuable food at a season when green forage is not otherwise to be had. It is, on this account, of importance to dairymen; and to them it has this further recommendation, that cows fed upon it give much rich milk, which is free from any unpleasant flavour. To turn it to good account, it must be sown in drills, kept clean by hoeing, and treated as a regular green crop. If sown in March, on land fitly prepared, and afterwards duly cared for, it is ready for use in the autumn of the following year. A succession of cuttings of proper age is obtained for several years from the same field. It is cut by a short stout scythe, and must be brought from the field daily; for when put in a heap, after being chopped and bruised, it heats rapidly. It is given to horses and cows, in combination with chopped hay or straw. An acre will produce about 2000 faggots of green two-year-old gorse, weighing 20 lb. each.

This plant is invaluable in mountain sheep-walks. The rounded form of the furze bushes that are met with in such situations shews how diligently the annual growth, as far as it is accessible, is nibbled by the sheep. The food and shelter afforded to them in snow-storms by clusters of such bushes is of such importance, that the wonder is our sheep farmers do not bestow more pains to have it in adequate quantity. Young plants of whin are so kept down by the sheep, that they can seldom attain to a profitable size unless protected by a fence for a few years.

Section 12.—*Tussac Grass.*

The tussac grass of the Falkland Islands has, of late years, attracted considerable attention as a forage plant. From its gigantic growth, even in those ungenial regions, and the extraordinary relish manifested for it by horses and cattle, sanguine hopes were entertained that it was to prove a truly valuable addition to our present list of forage plants. The attempts hitherto made to introduce it in Britain have not been of a very encouraging kind. The only successful cases have been in the Orkneys and in Lewis. Messrs. Lawson of Edinburgh, who have given much attention to it, say, "Our own experience leads to the conclusion, that localities within influence of the sea spray, the soil being of a peaty nature, are, without doubt, the best adapted for the growth of the tussac; and in such places it is likely to be of great service, as few other nutritive grasses will exist there. In our own experimental grounds it does not thrive well; which may, perhaps, be accounted for by the nature of the soil, which is light and dry. Regarding its value as a forage plant, we have before us an analysis made, at our request, by Professor Johnston, the results of which shew that 'the tussac grass ought to be very nutritive.' Propagation, in the absence of seed, is easily effected, under favourable circumstances, by subdivision of the roots."

We have thus noticed all the more important of our forage crops of ascertained value. Additions will probably be made to them from time to time, especially from the increased attention now bestowed on green crops of all kinds. It has lately been suggested that maize, and also lupins, although unfit for our climate as grain crops, might with advantage be tried as forage plants. Both are successfully grown for this purpose in Germany. Being unable to withstand frost, they should be sown not earlier than May. The maize requires a deep rich soil; the lupins again are said to do best on light siliceous soils. Both should be sown in rows 15 to 18 inches apart, and seeded at the rate of two bushels per acre. A trial which we made with lupins (both the blue and the yellow sort) in 1858, on a light muiry soil, proved a total failure.

Section 13.—*Haymaking.*

Having spoken of the cultivation and use in a green state of herbage and forage crops, it remains to describe the process by which they are preserved for use in a dry state, or *made into hay.* On every farm a supply of good hay, adequate to the wants of its own live stock, is, or at least ought to be, statedly provided. This is, no doubt, an expensive kind of food, but on the other hand it is highly nutritious, and conduces much to the healthfulness of the animals fed upon it. Many a valuable farm horse is annually sacrificed to a false economy in feeding him solely on innutritious straw or ill-gotten hay. The owners of such stock would do well to consider that the price of an annual dead horse, and the impaired health and condition of the whole stud, more than counterbalance any saving that can be effected by using bad fodder instead of good. But the great consumpt of hay is by the numerous horses constantly required in this country for other purposes than farm labour. In the vicinity of towns hay is therefore a staple agricultural product, and haymaking an important branch of rural economy. It is one in the practice of which English farmers generally excel their brethren north of the Tweed. In the counties near the metropolis, in particular, this process is conducted with admirable skill.

In converting the grasses and forage plants into hay the object is to get quit of the water which they contain, amounting to nearly *two-thirds* of their weight, with the least possible loss of their nutritive qualities. In order to this the crops must be mown at that stage of their growth when the greatest weight of produce with the maximum of nutritive value can be obtained; and then so to conduct the drying process that the insipissated juices shall not be washed out and lost by external wetting. A simple and sufficiently accurate rule for determining the first point, is to mow when the plants are in full flower. If this stage is exceeded, both the quality of the hay and amount of the foggage or aftermath are seriously impaired. It follows from this, that mowing should be commenced somewhat earlier than the stage indicated, otherwise, before the whole can be cut, the last portion will have exceeded the proper degree of ripeness. By cutting a part too soon a slight loss of weight is incurred, which, however, is compensated for by a better aftermath, whereas if part is allowed to mature the seeds, there is a loss both of weight, quality, and aftermath. Haymaking to be done well must be done quickly, and in order to this a full supply of labourers is indispensable. As a good mower can cut on an average an acre in a day, as many must be engaged as can overtake the extent of crop while it is in the best state for cutting. It is of great importance, too, to have the grass cut close by the ground. A loss of from five to ten per cent on the gross produce is frequently incurred by unskilful or careless mowers leaving the sward too high. Now that efficient mowing-machines can be had this work can be performed with a celerity and accuracy heretofore unattainable. To admit of accurate and expeditious mowing, whether by scythe or machine, care must be taken, at the proper season, to remove all stones and other obstructions, and to make the surface smooth by rolling.

Confining our attention, in the first place, to natural meadow grass, let us glance at the process as conducted by those who are most proficient in it. The mowers having commenced their work at sunrise, the haymakers, in the proportion of two men and three women to each mower, so soon as the dew is off, shake out the swathes evenly over the whole ground, until they have overtaken as much as they can get into cocks the same day. This quantity they now turn and toss about as frequently as possible, getting it, before evening, either into a compact wind-row, or forming it into very small cocks. Next day these cocks are again opened out, and as much more of the grass in swathe as can be overtaken, all of which is anew subjected to the same repeated turnings, and again, as evening approaches, secured from dew and rain by windrowing and cocking; that which is driest being put into larger cocks than on the previous day. If the weather is hot and parching, that which was first cut is by the fourth day ready for the stack, and is immediately carried. A large rick-cloth is drawn over the incipient stack until more hay is in condition to be added to it, and then, if weather favour, the whole process, from mowing to stacking, for a time goes on simultaneously, and is speedily completed. As the building of the stack proceeds, its sides are, by pulling, freed from loose hay and straightened; and when completed it is thatched with the least possible delay. If the weather prove showery, the grass is left untouched in the swathe until it begins to get yellow on the under side, in which case it is usually turned over without opening out until weather again favour. To produce fine hay, care must be taken to secure from dew or rain by cocking, before nightfall, all that has been spread out during the day—never to touch it until dew or wet is off—to shake all out so thoroughly as that the whole may be dried alike—and never to suffer it after being tedded out to lie so long as to get scorched on one side. When these operations are conducted successfully, the hay is of a fine, light-green colour, delightfully fragrant, and retains its nutritious matter unimpaired. To accomplish this in our variable climate, much skill and energy, and an ample command of labour, are necessary.

The cost and labour of this process are now, indeed, much reduced by the use of machinery, consisting of mower, tedder, and rake, by means of which a man and pair of horses can do the work of ten scythe-men, and another man and horse can toss, turn, and draw into windrows, as much grass as could be overtaken in the same time by fifteen people. The hay-tedder, moreover, shakes out the grass more thoroughly than it can be done by hand. After the hay is gathered into rows, horse-labour is also sometimes employed to thrust it into heaps by means of a sweep, that is, a piece of plank with a rope attached to each end of it, by which a horse draws it along *on edge*, while two lads hold it down, and the hay is thus pushed forward in successive portions, which are then, by hand-labour, made into orderly cocks. The yield of meadow hay ranges from one to two tons per acre, and the cost of making it about 10s. per ton. In London hay is brought to market in trusses, each weighing 56 lbs., and 36 of which are called a load. In cutting up a stack these trusses are removed from it in compact cubes, which are then neatly secured by bands of twisted hay.

In converting the cultivated forage crops, such as clover (either pure or mixed with ryegrass), sainfoin, lucerne, or vetches, into hay, the procedure varies considerably from that pursued with the natural grasses. A considerable part of these plants consists of broad, tender leaves, which, when scorched by the sun, become so dry and brittle that, on the least rough handling, they fly into dust, and are totally lost. These crops, therefore, do not admit of being shaken asunder, and tossed about like the natural grasses, a circumstance which unfortunately forbids the use of machinery and horse-labour in getting them. The swathes are accordingly left untouched until they have got slightly withered on the upper side, after which they are turned several times, with as little breaking up as possible; made up first into small cocks—opened out again—gently turned, and made into larger cocks, which, as speedily as possible, are carried and stacked. These crops can be stacked with safety in a very green state by mixing with them frequent layers of clean dry straw, by which the redundant juices are absorbed, and injurious heating prevented. The straw thus impregnated acquires a flavour which renders it palatable to cattle; but it is advisable, when this practice is adopted, to cut the whole into chaff before using it as fodder.

The following system of making clover and ryegrass into hay is practised in several districts:—

"So soon as the surface is dry, a portion, about a yard in length, of the swathe is taken, and the surface folded inwards, and the whole rolled into a kind of cone. A piece of ryegrass is pulled out of the top, and tied round the head of the 'ruckle,' as it is called, and set in rows to admit of being easily carted. Thus, while the sun and air thoroughly dry the whole mass, the rain, should it come, descends over the inclined surface of the cone, and as the large mass of leaves the clover possesses renders it peculiarly liable to injury from the wet, this process is most valuable, and in few places is it secured in better condition. In a dry time it is carted directly from the 'ruckles' to the stack; in a damp one, they are sometimes to pull down before they are carted off, and made into 'pikes,' or small heaps, of from two to three cart-loads each; here the clover is allowed to ferment, and in a week or two, put into the stack."*

When it is desired to save the seeds of Italian or common ryegrass, the crop after being mown is allowed to lie for a day or two in swathe, and is then neatly gathered into sheaves, bound, and stooked, precisely like a crop of oats. When sufficiently dried, the seed is either thrashed out in the field, the straw stacked like other hay, and the seed spread thinly over a granary floor, and turned several times daily until it is dry enough to keep in a bin or in sacks; or the sheaves are built into small round stacks, which stand until the seed is wanted, when it is thrashed out by machinery like grain.

Much has been said and written about the wastefulness of the system of haymaking annually practised in Scotland. To a considerable extent these animadversions are merited,

* *Royal Agricultural Society's Journal*, vol. ix. p. 507.

although those who make them usually overlook the causes which account for, and to some extent palliate, the faults complained of. The facts of the case are simply these. In many parts of England, hay is both an important marketable commodity and the principal winter food of the live stock of the farm. In Scotland it is neither, its place being there more than supplied by the turnip-crop, to which accordingly the farmer devotes his chief attention. Not only so, but from the nature of the climate, these two crops demand instant attention at precisely the same time; the hay needing to be made just when the turnips are urgently in want of thinning. The more important crop of course gets the preference, and the other is comparatively neglected. Add to this that it is but seldom that the Scottish farmer can command extraneous labour to help him in this dilemma, and it will be seen that it is not from mere ignorance or slovenliness that his hay-crop is usually so sadly mismanaged. This lack both of leisure and labour might be somewhat remedied by the use of haymaking machinery; but as it is almost exclusively "seeds" that are mown in Scotland, this resource is scarcely available. Still it might be cheaper to lose some weight of hay by the rough handling of the machinery, than, as at present, by over-ripeness and exposure to the weather. Perhaps, also, some aid may by and by arise, by the application of horse-labour to the preliminary thinning of turnips, and thus enable the hands to be spared for the haymaking. While we think it due to truth to make these statements, we are far from thinking that they justify the present state of matters. It would be better to have no hay at all than to ruin both crop and land, as is often done, by delaying to mow until the crop is little else than ripened seeds and woody fibre, and then to bleach it, and leave it afield in pikes, for weeks or even months before stacking. Such barbarity as this is of frequent occurrence, and is utterly inexcusable. We are but too well aware of the difficulty of doing anything like justice to a hay-crop with a turnip one competing with it for attention; but yet we find it practicable in our own experience so far to adjust their rival claims as to secure good green hay in about *four* years out of *five*.

CHAPTER XII.

CULTIVATED CROPS—CROPS OF LIMITED CULTIVATION.

UNDER this head we shall notice a variety of crops which, however valuable in themselves, and important to the farmers of particular localities, are, from one cause or other, not adapted for general cultivation.

Flax is probably the most important of them. Indeed, from the rapid growth of our linen trade, the growing demand for linseed and its products, and the fitness of the soil and climate for the successful growth of flax, it is not without cause that its more extended cultivation has been so strenuously urged upon our farmers, and that influential societies have been organised for the express purpose of promoting this object. Viewed merely as an agricultural crop, the cultivation of flax is exceedingly simple, and could be practised as readily and extensively as that of the cereal crops. The difficulty is, that before it can be disposed of to any advantage, it must undergo a process of partial manufacture; thus there is required not only an abundant supply of cheap labour, but such an amount of skill and personal superintendence on the part of the farmer, as is incompatible with due attention to corn and cattle husbandry. If a ready and remunerative market were available for the fibre in its simple form of flax straw, this, in combination with the value of the seed for cattle feeding, would at once hold out sufficient motive to our farmers to grow it statedly, and to any required extent. Until this is the case its culture cannot extend in the corn-growing districts of Great Britain. In Ireland, and parts of the Highlands of Scotland, where there is a redundant population much in want of such employment as the flax crop furnishes, and where the climate is suited for its growth, it is highly desirable that its culture should extend, and probable that it will do so. Flax prospers most when grown upon land of firm texture resting upon a moist subsoil. It does well to succeed oats or potatoes, as it requires the soil to be in fresh condition without being too rich. Lands newly broken up from pasture suit it well, as these are generally freer from weeds than those that have been long under tillage. It is usually inexpedient to apply manure directly to the flax crop, as the tendency of this is to produce over-luxuriance, and thereby to mar the quality of the fibre, on which its value chiefly depends. For the same reason it must be thickly seeded, the effect of this being to produce tall slender stems, free from branches. The land having been ploughed in autumn, is prepared for sowing by working it with the grubber, harrow, and roller, until a fine tilth is obtained. On the smooth surface the seed is sown broad-cast by hand or machine, at the rate of three bushels per acre, and covered in the same manner as clover seeds. It is advisable immediately to hand-rake it with common hay-rakes, and thus to remove all stones and clods, and to secure a uniform close cover of plants. When these are about three inches long the crop must be carefully hand-weeded. This is a tedious and expensive process, and hence the importance of sowing the crop on land as free as possible from weeds of all kinds. To obtain flax of the very finest quality the crop must be pulled so soon as the flowers fall, but in the improved modes of steeping, whether by Schenck's or Watt's patent, the value of the fibre is not diminished by allowing the seeds to mature. It must not, however, be allowed to become dead ripe, but should be pulled whenever the seeds appear, on opening the capsule, to be slightly brown coloured. The pulling requires to be managed with much care. It is performed by men or women, who seize a small quantity with both hands and pull it by a slight jerking effort. The important point to be attended to, is to keep the butts even, as successive quantities are seized and twitched from the ground. When a convenient handful has been pulled it is laid on the ground, and the next parallel to it at a foot or so apart. The next handfuls are laid across these, and so on until a small pile is made, after which another is begun. After lying in this position for a few days, the seed-vessels or bolls are separated from the flax by lifting each handful separately, and pulling the top through a ripple or iron comb fixed upon a piece of plank. As many of these handfuls as will make a small sheaf are then laid very evenly together, and bound near both ends with bands formed of a few stems of flax. These sheaves are set up in stooks, and when dry enough to keep without heating, are stacked and thatched until an opportunity occurs of disposing of the flax straw. Sometimes the flax is bound into sheaves and stooked as it is pulled, and treated exactly like a grain crop. In this case the seed is separated from the straw by passing the head of each sheaf betwixt iron rollers. The only objection to this plan is, that the bolls of separate sheaves get so entangled in each other as to render it exceedingly difficult to handle them in carrying the crop, and in building and taking down the stacks, without disarranging the sheaves and wasting much straw and seed.

It would be tedious to enter here into a minute detail of the ordinary method of separating the flax fibre from the woody part of the stem. Suffice it to say that in the ordinary practice the sheaves or beets of flax straw are immersed in a pit or pool filled with clear soft water. The sheaves are kept under water by laying boards upon them loaded with stones to keep them down. Here the flax undergoes a process of fermentation by which the parts are separated. About nine or ten days are usually required for this purpose, but this is much influenced by the temperature. A good deal of skill and close watching is required to know exactly when it has been watered enough. The flax is now taken from the pit and evenly spread upon a smooth, clean, recently-mown meadow, where it lies for about ten days more, receiving several turnings the while. When the *retting*, as it is called, is perfected, the flax is carefully gathered up when perfectly dry, and again tied into sheaves, in which state it is stored under cover until the breaking and scutching can be overtaken.

All this necessarily requires much skilful watching and nice manipulation,—more, as we have already said, than is compatible with the other avocations of an extensive farmer. There are, however, improved modes of accomplishing this preliminary manufacture of flax, which, wherever established, pave the way for the growth of flax as an ordinary field crop. The first of these is known as Schenck's process, which is thus described in a report by "The Royal Society for the Promotion and Improvement of the growth of Flax in Ireland:"—

"The tenements containing the vats and drying shelves are simple wooden sheds of cheap construction. In one end of the building are four vats, set parallel to each other, the length of the house. They are made of inch deal, in the form of a parallelogram, fifty feet long, six broad, and four deep. There are false bottoms, perforated with holes. Underneath these are introduced the steam-pipes, crossing the vats, and having stop-cocks at their entrance, by which the steam can be let on from the main pipe, as required. The steam is generated in a small boiler, which also serves to turn two hydro-extractors,—a patent apparatus used to drive off a portion of the water with which the flax is saturated on being taken from the vats. The flax is packed into the empty vats, on the butt ends, in a half sloping position, precisely as in the case of a steep-pool, only one layer being the depth. The water is then let in, and a frame fastened over the top of the flax, answering the end of stones and straw, or sods, in the steep-pools—the prevention of the rising of the flax in the course of fermentation.

"The steam is then let into the pipes by turning the stop-cocks, and the water is some eighteen or twenty hours in becoming heated to the required point—85° to 90°. The fermentation then commences, and no further steam is required, the action going on until the flax is thoroughly retted, which is in forty hours afterwards, being sixty from the time of the admission of the water. It is worthy of remark, that if the water be heated before the flax is put into the vats, or if the heat be raised above 90°, the process is not in the least hastened, but, on the contrary, the fermentation is rather retarded. The footsteps of nature must be followed, and the heat gradually communicated to the water; otherwise the uniformity of watering, and the preservation of quality and colour, cannot be fully realised. At the end of the sixty hours, the flax is taken out, the water allowed to run off, and the vat permitted to cool. The same process is then repeated, with fresh water and fresh flax. When taken from the water, the flax is packed into the hydro-extractor, which is a round vessel of iron, made to revolve by steam-power with great velocity, the water being driven out of the flax on the principle of centrifugal force. Thirty beets or small handfuls are placed on this machine at a time, and about twenty pounds of water are extracted in three to five minutes. A few hours suffice for the contents of a vat, each vat containing two tons of flax straw. The hydro-extractor only separates a portion of the water; the flax now remains to be thoroughly dried. In summer, or, indeed, for six months in the year, this can be accomplished, as usual, by spreading on grass land in the open air. During winter, however, it is necessary to find other means of drying. A shed has therefore been erected communicating by doors with the vat house, filled with ranges of shelves, composed simply of railings of lathwood, in five or six tiers. The flax is spread lightly along these shelves by women, and the house is heated by steam-pipes. This house is capable of drying the full of one vat *per diem*. The flax, when dried, is made up in small beets or handfuls, of a size suited for feeding into the breaking-rollers of the mill.

"About ten vats per week can be steeped in this establishment—say twenty tons weight of straw, and producing, say two-and-a-half to three tons of fibre. Thus, in one year, such an establishment would be capable of turning out 120 to 150 tons of flax for market, being the produce of 400 to 500 statute acres. The fuel used for the boilers is principally 'shoves,' with a small quantity of turf. Mr. Bernard estimates the cost of steeping, drying, heating, and scutching the flax, at

£10 to £11 per ton, which is £3 per statute acre. Subtracting say 10d. per stone, or 6s. per cwt., for scutching, the cost of steeping and drying would thus appear to be about 24s. per acre—a sum certainly less than the usual estimates of these operations, as commonly performed by farm labour."*

More recently what is believed to be an improvement on this plan has been introduced by Mr. Watt. It is thus described in the Annual Report of the Royal Society for the Promotion and Improvement of the growth of Flax in Ireland :—

"The flax straw is delivered at the works by the grower, in a dry state with the seed on. The seed is separated by metal rollers, and afterwards cleaned by fanners. The straw is then placed in close chambers, with the exception of two doors, which serve the purpose of putting in and discharging the straw; the top, which is of cast-iron, serves the double purpose of a top and condenser. The straw is then laid on a perforated false bottom of iron, and the doors being closed and made tight by means of screws, steam is driven in by a pipe round the chamber and between the bottoms, and penetrating the mass, at first removes certain volatile oils contained in the plant, and then is condensed on the bottom of the iron tank, descending in a continuous shower of condensed water, saturating the straw, and forming, in fact, a decoction of the extractive matters which attach the fibrous and non-fibrous portions of the plant. This liquid is drawn off from time to time, and the more concentrated portions are used for feeding; the process is shortened by using a pump, or such arrangements as will repeatedly wash the mass with the water allowed to accumulate. In about eight to twelve hours, varying with the nature of the straw, it is removed from the chambers, and having been robbed of its extractive matter without decomposition, it is then passed through the rollers for the purpose of removing the epidermis or outer skin of the plant, of discharging the greater part of the water contained in the saturated straw, and while in the wet and swollen state splitting it up longitudinally. The straw being free of all products of decomposition, is then easily dried, and is in a few hours ready for scutching."†

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* Morton's *Cyclopædia of Agriculture*, article "Flax."
† *North British Agriculturist*, 10th November 1852.

The growth of flax has greatly increased in Ireland of late years. In the Irish Agricultural Return for 1852, it is stated that the extent of the flax crop in 1850 was 91,040 acres, which in 1851 had increased to 140,536 acres.

Hemp, although at one time very generally cultivated in Great Britain, is now so rarely met with that it is unnecessary to enter into details of its management.

Section 2.—Hops.

The hop is, however, an important crop in several of the southern counties of England. We glean from Morton's *Cyclopædia*, and from the *Journal of the Royal Agricultural Society*, the following information regarding it. Although an indigenous plant, it was originally brought into England for cultivation from Flanders in 1525. It is cultivated to a considerable extent in Belgium, Bavaria, in the United States of America, and more recently in Australia. The duty now paid on home-grown hops is 17s. 7½d. per cwt.; that on those imported, is £2, 5s. per cwt. Before the alteration of the tariff in 1846 it was £4, 5s., and some years previous to that £8, 8s., which in practice was a prohibitory duty. Hops, as is well known, are chiefly used for preserving and imparting a peculiar flavour to beer. Probably the only parts of the hop flower which enter into the composition of the beer, are the seeds, and the yellow glutinous matter which surrounds the outer integuments of the seed, and lies at the bottom of the petals. This yellow matter (technically termed the *condition* of the hop) has an intensely bitter taste, and emits a peculiar and very agreeable aroma, which, however, is extremely volatile; and hence the necessity for close packing as soon as possible after the hops are dried. When kept over a year, much of this aroma flies off, and hence *new* hops are indispensable in brewing the first kinds of beer. Several varieties of the hop are cultivated in England. Of these the Farnham and Canterbury *whitebines* and *goldings* are esteemed the finest. These are tall varieties, requiring poles of from fourteen to twenty feet. The *grapes,* so called from growing in clusters, and of which there are several varieties of various quality, requires poles from ten to fourteen feet long. *Jones's,* adapted for lighter and inferior land, requires these but eight to ten feet. The *colegates* are a hardy and late ripening variety which grow best on stiff soils; and the *Flemish redbine,* only cultivated from its less liability than the other to be attacked by the aphis or black blight.

The hop is a very exhausting crop for the land, requiring to be planted only on the most fertile soils, and to have them sustained by frequent and large dressings of manure rich in nitrogen. Hops are principally cultivated in the counties of Kent, Sussex, Surrey, Hants, Worcester, and Hereford, and to a more limited extent in Essex, Suffolk and Nottingham. The best quality of hops are grown at Farnham in Kent, upon the outcrop of the upper greensand formation, from whence the phosphoric nodules or coprolites, now so well known in the manure market, are obtained. The greatest extent of land under this crop in any one year during the present century was in 1837, when it amounted to 56,323 acres. Owing to lower prices, and consequent less profitable returns, the extent in 1849 was reduced to 42,798 acres.

In forming a new plantation, the ground soon after Michaelmas is trenched to the depth of eighteen inches, if it has previously been in meadow or old pasture, taking care not to bury the surface-soil above half that depth. Subsoil-ploughing will suffice with land that is in tillage. If the land is wet, drains are made from four to five feet deep, laid with pipes, and a foot of broken stones over them, to prevent the roots of the hops from obstructing the pipes. The frequency of the drain is determined by the necessities of each case. Perfect draining is essential to the success of the crop; and the hops are planted in squares or triangles at equal distances, varying from six to seven feet, according to the fertility of the soil, and the greater or less luxuriant habit of growth of the variety selected. The plants are raised by cutting off the layers or shoots of the preceding year, which are bedded out during the month of March, in ground previously prepared, and in the succeeding autumn become what are called nursery plants or bedded sets. Early in November these are planted; one, two, or three being used for a hill according to the strength of the plants. Care must be taken to introduce a sufficient number of *male* plants, six hills to the acre being deemed sufficient. The presence of these is found to induce earlier maturity, and to improve both the quality and weight of the crops. The ground must at all times be kept free from weeds, and have a good depth of pulverised soil. From the first, a stick six feet high or so, is placed to each hill, to which *all* the young bines, as they shoot out during summer must be tied. A liberal dressing of superphosphate of lime and guano is in June hoed in around each hill, which is repeated in July, under which treatment, two or three cwt. of hops is obtained the first year, besides growing a crop of mangel, turnips, or potatoes, in the intervals betwixt the hills. On newly broken up ground, lime is applied the following spring. When a plantation has been established, the annual routine of culture begins in autumn, as soon as the crop has been gathered, when the haulm is stripped from the poles, and stored away as a substitute for straw. The poles are stacked or piled in quantities of 400 or 500, at regular distances on the ground. During winter they are sorted and repointed when required, and new ones substituted for those that are broken or decayed; this work and the carrying on of manure being accomplished in frosty weather. The ground is dug over by the fork at this season. In March the earth is removed from the plants by a beck or pronged hoe till the crown is exposed, that the plant may be pruned. Immediately after this the poles are set, the length and number of these for each hill depending upon the kind of hops and amount of growth anticipated. They are fixed into holes made for them by a hop-bar. As the season advances, the ground is hoed and again dug or stirred by a nidget or scarifier drawn by a horse. Early in May, the bines or young shoots, as soon as long enough, are, by women, tied to the poles with rushes or bast. This tying is repeated several times as the bines get higher, and has even to be done by step-ladders. In June, the hops are earthed up or *hilled*, at which time weak plants get a dressing of guano. Throughout the summer weeds are destroyed as they appear, and the soil kept loose by the nidget or the hand-hoe. If poles are blown over by high winds, they are constantly replaced.

The picking of the hops usually begins about the second week in September, and furnishes ample employment for several weeks to the entire population of the districts, and to a large influx of strangers; men, women, and children, all engaging in it. In favourable years, a labourer with his wife and several children can earn from £6 to £8 during the hop-picking season. The hop-pickers are arranged into companies, and are supplied with baskets or bins, holding seven or eight bushels each, and which are gauged with black lines inside to save the trouble of measuring. Each company is under the superintendence of a hop-bailiff, who keeps an account of the earnings, etc. Under him are several men called pole-pullers, whose duty it is to supply the pickers with poles of hops, and to assist in carrying the picked hops to the carts. They use an iron lever called a hop-dog in pulling up the poles. The hops are picked, one by one, into the bins, care being taken that no bunches, nor leaves, nor mouldy hops, are included. The price paid for picking ranges from 1½d. to 3d. per bushel, although in blighted seasons it may be as high as 6d. The hops are dried in kilns or oast-houses, on floors of haircloth. Great improvements have been made of late years in the construction of these oasts. Much nice discrimination is required in managing the drying, so as to produce the best quality of hops. As soon as they are removed from the kiln they are packed into pockets, which, during the process, are suspended from a hole in the floor, and the hops trodden into them by a man. This is now done more accurately by machines, in which a piston presses the hops into the pockets. Hop-growing is a hazardous speculative business, the return at times being very great, and at other times not covering expenses. This arises from the liability of the hop to the attacks of insects, but more especially to blight and mould. The blight is caused by innumerable hordes of the *aphis humuli*, which sometimes destroy the plants altogether. The mould is a parasitical fungus. It is believed that a means has at last been discovered of checking the ravages of these assailants, by enveloping each plant separately in a light covering, and subjecting it to the fumes of tobacco in the case of blight, and to a cloud of powdered brimstone in the case of mildew. The charges attendant upon the cultivation of an acre of hop-ground are estimated, including rent, tithes, interest on capital, and duty, at from £50 to £60; and as 10 cwt. is considered an average crop, and £5 per cwt. a frequent price, it is evident that the business is a very precarious one. In blight years it usually happens that some grounds altogether escape, in which case the returns from them are enormous owing to the enhanced price.

Section 3.—*Sugar-Beet.*

During the wars of the French revolution, the high price which colonial sugar obtained on the continent induced the manufacture of sugar in large quantities from beet-root. This has become so large in France that since the restoration of peace the French government have felt compelled to protect the beet-root sugar makers by the imposition of prohibitory duties on colonial sugars.

"Some years since, the manufacture of sugar from beet-root began to be attempted, and not without success, in England. The absence of any excise duties, and an existing considerable import duty on colonial sugars, seemed to offer a kind of premium to the English makers. The government naturally took the alarm; a revenue on imported sugars, which in 1850 yielded about £4,130,000, could not be allowed to be endangered. Parliament therefore interfered; and by the 1st Vict. c. 57 (1837), a duty of 24s. per cwt. was imposed on all sugar made from beet-roots in the United Kingdom. The manufacture was placed under the management of the Commissioners of Excise, and the entire process must now be carried on under the regular survey of their officers. Four hours' notice must be given before any maker can begin to rasp, or grind, or mash any beet-root, for the purpose of sugar-making, and other restrictions are directed. In 1840, by the 3d and 4th Vict. c. 57, the same duty was imposed upon sugar made from potatoes, rice, and other materials, in the United Kingdom. In 1845, however, by the 8th Vict. c. 13, the amount of this duty was reduced to 14s."*

By recent improvements in the manner of conducting the manufacture, it is said that the sugar obtained from beet amounts to 8 per cent of the gross weight of the roots, instead of 5 per cent, as at first. "That this is a question of national importance is beyond all doubt; and to shut our eyes to the undisputed advantages which home-made sugar promises, is to reject a benefit which our continental neighbours have long turned to good account. At the earliest period of this manu-

* *Farmer's Magazine*, vol. i. p. 481.—(June 1852.)

facture in France, great mechanical and chemical difficulties had to be overcome. The English manufacturer goes to his task with all the experience at his command which the continent has acquired. In France, for these reasons, the progress was slow at the commencement, but once having taken root was never given up.

"We subjoin an historical sketch of the gradual progress of this branch of industry in France from 1820 to 1840 :—

Year.	Production of Inland Sugar.	Foreign Sugar entered for Consumption	Total Consumption of Sugar.
	Kilogrammes.	Kilogrammes.	Kilogrammes.
1820	50,000	44,416,795	44,416,795
1821	100,000	41,502,749	41,502,649
1822	300,000	49,328,057	49,328,057
1823	500,000	37,590,270	38,590,270
1824	800,000	56,048,430	56,048,439
1825	1,000,000	48,546,683	49,546,683
1826	1,600,000	64,407,342	65,407,342
1827	2,000,000	50,797,139	52,797,139
1828	2,700,000	61,987,771	64,987,771
1829	4,400,000	62,160,175	66,160,175
1830	5,500,000	54,647,941	60,647,941
1831	7,000,000	67,750,207	74,750,207
1832	9,000,000	62,642,643	71,642,643
1833	12,000,000	57,874,877	69,874,876
1834	20,000,000	65,643,511	85,643,511
1835	30,000,000	64,095,647	94,095,647
1836	40,000,000	56,276,475	96,276,475
1837	45,000,000	64,167,840	109,167,840
1838	50,000,000	63,251,965	113,251,965
1839	55,000,000	62,731,995	117,731,095

"Within the last ten years the augmentation has been less rapid. In 1851 the production was 60,000 tons, or 60,000,000 of kilogrammes, notwithstanding the repeated prophecies that the beet-sugar would not compete with the cheap sugar of Brazil, Java, and Manilla.

"In Germany, the manufacture of sugar is of more recent date than in France. Its progress of late has been,—

"Beet-root Sugar made in the Zollverein.		Foreign Sugar imported.	
1848	26,000 tons.	1848	60,500 tons.
1849	34,000 "	1849	54,000 "
1850	40,000 "	1850	48,000 "
1851	43,000 "	1851	45,000 "

"In the Austrian empire 8000 tons were made in 1848, and in 1851, 15,000 tons. Russia is said to have contributed 25,000 tons in the year 1851.

"It does not at all follow that sugar made in England is to drive our colonial sugar out of the market. There is more foreign sugar imported than we could hope to see replaced in many years. In 1851, it exceeded 45,000 tons, of which but a small portion was re-exported. To this figure we may therefore push our efforts; and most gratifying it is to be able to reflect, that while slave-labour must inevitably grow dearer, every mechanical and scientific improvement can but enhance the powers of the European producers, and ensure their ultimate victory over the slave-owner. Samples have been shewn in the city of beet-sugar from the Rhine, quite equal to 'white Havanna, and refined sugar made from the same that could not be distinguished from West Indian.'"*

It has also been ascertained that excellent beer can be made from the juice of the beet. The refuse from the sugar manufacture is said to be available for feeding cattle and pigs, and as a manure. The excessive prevalence of the vine-mildew from 1852 to 1858 having caused an all but total failure of the wine crop in all the vine-growing countries of Europe, such an advance in the price of brandy occurred as led to the establishment of innumerable distilleries for the production of alcohol from the sugar-beet and from potatoes.

The cultivation of the Silesian white-beet, which is the variety of this plant most in repute for yielding sugar, differs

* *Farmer's Magazine*, vol. i. pp. 558, 559.

in no respect from that of mangel-wurzel, which we have already described.

Section 4.—Chicory for its Roots.

The very extensive and constantly increasing consumption of the roots of chicory as a substitute for coffee, renders it now an agricultural crop of some importance. The soils best adapted for its growth are deep friable loams. The process of cultivation is very similar to that required for the carrot, excepting only that it is not sown earlier than the first week of May, lest the plants should run to seed. When this happens, such plants must be thrown aside when the crop is dug, else the quality of the whole will be injured. About four pounds of seed is the quantity to sow per acre, either broadcast or in rows. The latter is undoubtedly the best mode, as it admits of the land being kept clean, and yields roots of greater weight. The crop is ready for lifting in November. A long stout fork is the best implement for this purpose. In using it, care must be taken to get out the roots entire, not only for the sake of the roots, but to lessen an inconvenience attendant on the culture of this plant, namely, that the fragments left in the soil grow amongst the after crops, and are as troublesome as weeds. The roots, when dry, are carefully washed, cut into thin slices, and kiln-dried, when they are fit for the coffee-grinder. From 1 to 1¼ tons per acre of the dried root is an average produce. A few years ago, from £20 to £30 per ton was a current price for good samples, but like other crops of limited consumption, it has been grown too extensively—the market has been glutted, and the price reduced to £6.

Section 5.—Oil-yielding Plants.

Various plants are occasionally cultivated in Britain for the sake of the oil which is expressed from their ripened seeds. We have already noticed the value of flax-seed for this purpose, although the fibre is the product which is chiefly had in view in cultivating it. The plants most commonly sown expressly as oil-yielding crops are, rape (*Brassica napus*), colsa (*Brassica campestris*), gold of pleasure (*Camelina sativa*), and the poppy (*Papaver somniferum*). Rape is the plant most frequently and extensively grown for the production of oil. The colsa or *B. campestris* is said to yield better crops of seed than the other species. This plant is much cultivated in Flanders for this purpose. In Great Britain it seems rather on the decline. It is chiefly on rich alluvial soils that this crop is grown. For a seed-crop rape is sown in June or July precisely in the manner already described for turnips. The young plants are thinned out to a width of six or eight inches apart, and afterwards kept clean by hoeing. The foliage may be eaten down by sheep early in autumn, without injuring it for the production of a crop of seed. In spring the horse and hand hoe must be used, and the previous application of one or two cwt. of guano will add to the productiveness of the crop. It suits well to lay down land to clover or grass after a crop of rape or turnip seed, and for this purpose the seeds are sown at the time of giving this spring culture. The crop must be reaped as soon as the seeds are observed to acquire a light brown colour. The reaping is managed precisely as we have described in the case of beans. As the crop after being reaped and deposited in separate handfuls on the ground very soon gets dry enough for thrashing, and as the seed is very easily shed after this is the case, this process must be performed as rapidly as possible. Sometimes it is conveyed to the thrashing-mill on harvest carts, on which a cloth is stretched to save the seeds knocked out in the loading and unloading, but more usually the flail is used on temporary thrashing-floors, provided in the field by spreading down large cloths. The crop is gently lifted from the ground and placed heads innermost, on a blanket which two persons grasp by the corners, and carry to the thrashing-floors. A great number of people are required to push this process through rapidly, for unless the crop is quickly handled, a great loss of seed ensues. The seed is immediately spread thinly upon a granary floor, and frequently turned until dry enough to keep in sacks, when it is cleaned and disposed of. On good soil, and in favourable seasons, the yield sometimes reaches to forty bushels per acre. The haulm and husks are either used for litter, or burned, and the ashes spread upon the land. It makes good fuel for clay burning.

Section 6.—*Seeds of Agricultural Crops.*

In the case of seed-corn it is customary for farmers either to select from the best of their own growth, to exchange with or purchase from neighbours, or, if they wish a change from a different county, to employ a commission-agent to buy for them. In all districts there are careful farmers, who, by occupying land that produces grain of good appearance, and being at pains to have good and pure sorts, are stated sellers of seed-corn, and manage in this way to get a few shillings more per quarter for a part of their produce. It is therefore only in the case of new and rare varieties that professional seedsmen ordinarily deal in seed-corn. There are, however, other field crops, such as clovers, grasses, turnip, mangel, carrots, winter vetches, etc., the seeds of which, to a large extent, pass through the hands of seedsmen, and the growing of which is restricted to particular districts, and is in the hands of a limited number of farmers. In general, a good soil and climate, and a considerable amount of skill and minute personal attention on the part of the farmer, are indispensable, in order to produce these seeds of good quality. These seed crops are sometimes very remunerative to the grower; but are hazardous ones for farmers to attempt at their own risk. The only safe course is to grow them at a stipulated price, to the order of some thoroughly respectable seedsman, and to hold to the production of the particular kind or kinds which he requires. This applies, in a less degree, to the clovers, and to the more commonly cultivated grasses, than to the other seeds just referred to. Such an arrangement is beneficial to all concerned. The grower having a fixed price, and certain market, knows exactly what he is doing; the seedsman purchasing only from selected growers, to whom he usually supplies a choice stock of the article to be raised by them, can vouch for the genuineness and freshness of his seeds; and his customers knowing the guarantee against disappointment and loss which this mode of conducting his business affords to them, give him a full price, and find it true economy to do so.

We have already described (chap. xi. sec. 13), the mode of saving the seeds of Italian or common ryegrass; and as other grasses are managed in the same way, it is unnecessary to say more regarding them.

It is only in the southern parts of England that clover is grown for the sake of its seeds. When it is meant to take a crop of seed, the clover is fed off with sheep, or mown early in the season, and then allowed to produce its flowers and ripen its seeds. This preliminary eating or cutting over causes the plants to throw up a greater number of seed-stems, and to yield a fuller and more equally ripening crop. The crop is mown when the seeds are seen to be matured. In the case of white clover the cutting takes place while the dew is upon the crop, as working amongst it when dry would cause a loss of seed. After mowing and turning the crop, the ground is raked with close-toothed iron rakes, to catch up loose heads. The thrashing is a twofold process; first the separation of the heads or cobs from the stem, called "cobbing," and then of the seeds from the husks, called "drawing." This was formerly accomplished by a laborious and tedious process of thrashing with flails, but it is now done by machinery. In favourable seasons, the yield is about five or six bushels (of 70 lb. each) per acre.

Turnip Seed is the next most important crop of this kind. From the strong tendency in the best varieties of turnips and Swedes to degenerate, and the readiness with which they hybridise with each other, or with any member of the family *Brassica*, no small skill and pains are needed to raise seed that can be depended upon to yield roots of the best quality. Turnip seed is saved either from selected and transplanted roots, or from such as have been sown for the express purpose, and allowed to stand as they grow. The first plan, if the selection is made by a competent judge, is undoubtedly that by which seed of the purest quality is obtained. But it is an expensive way, not only from the labour required in carrying it out, but from the yield of seed being generally much less than from plants that have not been disturbed. Professional seed-growers usually resort to a compromise, by which the benefit of both plans is secured, viz., by selecting with great care, and transplanting a limited number of bulbs, and saving the seed obtained from them to raise the plants which are to stand for their main seed crop. The latter are carefully examined when they come into bloom, and all plants destroyed the colour of whose flower varies from the proper shade. Turnips that are to bear seed are purposely sown much later in the season than when intended to produce cattle food, as it is found that bulbs about 1 lb. weight are less liable to be injured by frost, or to rot before the seed is matured, than those of larger size. The management of a turnip-seed crop, both as regards culture and harvesting, is identical with that of rape for its seeds, which has already been described.

Mustard.—Both the white and brown mustard is cultivated to some extent in various parts of England. The former is to be found in every garden as a salad plant; but it has of late been coming into increasing favour as a forage crop for sheep, and as a green manure, for which purpose it is ploughed down when about to come into flower. The brown mustard is grown solely for its seeds, which yield the well-known condiment. When white mustard is cultivated for its herbage, it is sown usually in July or August, after some early crop has been removed. The land being brought into a fine tilth, the seed, at the rate of 12 lb. per acre, is sown broad-cast, and covered in the way recommended for clover seeds. In about six weeks it is ready, either for feeding off by sheep, or for ploughing down, as a preparative for wheat or barley. White mustard is not fastidious in regard to soil. When grown for a seed crop, it is treated in the way about to be described for the other variety. For this purpose either kind requires a fertile soil, as it is an exhausting crop. The seed is sown in April, is once hoed in May, and requires no further culture. As soon as the pods have assumed a brown colour the crop is reaped and laid down in handfuls, which lie until dry enough for thrashing or stacking. In removing it from the ground, it must be handled with great care, and carried to the thrashing-floor or stack on cloths, to avoid the loss of seed. The price depends much on its being saved in dry weather, as the quality suffers much from wet. The yield varies from twenty to thirty bushels per acre, and the price from 10s. to 20s. per bushel. It is chiefly grown on rich alluvial soils in the south-eastern counties of England. This great evil attends its growth, that the seeds which are unavoidably shed in harvesting the crop remain in the soil, and stock it permanently with what proves a pestilent weed amongst future crops.

Canary Seed (*Phalaris canariensis*) is cultivated to some extent in Essex and adjoining counties, for the sake of its grain which is used exclusively for feeding cage-birds. In an agricultural point of view, it is exceedingly similar to our staple corn crops, and in practice is sown instead of wheat or barley. It is drilled in February, at the rate of two gallons per acre, on land that has been ploughed the previous autumn, and stirred by the grubber immediately before sowing. It requires hoeing, to protect it from weeds during the first stages of its growth. It is late in ripening, and requires to be thoroughly dried before being stacked. It is recommended to stack it on frames, to guard it from the attacks of mice, which manifest a peculiar fondness for it. Its yield and weight per bushel are similar to those of wheat. Its price fluctuates exceedingly, but averages from 50s. to 60s. per quarter.

Coriander and Caraway are noticed together, not only because they are used for similar purposes, but because they are frequently grown in mixture. Both are cultivated for the sake of their seeds, which are used by confectioners and for medicinal and other purposes. The coriander being an annual and the caraway a biennial, the former yields a crop the first year, and then leaves the latter in possession of the ground. At one time a third crop, viz., the teazel, was also sown with them, but owing to improvements on the machinery for dressing cloth it has become obsolete. The coriander being also less grown than formerly, the caraway is frequently drilled amongst wheat. After the latter is harvested, the stubble and weeds are cleared away by horse and hand-hoeing. Beans or dwarf pease are also sometimes grown betwixt the rows of caraway during the first and unfruitful year of its growth. The mode of harvesting both of these crops is the same. They are reaped and deposited in handfuls until dry enough for thrashing, and are then carried with great care on cloth-covered sledges to a temporary thrashing-floor, where the seeds are beaten out by flails. About ten cwt. of coriander and five of caraway per acre, is an average yield. The price of the former ranges from 10s. to 20s. per cwt., that of the latter from 35s. to 45s. per cwt. The cultivation of these crops for sale is nearly confined to the county of Essex; but plots of caraway are to be met with in farm and cottage gardens in all parts of Great Britain.

In Essex and Kent no inconsiderable extent of land is annually occupied in growing the seeds of the staple crops of our kitchen and flower gardens. Wholesale seedsmen contract with farmers to grow these seeds for them at a stipulated price.

The growth of fruits and of culinary vegetables is in various parts of Great Britain an important department of farming —for the scale on which it is conducted allies it quite as much to agriculture as to horticulture. We learn from Mr. Cuthill,* that in the counties contiguous to London above 12,000 acres are occupied in growing vegetables, and about 5000 more in producing fruit. About 35,000 people find employment in these market gardens. The system of cultivation pursued in them is admirable. The soil is trenched two spits deep for nearly every crop; it is heavily manured and kept scrupulously clean by incessant hoeing. Whenever a crop is removed, some other suited to the season is instantly put in its place, and not an inch of ground is suffered to be unproductive. A young farmer bent on knowing his business thoroughly, could not well occupy a few months to better purpose than by placing himself under one of these clever market gardeners.

Kent has long been peculiarly celebrated for its orchards. The best of them are on the borders of the greensand formation, or ragstone as it is provincially called. Apples, pears, plums, cherries, and nuts are produced in immense quantities.

* See *Market Gardening round London*, by James Cuthill, Camberwell, 1851.

The filbert plantations alone are said to occupy 5000 acres. An abundant and cheap supply of fruit and vegetables for the inhabitants of our towns is undoubtedly an important object, and is likely to occupy increased attention wherever a suitable soil and exposure with facility of carriage by railway are combined.

CHAPTER XIII.

LIVE STOCK—HORSES.

The breeding and rearing of domesticated animals has ever been a favourite pursuit in Great Britain, and has been carried to greater perfection than any other department of rural affairs. In no other country of similar extent can so many distinct breeds of each class of these animals be found; most of them excellent of their kind, and admirably adapted to the particular use for which they are designed. Observing the usual order, we notice first *Horses.*

Section 1.—*Breeds.*

In doing so we shall confine our attention to those breeds which are cultivated expressly for the labours of the farm; for although the breeding of saddle-horses is chiefly carried on by farmers, and forms in some districts an important part of their business, it does not seem advisable to treat of it here. It is a department of husbandry requiring such a combination of fitness in the soil, climate, and enclosures of the farm, of access to first-class stallions, and of taste and judgment on the part of the farmer, that few indeed of the many who try it are really successful. The *morale* too of the society into which the breeding of this class of horses almost necessarily brings a man, is so unwholesome, that none can mingle in it freely without experiencing to their cost that "that evil communications corrupt good manners." We have noted it as a fact of peculiar significance, in this connection, that of the few men who really make money by this business, scarcely one desires to see it prosecuted by his sons.

The immense size and portly presence of the *English black horse*, entitle him to priority of notice. This breed is widely diffused throughout England, though found chiefly in the Midland Counties. It is in the fens and rich pastures of these counties, that the celebrated dray horses of London are bred and reared. "These ponderous animals are frequently seventeen hands high, and their sleek and glossy appearance as they move majestically through the streets of the metropolis, presents one of the most striking sights to the eye of the foreigner."

These horses are too slow and heavy for ordinary farm-work, and would not be bred but for the high prices obtained for them from the great London brewers, who pride themselves on the great size, majestic bearing, and fine condition of their team horses. It is alleged indeed, that it is only such massive animals that can cope with the heavy loads of coals, timber, and merchandise of all kinds, requiring to be conveyed over jolting pavements from wharves and similar places. But in reality these heavy horses are destroyed by their own weight, few of them being free from ring-bone and other diseases of the feet and pasterns. Smaller but more muscular and energetic horses—especially if yoked singly in carts, instead of by teams in great waggons—would perform more work at less expense, and with less fatigue to themselves. The breeders of these horses employ brood mares and young colts exclusively for their farmwork. The colts are highly fed, and worked very gently until four years old, when they are sold to the London brewers, often at very great prices. The same breed is largely used in England for ordinary farm labour, although not found of such gigantic proportions as in those districts where they are bred for the special destination just referred to. Although very docile, their short step, sluggish gait, large consumption of food, and liability to foot lameness, render them less profitable for ordinary farm-work than the breeds about to be mentioned.

The Suffolk Punch is a well-marked breed which has long been cultivated in the county from which it takes its name. These horses are, for the most part, of a sorrel, bay, or chestnut colour, and are probably of Scandinavian origin. They are compact, as their name imports, hardy, very active, and exceedingly honest pullers. These horses at one time were very coarse in their form, and rather slow; but they have now been so much improved in form and action, that we find them the chief prize-takers at the recent exhibitions of the Royal Agricultural Society.

The Cleveland Bays are properly carriage-horses; but still in their native district they are largely employed for field work. Mr. Milburn says, "The Cleveland, as a pure breed, is loosing something of its distinctiveness. It is running into a proverb, that 'a Cleveland horse is too stiff for a hunter, and too light for a coacher;' but there are still remnants of the breed, though less carefully kept distinctive than may be wished by advocates of purity. Still the contour of the farm-horses of Cleveland has the lightness, and hardiness, and steadiness of the breed in outline; and it is singular that while the lighter soils have horses more calculated for drays, the strong-land farmer has the compact and smaller, but comparatively more powerful animal."

In the north-eastern counties of England, and the adjacent Scottish borders, compact, clean-legged, active horses, of medium size, with a remote dash of blood in them, are generally preferred to those of a heavier and slower kind. One needs only to see how such horses get along at turnip-sowing, or with a heavy load in a one-horse cart, to be convinced of their fitness for the general work of a farm.

The Clydesdale Horses are not excelled by any cart breed in the kingdom for general usefulness. They belong to the larger class of cart-horses, sixteen hands being an average height. Brown and bay are now the prevailing colours. In the district whose name they bear, the breeding of them for sale is extensively prosecuted, and is conducted with much care and success. Liberal premiums are offered by the local agricultural societies for good stallions. Many admirable specimens of this breed of horses were brought forward at the Highland Society meeting at Glasgow in 1850; not the least interesting of which were those which competed for the premiums offered for the best cart-horses statedly employed on the streets of that city attended by their usual drivers and mounted with their usual harness. Horses of this breed are peculiarly distinguished for the free step with which they move along, when exerting their strength in cart or plough. Their merits are now so generally appreciated, that they are getting rapidly diffused over the country. Many small farmers in Clydesdale make a business of raising entire colts, which they either sell for stallions, or send into distant counties to serve for hire in that capacity.

In the Highlands of Scotland, a breed of hardy and very serviceable ponies, or "Garrons," as the natives call them, are found in great numbers. In their native glens they are employed in tillage, and although unable for stated farm-work in the low country, are even there often used in light carts for work requiring despatch rather than great power. Similar ponies abound in Wales.

Section 2.—Breeding of Cart-Horses.

In breeding cart-horses, regard must be had to the purpose for which they are designed. If the farmer contemplates the raising of colts for sale, he must aim at larger frame than if he simply wishes to keep up his own stock of working cattle.

These considerations will so far guide him as to the size of the mares and stallions which he selects to breed from; but vigorous constitutions, perfect freedom from organic disease, symmetrical form, and good temper, are qualities always indispensable. Nothing is more common than to see mares used for breeding, merely because, from lameness or age, they have ceased to be valuable for labour. Lameness from external injury is, of course, no disqualification; but it is mere folly to expect valuable progeny from unsound, misshapen, ill-tempered, or delicate dams, or even from really good ones, when their vigour has declined from age. A farmer may grudge to lose the labour of a first-rate mare for two or three months at his busiest season; but if he cannot make arrangements for doing this, he had better let breeding alone altogether; for it is only by producing horses of the best quality that it can be worth his while to breed them at all. In the case of horses it is always desirable that both sire and dam should have arrived at maturity before being put to breed.

The head of the cart-horse should not be large, at least not heavy in the bones of the face and jaws, nor loaded with flesh. Full development of brain is, indeed, of great importance, and hence a horse somewhat wide betwixt the ears is to be preferred. Prick ears and narrow forehead have by some been reckoned excellences, but we have so invariably noticed such horses to be easily startled, given to shying, and wanting in courage and intelligence, that we regard such a form of head as a defect to be avoided. The eye should be bright, full, and somewhat prominent, the neck inclining to thickness, of medium length, and slightly arched, and the shoulders oblique. Upright shoulders have been commended as an advantage in a horse for draught, it being alleged that such a form enables him to throw his weight better into his collar. It should be remembered, however, that the horses which display the greatest power in drawing heavy loads, are characterised by muscular vigour and nervous energy, rather than mere weight of carcase; and these qualities are more usually found in connection with the oblique shoulder than the upright one—not to mention that this form is indispensable to that free and full step so necessary in a really useful farm-horse.

"The back should be straight and broad, the ribs well arched, and the false ribs of due length, so as to give the abdomen capacity and roundness. The tail should be well set out, not too drooping, and the quarters should be full and muscular. The horse should girth well, and have his height in his body rather than in his legs, so as to look less than measurement proves him to be. The forelegs should be strong, and flat below the knee, and by no means round and gummy either before or behind, neither should they have white hair about them, nor much hair of any colour. The hocks should be broad in front, and neither too straight nor too crooked, nor yet cat-hammed. All diseases of this joint, whether curbs, spavins, or thoroughpins, are sufficient grounds for rejecting a horse. The feet are a matter of very much importance. The tendency of many heavy horses is to have thin horn and flat feet. A stallion possessing such feet is exceedingly objectionable. Plenty of horn is a recommendation, and the feet had better be too large than too small. The brood mare should possess as many of the points now enumerated as possible. If the mare is small, but symmetrical, we may very properly select a large stallion, provided he has good action. If, on the other hand, the mare is large, and has a tendency to coarseness, we should select a middle-sized horse of symmetrical appearance."*

Sixteen hands is a good height for a farm-horse. Except for very heavy land, we have always had more satisfaction from horses slightly below this standard than above it.

We have repeatedly put a well-bred saddle mare to a cart-horse, and have invariably found the produce to prove excellent farm-horses. The opposite cross, betwixt a cart-mare and blood stallion, is nearly as certain to prove ungainly, vicious, and worthless. These horses are generally

* Morton's *Cyclopædia of Agriculture*—article "Horse."

much stronger than their appearance indicates, have great powers of endurance, and can be kept in prime working condition at much less cost than bulkier animals. We have often noticed that village carters, who perform cartage for hire, invariably purchase small horses, and yet carry loads with them which farmers would consider too much for their best cattle. It is on muscular power, and nervous energy, that the strength of animals depends, and this, therefore, should be sought after in the farm-horse, rather than mere bulk.

Cart-mares should not foal earlier than May. So that they are not unduly pushed nor put to draw heavy loads, they may be kept at work almost up to their time of foaling, and are thus available for the pressing labours of spring. It is of importance, too, that the pasture should be fresh, and the weather mild, ere their nursing duties begin. Mares seldom require assistance in bringing forth their young, and, although it is well to keep an eye upon them when this event is expected, they should be kept as quiet as possible, as they are impatient of intrusion, and easily disturbed in such circumstances. The new-born foal not unfrequently has some difficulty in getting suck, and also in voiding the first fæces. Both these matters must be attended to, and assistance given if necessary. If it is observed to strain without voiding the tough excrement which is in its bowels at birth, greasing the passage, by pushing in a tallow candle, will usually afford it instant relief. A sheltered paddock with good grass, and where there are no other horses, is the most suitable quarters for a mare that has newly foaled. There must be no ditch or pond in it, as young foals have a peculiar fatality for getting drowned in such places. A mare, in ordinary condition, receives the stallion on the ninth or tenth day after foaling, and with a greater certainty of conceiving than when it is delayed until she is again in heat. If the mare's labour can at all be dispensed with, it is desirable to have her with her foal for two months at least. She may then be put to easy work with perfect safety, so that she is not kept away from the foal longer than two or three hours at a time. When the foal has got strong enough, it may even be allowed to follow its dam at her work, and to get suck as often as it desires it. Towards the end of September, foals are usually weaned, and are then put under cover at night, and receive a little corn, along with succulent food. If the dam has been put to work before weaning, she will have been allowed a feed of oats, in which case the foal will already have got a liking for this food by tasting a little along with her. This is a great advantage, as when put on its own resources, it takes at once to the generous fare which it ought always to be allowed at this stage. Good hay, bran, carrots, or Swedes, and a few oats, must be given regularly during the first winter, with a warm shed to lie in, and an open court for exercise. At weaning it is highly expedient to put a cavasin on colts, and lead them about for a few times. A few lessons at this early age, when they are easily controlled, saves a world of trouble afterwards. Before being turned to grass in spring, they should, on the same principle, be tied up in stalls for a week or so. It is customary to castrate colts at a year old. Some, indeed, advise its being done a few weeks after birth, when, of course, the pain to the animal, and risk of death, are less. It must, however, be borne in mind that this early emasculation will probably ensure a skranky neck, whereas a natural tendency to this defect can in good measure be remedied by deferring the operation. We have seen a puny colt much improved in figure by being left entire until he was two years old. By giving good pasture in summer, and a liberal allowance of hay, roots, and oats in winter, colts may, with safety, and even benefit, be put to moderate work in their third spring. Some time before this is done, they should be put through a short course of training, to use them to the bit, and make them quiet and handy. Many good cart-horses are ruined for want of a little timeous attention in this way. When they have got familiar with the harness, they should be yoked to a log of wood, and made to draw that up and down the furrows of a fallow field, until they become accustomed to the restraint and exertion, after which they may with safety be put to plough alongside a steady and good-tempered horse, and what is of equal consequence, under the charge of a steady good-tempered ploughman. As they should not have more than five hours' work a day for the first summer, it is always an advantage to have a pair of them to yoke at the same time, in which case they take half-day about, and do a full horse's work betwixt them. With such moderate work and generous feeding their growth will be promoted. By midsummer, the thrông of field labour being over, it is advisable to turn the striplings adrift, and let them enjoy themselves in a good pasture until after harvest, when they can again be put to plough. Horses should not be required to draw heavy loaded carts until they are five years old. When put into the shafts earlier than this they frequently get strained and stiffened in their joints. On every farm requiring four or five pairs of horses, it is highly expedient to have a pair of young ones coming in annually. This enables the farmer to be provided against contingences, and to have his stable occupied at all times with horses in their full vigour, which go through their work with spirit, and never falter for a little extra pushing in emergencies.

Section 3.—*Feeding and General Management of Farm-Horses.*

As there is true economy in employing only the best quality of horses, and these in their prime, so also is there in feeding them uniformly well, and looking to their comfort in all respects. The following quotation from the report of a discussion on the feeding of farm-horses, at a monthly meeting of the Highland and Agricultural Society of Scotland, published in the *Transactions* for October 1850, describes the practice of some of our most experienced farmers in this particular.

"The system of feeding I adopt is as follows:—From the middle of October till the end of May, my horses get one feed of steamed food, and two feeds of oats daily, with the best oat or wheat straw for fodder. I never give bean straw, unless it has been secured in fine condition, having often seen the bad effects of it, partly owing, I think, to its long exposure to the weather. In our variable climate, and from the quantity of sand which adheres to it, I use it generally for litter. The steamed food used is well washed Swedish turnips and potatoes in equal proportions, mixed with sifted wheat-chaff. In those years when we had a total loss of potatoes, Swedish turnip alone was used, but not with the same good effects as when mixed with potatoes. This year having plenty of diseased potatoes in a firm state, I give a larger proportion of potatoes than turnip, and never upon any occasion give oat husks, commonly called meal-seeds, having often seen their injurious effects. At five o'clock in the morning each horse gets 6 lb. weight of bruised oats, at noon the same quantity of oats, and at half-past seven P.M., 47 lb. weight of steamed food. I find that it takes 62 lb. weight of unsteamed potatoes and turnip to produce 47 lb. steamed; to each feed of steamed food, 4 oz. of common salt are added, and mixed up with one-fourth part of a bushel of wheat-chaff, weighing about 1½ lb., a greater quantity of wheat-chaff than this having generally too laxative an effect. Each horse eats from 14 lb. to 18 lb. of fodder during the twenty-four hours, besides what is required for litter. In spring I sometimes give a mixture of bruised beans and oats, instead of oats alone; from June to the middle of October, those horses that are required for the working of the green crop, driving manure, and harvest-work, are fed with cut grass and tares in the house; and about 7 lb. of oats each day, given at twice, increasing or decreasing the quantity according to the work they have to do; and I turn out to pasture only those horses that are not required until the busy season. I disapprove of horses that are regularly worked being turned out to grass, and exposed to all the changes of our variable climate, as I believe it to be the origin of many diseases. The expense of this mode of feeding, at present prices in this district, for each horse per annum, is as follows:—

12 lb. of oats per day, for 30 weeks, is $7\frac{1}{2}$ qrs. of 42 lb. per bushel.
7 lb. of do. do. 22 do. $3\frac{1}{8}$ do. do.

	£	s.	d.
$10\frac{5}{8}$ qrs. at 17s.	£9	0	7
145 stones straw consumed, at 4d. per stone of 22 lb.	2	8	4
Each horse consumes 5 tons 16 cwt. of turnips and potatoes in 30 weeks.			
58 cwt. potatoes, at 1s. 6d.	4	7	0
58 cwt. turnips, at 9d.	2	3	6
53 lb. salt, 1s. 8d., 52 bushels wheat-chaff, 4s. 4d. .	0	6	0
22 weeks on cut grass and tares, at 9d. per day . .	5	15	6
	£24	0	11

For the thirty weeks, the keep of each horse per day is 7d. for oats, $7\frac{1}{2}$d. for steamed food, and $2\frac{1}{2}$d. for fodder, or 1s. 5d. per day; for the twenty-two weeks, the keep is, grass 9d., oats 4d., or 1s. 1d. per day. The expense of preparing the steamed food, including coals, is 1s. 2d. per day for each horse. 260 stones of straw will be required for litter for each horse during the year; for this no charge is made, as it is left in manure. By this mode of feeding, the horses are always in fine sleek condition, and able for their work. I have acted upon this system for the last fifteen years; have always had from sixteen to twenty horses, and during that period I have only lost seven horses, three of them from accidental causes; and I attribute this, in a great measure, to the mode of feeding, and in particular, to the steamed food."

The general treatment of horses in Berwickshire differs somewhat from that now detailed. They are usually turned to pasture so soon as the mildness of the weather and the forwardness of the pasture admit of it. While employed in carrying the crop, their fodder consists largely of tares, from whence until Martinmas they are fed on hay. From this date until 1st March, oat and bean straw, with 8 or 10 lbs. of raw Swedes per horse per diem, is substituted, when, with the recurrence of harder labour, hay is again given until the return of the grazing season. During three-fourths of the year, they receive about 16 lb. of oats per diem, in three separate feeds. From the close of turnip-sowing until harvest oats are either withheld or given only when a harder day's work occurs. The practice of bruising the whole of the oats given to horses, and also of chopping their hay, is now very prevalent. By giving a few pounds of chopped hay with each feed of bruised oats, and oat-straw in the racks, during the whole of the winter half-year, horses are kept in better condition, and at no more expense, than by giving them straw alone for half the period, and hay alone the other half. We are persuaded, also, that unless horses are stripped of their shoes and turned adrift altogether for a summer's run, soiling in boxes, or sheds, with an open yard is preferable to grazing. Hay and oats ought undoubtedly to constitute the staple fare of farm-horses. Without a liberal allowance of suitable and nourishing food, it is impossible that they can perform the full amount of work of which they are capable, or be sustained for any length of time in robust health. When *alleged* very cheap plans of feeding horses are inquired into, it is usually found that the amount and quality of the work performed by them is in fitting proportion. In this, as in so many other things, cheapness and economy are not convertible terms. The true way to economise the horse-labour of a farm is to have only good and well-fed cattle, and to get the greatest possible amount of work out of them.

CHAPTER XIV.

LIVE STOCK—CATTLE.

Section 1.—*Breeds*—1*st, Heavy Breeds.*

As our limits do not admit of even a brief notice of all those breeds of cattle for which Great Britain is so famous, we shall restrict our remarks to some of the most important of them. Without entering upon curious speculations as to the origin of these breeds we proceed to notice them in that order which is suggested by their relative importance in practical agriculture. The large lowland cattle thus claim our first attention, and amongst them we cannot hesitate in assigning the first place to the

Short-horns.—It appears that from an early date the valley of the Tees possessed a breed of cattle which, in appearance and general qualities, were probably not unlike those *quasi* short-horns which abound in various parts of the country at the present day. By the time that the Messrs. Colling came upon the field, it is evident that there were many herds around them in which considerable improvement had already been effected, and that they commenced their memorable efforts in cattle-breeding with exceedingly hopeful materials to work upon. But in their masterly hands these materials seemed at once to acquire an unwonted plasticity; for in an incredibly short time their cattle exhibited, in a degree that has not yet been excelled, that combination of rapid and large growth with aptness to fatten, of which their symmetry, good temper, mellow handling, and gay colours, are such pleasing indices, and accompaniments, and for which they have now acquired a world-wide celebrity. It was by judicious selection in the first instance, and then by coupling animals of near affinity in blood, that they so developed and stereotyped these qualities in their cattle, as to entitle them at once to take rank as the progenitors of a new and well-marked breed. These *Durham*, *Teeswater*, or *Short-horn* cattle, as they were variously called, were soon eagerly sought after, and spread over the whole country with amazing rapidity. For a time their merits were disputed by the eager advocates of other and older breeds, some of which (such as the long-horns, once the most numerous breed in the kingdom) they have utterly supplanted, while others, such as the Herefords, Devons, and Scotch polled cattle, have each their zealous admirers, who still maintain their superiority to the younger race. But this controversy is meanwhile getting practically decided in favour of the short-horns, which constantly encroach upon their rivals even in their headquarters, and seldom lose ground which they once gain. Paradoxical as the statement appears, it is yet true that the very excellence of the short-horns has in many cases led to their discredit. For many persons desiring to possess these valuable cattle, and yet grudging the cost of pure-bred bulls, or being ignorant of the principles of breeding, have used worthless cross-bred males, and so have filled the country with an inferior race of cattle, bearing, indeed, a general resemblance in colour, and partaking in some measure of the good qualities of short-horns, but utterly wanting in their peculiar excellences. By ignorant or prejudiced persons the genuine race is nevertheless held answerable for the defects of the mongrels which usurp their name, and for the damaging comparisons which are made betwixt them, and choice specimens of other breeds. That the short-horn breed should spread as it does, in spite of this hinderance, is no small proof of its inherent excellence, and warrants the inference that whenever justice is done to it, it will take its place as the one appropriate breed of the fertile and sheltered parts of Great Britain. This desirable consummation has hitherto been retarded by the scarcity and high price of pure-bred bulls. We are quite aware that bull-breeding, as hitherto conducted, is a hazardous and unremunerative business, notwithstanding the great prices sometimes obtained for first-class animals. We are of opinion, however, that it might be conducted in such a way as to be safer and more profitable to the breeder, and more beneficial to the country at large than it has hitherto been. There is at present a large and growing demand for good yearling short-horn bulls, at prices ranging from £20 to £30. With a better supply both as to quality and numbers, this demand would steadily increase, for we have long observed that there is no want of customers for really good animals at such prices as we have named. When higher prices than these are demanded, farmers who breed only for the production of beef feel that they are beyond their reach, and are fain to content themselves with lower-priced and inferior animals. What we desire is, to see this business taken up by parties who, avoiding all needless expense, diminishing the risk of abortion and barrenness in their cows by never overfeeding them, and bestowing more pains to have their cows good milkers, would look for their profit from the sale of large numbers at moderate prices, rather than of few at exorbitant ones. The portraits of short-horn cattle given in this treatise afford a good illustration of the prominent features of the breed.

As already hinted, the *Hereford* is the breed which, in England, contests most closely with the short horns for the palm of excellence. They are admirable grazier's cattle, and when of mature age and fully fattened, present exceedingly level, compact, and massive carcases of excellent beef. But the cows are poor milkers, and the oxen require to be at least two years old before being put up to fatten, defects which, in our view, are fatal to the claims which are put forward on their behalf. To the grazier who purchases them when their growth is somewhat matured they usually yield a good profit, and will generally excel short-horns of the same age. But the distinguishing characteristic of the latter is that, when properly treated, they get sufficiently fat, and attain to remunerative weights at, or even under, two years old. If they are kept lean until they have reached that age their peculiar excellence is lost. From the largeness of their frame they then cost more money, consume more food, and yet do not fatten more rapidly than bullocks of slower growing and more compactly formed breeds. It is thus that the grazier frequently gives his verdict in favour of Herefords as compared with short-horns. Even under this mode of management short-horns will usually yield at least as good a return as their rivals *to the breeder and grazier conjointly.* But if fully fed from their birth so as to bring into play their peculiar property of growing and fattening simultaneously, we feel warranted in saying that they will yield a quicker and better return for the food consumed by them than cattle of any other breed. Unless, therefore, similar qualities are developed in the Herefords, we may expect to see them more and more giving place to the short-horns. These remarks apply equally to another breed closely allied to the Herefords, viz., the

North Devons, so much admired for their pleasing colour, elegant form, sprightly gait, and gentle temper, qualities which fit them beyond all other cattle for the labour of the field, in which they are still partially employed in various parts of England. If it could be proved that ox-power is really more economical than horse-power for any stated part of the work of the farm, then the Devons, which form such admirable draught oxen, would be deserving of general cultivation. We see, however, that duly as agriculture reaches a certain stage of progress, ox labour has been found inadequate to the more rapid and varied operations that are called for, and has been superseded by that of horses. But supposing the ox-team to be everywhere laid aside, is this beautiful breed of cattle not worthy of being cherished for the purposes of the dairy-man or the grazier? Now, although the milk of the Devon cows is very rich, it is too scanty, and they go too soon dry to admit of their being selected for strictly dairy purposes, or by the breeder who desires to rear several calves by the milk of each cow; and although the oxen of this breed, *when their growth is matured*, can be fattened more quickly and on less food than short-horns of the same age, they do not yield so good a return as the latter for the whole food consumed by them respectively from birth to maturity. We consequently infer that they will, like other cherished breeds, either be superseded by the short-horns or amalgamated with them.

Until a comparatively recent period the *Long-horns* were the prevailing breed of our midland counties, as they still are of many parts of Ireland. Bakewell applied himself with his characteristic skill and success to the improvement of this breed; but at best they were so decidedly inferior to short-horns that they have now everywhere given place to them. Even in Lancashire, where they lingered longest, they have, within these few past years, nearly disappeared.

Scotland possesses several indigenous breeds of heavy cattle, which, for the most part, are black and hornless, such as those of Aberdeen, Angus, and Galloway. These are all valuable breeds, being characterised by good milking and grazing qualities, and by a hardiness which peculiarly adapts them for a bleak climate. Cattle of these breeds, when they have attained to three years old, fatten very rapidly, attain to great size and weight of carcase, and yield beef which is not surpassed in quality by that of any cattle in the kingdom.

The cows of these breeds, when coupled with a short-horn bull, produce an admirable cross-breed, which combines largely the good qualities of both parents. The great saving of time and food which is effected by the earlier maturity of the cross-breed has induced a very extensive adoption of this practice in all the north-eastern counties of Scotland. Such a system is necessarily inimical to the improvement of the pure native breeds: but when cows of the cross-breed are continuously coupled with pure short-horn bulls, the progeny in a few generations become assimilated to the male parent, and are characterised by a peculiar vigour of constitution, and excellent milking power in the cows. With such native breeds to work upon, and this aptitude to blend thoroughly with the short-horn breed, it is much more profitable to introduce the latter in this gradual way of continuous crossing than at once to substitute the one pure breed for the other. The cost of the former plan is much less, as there needs but the purchase from time to time of a good bull; and the risk is incomparably less, as the stock is acclimated from the first, and there is no danger from a wrong selection. The greatest risk of miscarriage in this mode of changing the breed is from the temptation to which the breeder is exposed, on a false view of economy, of rearing a cross-bred bull himself, or purchasing a merely nominal short-horn bull from others.

From this hurried review of our heavy breeds of cattle it will be seen that we regard the short horn as incomparably the best of them all, and that we anticipate its ultimate recognition as the breed which most fully meets the requirements of all those parts of the country where grain and green crops are successfully cultivated.

2d.—Dairy Breeds.

The *dairy breeds* of cattle next claim our attention, for although cattle of all breeds are used for this purpose, there are several which are cultivated chiefly, if not exclusively, because of their fitness for it. Dairy husbandry is prosecuted under two very different and well-defined classes of circumstances. In or near towns, and in populous mining and manufacturing districts, it is carried on for the purpose of supplying families with new milk. In the western half of Great Britain, and in many upland districts, where the soil and climate are more favourable to the production of grass and other green crops than of corn, butter and cheese constitute the staple products of the husbandman. The town dairyman looks to quantity rather than quality of milk, and seeks for cows which are large milkers, which are long in going dry, and which can be readily fattened when their daily yield of milk falls below the remunerative measure. Large cows, such as short-horns and their crosses, are accordingly his favourites. In the rural dairy, again, the merits of a cow are estimated by the weight and quality of the cheese or butter which she yields, rather than by the mere quantity of her milk. The breeds that are cultivated expressly for this purpose are accordingly characterised by a less fleshy and robust build than is requisite in grazier's cattle. Of these we select for special notice the Ayrshire, the Suffolk-dun, and the Jersey breeds.

The Ayrshires, by common consent, now occupy the very first rank as profitable dairy cattle. From the pains which have been taken to develope their milk-yielding power it is now of the highest order. Persons who have been conversant only with grazing cattle cannot but be surprised at the strange contrast betwixt an Ayrshire cow in full milk, and the forms of cattle which they have been used to regard as most perfect. Her wide pelvis, deep flank, and enormous udder, with its small wide-set teats, seem out of all proportion to her fine bone and slender forequarters. As might be expected, the breed possesses little merit for grazing purposes.

Very useful animals are however obtained by crossing these cows with a short-horn bull, and this practice is now rather extensively pursued in the west of Scotland by farmers who combine dairy husbandry with the fattening of cattle. The function of the Ayrshire cattle is however the dairy. For this they are unsurpassed, either as respects the amount of produce yielded by them in proportion to the food which they consume, or the faculty which they possess of converting the herbage of poor exposed soils, such as abound in their native district, into butter and cheese of the best quality.

The county of Suffolk has for centuries been celebrated for its dairy produce, which is chiefly obtained from a polled breed of cattle, the prevailing colour of which is dun or pale red, from which they are known as the *Suffolk Duns.* They have a strong general resemblance to the Scotch polled cattle, but nevertheless seem to be indigenous to Suffolk. They are ungainly in their form, and of little repute with the grazier, but possess an undoubted capacity of yielding a large quantity of milk in proportion to the food which they consume. They are now encroached upon, and will probably give place to the short-horns, by which they are decidedly excelled for the combined purposes of the dairy and the fattening stall.

The breeds already referred to are those to which professional dairymen give the preference, but the cattle of the Channel Islands, of which the *Jersey* may be regarded as the type, are so remarkable for the choice quality of the cream and butter obtained from their rather scanty yield of milk, that they are eagerly sought after for private dairies, in which quality of produce is more regarded than quantity. The rearing of heifers for the English market is of such importance to these islands, that very stringent regulations have been adopted for insuring the purity of their peculiar breed. These cattle in general are exceedingly ungainly in their form, and utterly worthless for the purposes of the grazier. The choicer specimens of the Jerseys have a certain deer-like form which gives them a pleasing aspect. The race, as a whole, bears a striking resemblance to the Ayrshires, which are alleged to owe their peculiar excellences to an early admixture of Jersey blood.

3d.—*Mountain Breeds.*

The mountainous parts of Great Britain are not less favoured than the lowlands in possessing breeds of cattle peculiarly adapted to the exigencies of the climate.

The *Kyloes* or *West Highland cattle* are the most prominent of this group. They are widely diffused over the Highlands of Scotland, but are found in the greatest perfection in the larger Hebrides. Well-bred oxen of this breed, when of mature growth, and in good condition, exhibit a symmetry of form and noble bearing which is unequalled by any cattle in the kingdom. Although somewhat slow in arriving at maturity, they are contented with the coarsest fare, and ultimately get fat, where the daintier short-horns could barely exist. Their hardy constitution, thick mellow hide, and shaggy coat, peculiarly adapt them for a cold humid climate and coarse pasturage. Fewer of these cattle are now reared in the Highlands than formerly, owing to the lessened number of cottars and small tenants, and the extension of sheep husbandry. Large herds of cows are however kept on such portions of farms as are unsuited for sheep walk. The milk of these cows is very rich, but as they yield it in small quantity, and go soon dry, they are unsuited for the dairy, and are kept almost solely for the purpose of suckling each her own calf. The calves are generally housed during their first winter, but after that they shift for themselves out of poors all the year round. Vast droves of these cattle are annually transferred to the lowlands, where they are in request for their serviceableness in consuming profitably the produce of coarse pastures and the leavings of daintier stock. Those of a dun or tawny colour are often selected for grazing in the parks of the aristocracy, where they look quite as picturesque as the deer with which they are associated. Indeed, they strikingly resemble the so-called wild cattle that are carefully preserved in the parks of several of our nobility, and like them are probably the descendants of the cattle of the ancient Britons. This view is confirmed by the strong family likeness borne to them by the

Welsh cattle, which is quite what might be expected from the many features, physical and historical, which the two provinces have in common. Although the cattle of Wales, as a whole, are obviously of common origin, they are yet ranged into several groups, which owe their distinctive features either to peculiarities of soil and climate, or to intermixture with other breeds. The *Pembrokes* may be taken as the type of the mountain groups. These are hardy cattle, which thrive on scanty pasturage and in a humid climate. They excel the west highlanders in this respect, that they make good dairy cattle, the cows being peculiarly adapted for cottagers' purposes. When fattened they yield beef of excellent quality. Their prevailing and most esteemed colour is black, with deep orange on the naked parts. The *Anglesea* cattle are larger and coarser than the Pembrokes, and those of *Merioneth* and the higher districts are smaller, and inferior to them in every respect. The county of *Glamorgan* possesses a peculiar breed, bearing its name, which has long been in estimation for combined grazing and dairy purposes. It has latterly been so much encroached upon by Herefords and short-horns that there seems some likelihood of its becoming extinct, which will be cause for regret, unless pains are taken to occupy their place with cattle not inferior to them in dairy qualities.

We conclude this rapid review of our native breeds by noticing the most singular of them all, viz.,

The *Shetland cattle*, which are the most diminutive in the world. The carcase of a Shetland cow when fully fattened scarcely exceeds in weight that of a long-wooled wedder. These little creatures are however excellent milkers in proportion to their size, they are very hardy, are contented with the scantiest pasturage, they come early to maturity, are easily fattened, and their beef surpasses that of all other breeds for tenderness and delicacy of flavour. These miniature cows are not unfrequently coupled with short-horn bulls, and the progeny from such apparently preposterous unions not only possess admirable fattening qualities, but approximate in bulk to their gigantic sires. These curious and handsome little creatures, apparently of Scandinavian origin, are so peculiarly fitted to the circumstances of their bleak and stormy habitat, that the utmost pains ought to be taken to preserve the breed in purity, and to improve it by judicious treatment.

We cannot leave this part of our subject without reminding the reader of the singular richness of our country in cattle, not merely as regards numbers, but variety of breeds, endowed collectively with qualities which adapt one or other of them to every diversity in its soil and climate. So great is this diversity, and so complete that adaption, that the requirements of each district are met, and the country as a whole enriched with every benefit that the domestic ox is capable of rendering to mankind.

Section 2.—*Farm management of Cattle.*

We shall now endeavour to describe the farm management of this valuable animal, under the several heads of *breeding*, *rearing*, *fattening*, and *dairy management*. The proceedings of those engaged in the breeding and rearing of cattle for the production of beef, are, however, largely determined by the character of the soil and climate of particular districts and farms. The occupiers of all comparatively fertile soils carry forward to maturity such animals as they breed, and dispose of them directly to the butcher. Those who are less fortunately circumstanced in this respect, advance their young cattle to such a stage as the capabilities of their farms admit of, and then transfer them to others by whom the fattening process is conducted. The ultimate object of both these parties being essentially the same, their practice, as far as it goes, ought undoubtedly to be also similar. In practice, this, we regret to say, is very far from being the case. The principles upon which this branch of husbandry should be conducted are, indeed, little affected by diversity of situation. This may and ought to determine the particular breed of cattle to be selected, but it is everywhere alike important to have a breeding stock of the best quality, to keep their produce uniformly in good condition, and to dispose of them whenever they cease to improve on such food as the farm affords. It cannot be too strongly impressed upon those who engage in this business, that it never can be profitable to breed inferior cattle; or (however good their quality) to suffer their growth to be arrested by cold or hunger; or to sell them in a lean state. In selecting a breeding stock of cattle, the qualities to be aimed at are, a sound constitution and a symmetrical form, aptitude to fatten, quiet temper, and large milk-yielding power in the cows. As all these qualities are hereditary, cattle are valuable for breeding purposes not merely in proportion as they are developed in the individuals, but according to the measure in which they are known to have been possessed by their progenitors. A really good pedigree adds therefore greatly to the value of breeding-stock. It is doubtless important to have both parents good; but in the case of ruminants, the predominating influence of the male in determining the qualities of the progeny is so well ascertained, that the selection of the bull is a matter of prime importance. We are able to state, from ample personal experience, that by using a bull that is at once good himself, and of good descent, a level and valuable lot of calves can be obtained from very indifferent cows. In Berwickshire it is the practice to employ chiefly married labourers, who reside upon the farm, and one part of whose wages is the keep of a cow. These labourers usually give the preference to small cows, and—so that they are healthy, and yield milk plentifully—care little about their breed or other qualities. A good judge of grazier's cattle could not easily imagine a more unpromising breeding-stock than is furnished by these cottager's cows; and yet when they are coupled with a really good short-horn bull, it is truly surprising to see what admirable cattle are obtained from them. It is indeed miserable economy to grudge the price of a good bull. Coarse, mis-shapen, unthrifty cattle cost just as much for rearing and fattening as those of the best quality, and yet may not be worth so much by £3 or £4 a-head, when they come ultimately to market. The loss which is annually sustained from breeding inferior cattle is far greater than those concerned seem to be aware of. It is impossible to estimate this loss accurately, but from careful observation and inquiry, we feel confident that it amounts to not less than 50s. a-head on one-half of the fat cattle annually slaughtered in Great Britain. If this be so, it follows that without expending a farthing more than is done at present on food, housing, and attendance, the profit which would accrue from using only the best class of bulls would be equivalent to an advance of 1s. per stone in the price of beef as regards half of the fat bullocks brought to market. This profit could moreover be secured by a very moderate outlay; for if properly gone about, the best class of bulls might be employed without adding more than 3s. or 4s. a-head to the price of each calf reared. We may surely anticipate that such a palpable source of profit will not continue to be neglected by the breeders of cattle. There are many instances in which landlords would find it much for their interest to aid their tenantry in at once procuring really good bulls. Cattle-shows and prizes are useful in their way as a means of improving the cattle of a district, but the introduction of an adequate number of bulls from herds already highly improved is the way to accomplish the desired end cheaply, certainly, and speedily. We must here protest against a practice by which short-horn bulls are very often prematurely unfitted for breeding. Their tendency to obesity is so remarkable that unless they are kept on short commons they become unwieldy and unserviceable by their third or fourth year. Instead, however, of counteracting this tendency, the best animals are usually "made up," as it is called, for exhibition at cattle-shows, or for ostentatious display to visitors at home, and the consequence is that they are ruined for breeding purposes. We rejoice to see that the directors of our national agricultural societies are resolutely setting their faces against this pernicious practice. It is needful certainly that all young animals, although intended for breeding stock, should be well fed, for without this they cannot attain to their full size and development of form. But when this is secured, care should be taken in the case of all *breeding* animals never to exceed that degree of flesh which is indispensable to perfect health and vigour. The frequent occurrence of abortion or barrenness in high-pedigreed herds seems chiefly attributable to overfeeding. The farmer who engages in cattle-breeding with the view of turning out a profitable lot of fat beasts annually, will take pains first of all to provide a useful lot of cows, such as will produce good calves, and if well fed while *giving milk* will yield enough of it to keep two or three calves a-piece. That he may be able to obtain a sufficient supply of good calves, he will keep a really good bull, and allow the cottagers residing on the farm or in its neighbourhood to send their cows to him free of charge, stipulating only that when they have a calf for sale he shall have the first offer of it. When cows are kept solely for the purpose of rearing calves, it becomes a matter of prime importance to have an adequate and seasonable supply of calves from some source that can be relied upon both as regards their quality and numbers. We have long observed that calves produced in the early and late months of the year thrive better than those that are born in the summer months. Cottagers and others who keep cows in rural districts usually find it most suitable to have them to calve in spring, that they may be in full milk when pasturage is at its best. On the other hand, dairymen who provide milk for the supply of large towns, usually try to have a set of cows to calve in autumn, as it is in the winter months that their produce is most valuable. When a farmer has access to both these sources of supply, he can, by having his own cows to calve chiefly in spring, avail himself of both, and thus rear four or five calves annually, by the milk of each cow which he keeps, and at the same time allow her to go dry for two or three months before again calving. Cows are an expensive stock to keep, and it is therefore of importance to turn their milk to the best account. It is poor economy, however, to attempt to rear a greater number of calves than can be done justice to. Seeing that they are to be reared for the production of beef, the only profitable course is to feed them well from birth to maturity. During the first weeks of calf-hood the only suitable diet is unadulterated milk, warm from the cow, given three times a-day, and not less than two quarts of it at each meal. By three weeks old they may be taught to eat good hay, linseed cake, and sliced Swedes. As the latter items of diet are relished and freely eaten, the allowance of milk is gradually diminished until about the twelfth week, when it may be finally withdrawn. The linseed cake is then given more freely, and water put within their reach. For the first six weeks calves should be kept each in a seperate crib; but after this they are the better of having room to frisk about. Their quarters, however, should be well sheltered, as a comfortable degree of warmth greatly promotes their growth. During their first summer, they do best to be soiled on vetches, clover, or Italian rye-grass, with from 1 lb. to 2 lb. of cake to each calf daily. When the green forage fails, white or yellow turnips are substituted for it. A full allowance of these, with abundance of oat straw, and not less than 2 lb. of cake daily, is the appropriate fare for them during their first winter. Swedes will be substituted for turnips during the months of spring, and these again will give place in due time to green forage, or the best pasturage. The daily ration of cake should never be withdrawn. It greatly promotes growth, fattening, and general good health, and in particular is a specific against the disease called blackleg, which often proves so fatal to young cattle. Young cattle that have been skilfully managed upon the system which we have now sketched, are at 18 months old already of great size, with open horns, mellow hide, and all those other features which indicate to the experienced grazier that they will grow and fatten rapidly. This style of management is not only the best for those who fatten as well as rear; but is also the most profitable for those who rear only. We cannot better illustrate this statement, than by referring to a set of contemporaneous sales of young cattle which once came under our personal observation. In June 1851 we happened to purchase in Kelso market at £6, 18s. a head, a lot of fifty two-year-old short-horn steers from a dealer who had just brought them from Yorkshire. A fortnight before this a lot of *yearlings* (steers and heifers), bred and reared in the heart of the Lammermuirs, were sold in a neighbouring market at £8, 8s. each. About the same time a friend of ours in Roxburghshire who annually rears a large lot of cattle, having noticed one of his calves affected with giddiness, forwarded him to Newcastle market, where he was sold to a butcher for £8, being then not quite eight months old, and not a better animal than many of his lot. Now, these cases are the more valuable, because none of them were extreme ones; but just fair average examples of the fruits of the systems to which they respectively belong. They shew conclusively that of a number of persons engaged contemporaneously in the business of cattle-rearing, and bringing their stock to the same markets, those who adopted the generous system of feeding realised handsome profits, while those who, for thrift, starved their cattle must have done so at a loss to themselves. Nor are the evils of the starving system limited to the breeder. The grazier who purchases cattle that have been hunger-bitten in their youth, finds to his cost that he can only fatten them by an extra expenditure of time and food, and that after all they are worth less—weight for weight—than such as have never been lean.

We have already stated that, in Scotland, comparatively few cattle are fattened on pasturage. An increasing number of fat beasts are now prepared for market during the summer months by soiling on green forage; but it is by means of the turnip-crop, and during the winter months, that this branch of husbandry is all but exclusively conducted in the northern half of Great Britain. But a few years ago, the fattening of cattle on Tweedside, and in the Lothians, was conducted almost exclusively in open courts, with sheds on one or more sides, in which from two to twenty animals were confined together, and fed on turnips and straw alone. Important changes have now been introduced, both as regards housing and feeding, by means of which a great saving of food has been effected. Under the former practice, the cattle received as many turnips as they could eat; which, for an average-sized two-year-old bullock, was not less than 220 lb. daily. The consequence of this enormous consumption of watery food was, that for the first month or two after being thus fed, the animals were kept in a state of habitual diarrhœa. Dry fodder was, indeed, always placed within their reach; but as long as they had the opportunity of taking their fill of turnips, the dry straw was all but neglected. By stinting them to about 100 lb. of turnips daily, they can be compelled to eat a large quantity of straw, and on this diet they thrive faster than on turnips at will. A better plan, however, is to render the fodder so palatable as to induce them to eat it of choice. This can be done by grating down the turnips by one or other of the pulping machines now getting into common use, and then mixing the grated turnip with an equal quantity, by measure, of cut straw. Some persons allow the food after being thus mixed to lie in a heap for two days, so that fermentation may ensue before it is given to the cattle. There is, however, a preponderance of evidence in favour of using it fresh. To this mess can conveniently be added an allowance of ground cake, whether of linseed, rape, or cotton seed, and of meal of any kind of grain which the farmer finds it most economical at the time to use. The ground cake and meal are, in this case, to be thoroughly mixed with the pulped turnip and cut straw. The same end can be accomplished by giving a moderate feed, say 50 lbs. of sliced roots twice a day, and four hours after each of these meals another, consisting of cut straw, cake, and meal. In this case, the chaff and farinaceous ingredients should be mixed and cooked by steam in a close vessel, or the meal can be boiled in an open kettle with water enough to make it of the consistency of gruel, and then poured over the chaff, mixed thoroughly with it, and allowed to lie in a heap for two or three hours before it is served out to the cattle. From 2 to 4 lbs. of meal, etc., a head per diem, is enough to begin with. But as the fattening process goes on it is gradually increased, and may rise to 7 or 8 lbs. during the last month before sending to market. It is advisable to mix with the cooked mess about 2 ounces of salt per diem for each bullock. An important recommendation to this mode of preparing cattle food is, that it enables the farmer to use rape-cake freely; for when this article is reduced to a coarse powder, and heated to the boiling point, it not only loses its acrid qualities, but acquires a smell and flavour which induce cattle to eat it greedily. Moreover, if the rape-seeds should have been adulterated with those of wild mustard before going to the crushing mill (as not unfrequently happens), and a cake is thus produced which in its raw state is poisonous to cattle, it has been ascertained that boiling deprives such spurious cake of its hurtful qualities and renders it safe and wholesome. As rape-cake possesses fattening elements equal to those of linseed-cake, and can usually be bought at half the price, it is well worth while to have recourse to a process by which it can so easily be rendered a palatable and nourishing food for cattle.

When fattening cattle are about to be transferred from the pastures to the yards or boxes—which in Berwickshire should usually take place towards the end of September, it is advisable, for a week at least, to spread out on the sward a daily feed of white turnips, that the animals may be gradually introduced to the change of food. For the first two months after they go into winter quarters they make as good progress on white globe turnips as on any kind of roots; for the three following months well stored Swedes are the best food for them; and from the beginning of March until the end of the season, mangel wurzel and potatoes, in the proportion of four parts of the former to one of the latter. The chaff of wheat, oats, or beans, if tolerably free from dust, is quite as suitable as cut straw for mixing with the pulped roots and cooked food. The addition of a small quantity of chopped hay, or of the husks of kiln-dried oats, to the other food, usually induces cattle to feed more eagerly. In short, the animals must be closely watched, and occasional variations made in the quantity and quality of the food given to particular individuals, or of the genaral lot, as their circumstances may require. Besides the food given in the manger it is desirable that each animal should receive a daily allowance of fresh oat-straw in a rack to which he has access at pleasure. The digestive organs of the ox being naturally adapted for disposing of bulky and but moderately nutritive food, it is essential to his comfort and healthful rumination that his food be in sufficient bulk to enable him at each meal to fill his paunch. To fatten him it must of course possess flesh and fat-forming elements in due proportion. But if these latter are in excess of his powers of assimilation, the surplus goes to the dung-heap, and along with it any chance of a direct profit from his carcase.

A better appreciation of the effects of temperature on the animal economy has of late years exerted a beneficial influence upon the treatment of fattening cattle. Observant farmers have long been aware that their cattle, when kept dry and moderately warm, eat less and thrive faster than under opposite conditions. They accounted for this in a vague way by attributing it to their greater comfort in such circumstances. Scientific men have now, however, shewed us that a considerable portion of the food consumed by warm-blooded animals is expended in maintaining the natural heat of their bodies, and that the portion of food thus disposed of is dissipated by a process so closely analogous to combustion, that it may fitly be regarded as so much fuel. The fat which, in favourable circumstances, is accumulated in their bodies, may in like manner be regarded as a store of this fuel laid up for future emergencies. The knowledge of this fact enables us to understand how largely the profit to be derived from the fattening of cattle is dependent upon the manner in which they are housed, and necessarily forms an important element in determining the question whether *yards, stalls,* or *boxes,* are best adapted for this purpose. A really good system of housing must combine the following conditions :—

1*st,* Facilities for supplying food and litter, and for removing dung with the utmost economy of time and labour.

2*d,* Complete freedom from disturbance.

3*d,* A moderate and equal degree of warmth.

4*th,* A constant supply of pure air.

5*th,* Opportunity for the cattle having a slight degree of exercise ; and

6*th,* The production of manure of the best quality.

We have no hesitation in expressing our opinion that the whole of these conditions are attained most fully by means of well-arranged and well-ventilated boxes. Stalls are to be preferred where the saving of litter is an object ; and yards for the rearing of young cattle, which require more exercise than is suitable for fattening stock. These yards are now however, in the most improved modern homesteads, wholly roofed over, and thus combine the good qualities of both yard and box.

But however excellent the system of housing and feeding which is adopted, a successful result will, in every instance, be much dependent upon the vigilant superintendence of the owner, and his skill in so managing the commissariat as to secure throughout the year a sufficiency of suitable food for the stock on hand. Unless this is attended to, he may find himself necessitated to sell his cattle before they are fat, and when markets are glutted. Whenever they have attained to what is technically called *ripe* fatness, and prices are at their average rate, it is generally more profitable forthwith to dispose of them than to speculate upon a rise in the markets.

CHAPTER XV.

LIVE STOCK.—DAIRY MANAGEMENT.

Section 1.—*General Observations.*

MILK, either in its natural state, or in the form of butter and cheese, is an article of diet so wholesome and so palatable, that the health and comfort of our people, especially such of them as dwell in cities, depend much upon their having a pure and plentiful supply of it at all seasons. DAIRY MANAGEMENT, which includes everything about the production and treatment of milk, is consequently a very important branch of husbandry, and one in which everybody feels interested. The physical conditions of the different countries of the world have determined in each case the particular milk-yielding animal most suitable to be there used for dairy purposes. The Laplander obtains his supplies of milk from his rein-deer, the roving Tartar from his mares, and the Bedouin of the desert from his camels. In the temperate regions of the earth many pastoral tribes subsist mainly upon the milk of their sheep. In some rocky regions the goat is invaluable for this purpose; and the buffalo is equally so amid the swamps and jungles of tropical climates. The milking of ewes was once a common practice in Great Britain; but it has fallen into disuse because of its hurtful effects upon the flock. A few milch asses and goats are here and there kept for the benefit of infants or invalids; but with these exceptions the Cow is the only animal now used for dairy purposes in this country.

Cows of every variety are used for the dairy; but there are several of our native breeds of cattle which possess such peculiar merit in this respect that they are called *par excellence* "the dairy breeds." As an account of these has already been given in the preceding chapter, it may here suffice to say, that for the production of butter or cheese from pasturage of medium quality the *Ayrshire* cow is the best that can be found. For the city dairy, where an animal is wanted that in return for very generous feeding will give a large quantity of milk for a long time, and be easily fattened when the daily yield at length falls below a remunerative measure, or in districts where the business of the grazier is conjoined to that of the dairyman, the short-horn breed is undoubtedly the most profitable. Wherever, as in private families, the quality of the dairy produce is more regarded than its quantity, the preference is deservedly given to cows of the Channel Island breed.

But whatever the breed, the quality is much influenced, 1st, by the age of the cow, and 2d, by the way in which she is fed. So clearly is it ascertained that the milk of cows not exceeding four years of age yields a larger proportion of curd and of a richer quality than can be obtained from the milk of the same animals when kept beyond that age, that it is customary in those parts of England where cheese-making is chiefly carried on, to draft off the cows to the grazier after they have borne two or at most three calves each. Cows that shew unusual excellence for the dairy, or that are prized for their pedigree, are of course kept for longer periods. Taking into account the superior quality of the produce of three and four year old cows, and their higher value for grazing purposes at that age, as compared with what it is at six years old and upwards, the practice of drafting at the earlier age is well worthy of being more generally adopted.

The influence which the food of the cow exerts upon the amount and qualities of her milk has always been recognised.

At one time, provided that a large yield of milk, free from any unpleasant taste, was obtained, little regard was paid to its other qualities. It has accordingly been the practice in new-milk dairies to feed the cows chiefly with soft sloppy food, such as boiled turnips, brewers' grains, and distillery wash. The milk produced from such food contains an undue proportion of serum, and is deficient in butter, caseine, sugar, and phosphates—the very elements which give to milk its value as an article of food, and in particular which fit it so peculiarly for building up the frame of young animals. When these elements are wanting in the food which is given to the cow, they are to a certain extent imparted to her milk by being withdrawn from her own system. And hence it is well known that cows which give a very large quantity of milk generally loose the fat and flesh which they had accumulated before calving. In order, therefore, to maintain the condition of the cow, and enable her to give milk of the best quality, it is necessary that her food contain an adequate supply of these elements which are required in good milk. Her food, in short, must be substantially the same as that which is found to be most efficacious in promoting the increase of flesh and fat in cattle which are preparing for the butcher. It is now pretty well ascertained that the fattening process is accomplished most economically by giving a moderate allowance of linseed or rape cake, and of the meal of beans and other grains, in addition to the pasturage, green forage, roots, and fodder, which constitute the bulk of the food of such animals. The following dietary for milch cows we have gleaned from an article by Mr. Horsfall of Burley, near Otley, entitled "Rape-Cake for Feeding" in the *Agricultural Gazette*, of 30th September and 7th October 1854,* in which the topics now

* See also articles on "Dairy Management," by the same author, in the *Journal of the Royal Agricultural Society*, vol. xvii. p. 260 ; vol. xviii. p. 150.

under discussion are handled more satisfactorily than in any other work we have met with. This writer states that the daily fare of his fattening cattle consists of—

	lbs.
Chopped oat-straw, shells of oats, and bean-straw .	18
Rape-cake 4 lbs., bran 2 lbs.	6
Swedish turnip (if mangold, 50 lbs.) . .	60
	84

The rape-cake, bran, and 16 lbs. of the chopped straw, after being intimately mixed, are cooked by steaming, and so given to the cattle. The Swedes or mangold are given raw, and the other 2 lbs. of the chopped straw are given as dry fodder. On such rations he finds his cattle to make good progress; so much so, that heifers of from 7 to 9 cwt. each increase at the rate of 14 lbs. per week, and larger cattle at the rate of from 14 to 18 lbs. per week, over the whole period of fattening, which (according to the condition of the animals at starting) ranges from 16 to 24 weeks. From October to May he gives his milch cows the same *cooked* mess as has been described for the fattening of stock, with 12 lbs. of meadow hay and 30 lbs. of roots. For the first half of the period the roots consist of kohl-rabi, and of mangold for the remainder of it. From May to October the cows are turned out to pasture during the day, and are housed at night. The same cooked mess continues to be given daily in two equal portions at morning and evening; but its quantity is somewhat diminished during the height of summer, when the pasturage is at its best. They receive also in the house a morning and evening feed of green forage. On this fare the cows yield a very abundant flow of rich well-flavoured milk; and they besides maintain their condition at the height of their milking, and gain flesh as it diminishes. It is from a regard to the flavour of the milk, that roots are given to them more sparingly than to fattening stock; and that kohl-rabi and mangold are used in preference to turnips or cabbages. Gorse, bruised and chopped, has been found to be a peculiarly suitable kind of green winter forage for milch cows.

The best pasturage for cows is that obtained from good old grass land, in sheltered inclosures of moderate size, and in which there is a constant supply of pure water. To have dairy produce of the best quality, the grass must never be allowed to get too rank, and must therefore be so stocked as to have it always fresh grown and sweet. This is most easily secured by frequently changing the cows from one field to another; and hence the advantage of having small inclosures, one of which can be rested, while another is keeping the stock of both. When soiling is resorted to, Italian rye-grass is at once the cheapest and best forage that can be used; but it can be varied, as circumstances dictate, with clover, sainfoin, vetches, or green rape. When cows are kept entirely at pasture during the summer, from 1¼ to 2 acres of grass land is required for each animal; and if hay alone is given in winter (as is the practice in Gloucestershire), the produce of another 1½ acre of meadow is required to supply their winter keep. As 1 cwt. of green forage is an ample daily allowance for a cow, and as two cuttings of clover or Italian rye-grass, averaging 8 tons each per acre, can with suitable manuring be easily obtained, it is obvious that by soiling in summer and feeding on roots and cooked food in winter, half the extent of land will suffice to maintain a cow on the latter system that is found requisite on the former. The dung produced under the soiling system is also richer, and can be more economically used. And, above all, the produce in milk, besides being of richer quality, is greater in quantity by fully one-fourth. The average yield of milk per cow per annum in Gloucestershire is estimated at 525 gallons. Under the more generous house-feeding system an average of 680 gallons is obtained. All changes of diet must be made with caution. The utmost vigilance must also be used in order to insure regularity in the times of feeding and milking, in seeing that the latter process is thoroughly performed, and in guarding the cows from exposure to extremes of heat or cold. Through inattention to these particulars the flow of milk may easily be so diminished as altogether to neutralize the profit of a dairy.

Section 2.—Dairies.

Dairies are of three kinds, viz.—

1. New-milk dairies.
2. Butter dairies.
3. Cheese dairies.

1*st. New-Milk Dairies.*

Dairies whose produce is sold as new milk have hitherto existed only in or near to towns, or amidst the dense population of mining and manufacturing districts. This branch of dairy business is to a large extent in the hands of a class of frugal industrious persons, possessing each from one to a dozen of cows, and who, with the aid of their own families, overtake the whole management of their cows, and the delivery of the milk to their customers. But in our large towns there are now also to be found gigantic establishments, in some of which so many as a thousand cows may be seen at one time. In these town dairies the cows are usually purchased when they have newly calved, or at the point of calving. They are retained as long as they continue to give a remunerative quantity of milk daily. From the generous feeding which they receive, they are usually by that time so well in flesh that they either go at once to the shambles or are fit for doing so in a very short time after being put dry. The stalls thus vacated are at once refilled by the purchase of cows that have newly calved, and so the number of cows and the supply of milk is kept up all the year round. This, at least, is the way in which such dairymen would prefer to conduct their business; but the prevalence for several years past of the dreaded epizootical lung disease has altogether broken up many of the lesser dairies, and has constrained the owners of the larger ones to adopt to some extent a different mode of management. It being found that cows which recover from this disease are afterwards exempt from its attacks, it becomes an object of some importance to retain them as long in the dairy as possible. Such cows are accordingly put to the bull, and during the period of rest which they are allowed before calving again are sent to country quarters, where they are kept at less expense than in town, and whence they are brought up as soon as they are again in milk. In these dairies the cows are milked twice a day. The milk is conveyed at once to the milk-room, where it is strained, measured, and delivered over to retailers, or to servants of the establishment, by whom it is distributed to the customers. A portion, in some cases a half, of the new milk is, however, retained in the dairy for twelve hours. It is then skimmed, and the cream either retailed as cream or made into butter; and the milk being mixed with an equal quantity of new milk, the whole is disposed of under that character. This business requires the employment of a large capital; it is attended with much risk, and calls for much skill and vigilance in carrying out its various details. When well managed, it is, however, a remunerative one to those engaged in it, and has undoubtedly tended to improve the quality of the milk supplied to the community, as well as to make that supply more ample and regular.

Railways, which have revolutionized so many things, bid fair to introduce important changes in this branch of dairy business. Instead of keeping the cows in or near cities, where housing, food, and litter are costly, it is becoming a common practice to keep the cows on farms near railway stations, and to forward the new milk in suitable vessels twice a day to parties who retail it to the citizens. This plan has many things to recommend it. It is much easier to carry the milk only to the point of consumption, than first to convey thither the cows and all the litter and food which they require, and then to recarry to the country the manure which they produce. It may also be fairly presumed that a rural residence, with sweet pasturage and pure air, will be more conducive to the health of the cows and the wholesomeness of their milk, than their being cooped up in city byres or cow-houses, and fed largely on the refuse of breweries and distilleries.

2d. *Butter Dairies.*

These are the most common form of the dairy, inasmuch as the making of butter admits of being combined with various uses of the milk. We have seen that a portion of the cream in new-milk dairies is thus employed, and the same thing occurs in the cheese-making districts. Indeed, wherever cows are kept for any purpose, some portion of the milk is used for the production of butter. There are, however, extensive districts both in England and Scotland where such prominence is given to this particular product that the dairies of these districts are with propriety spoken of as "butter-dairies. In the midland and western counties of England, where the breeding of cattle is extensively carried on, the calves receive new milk for the first two or three weeks only, and are afterwards fed upon skimmed milk and a gruel composed of bruised linseed and oatmeal cooked together. This admits of the greater part of the cream being converted into butter. When the calves are all weaned, the skim milk is employed in fattening pigs. In many parts of the country butter-milk is much relished by the labouring classes. Whenever milk can be disposed of readily in this form, dairy farmers direct their attention chiefly to the production of butter.

New milk of average quality contains about four per cent of oily or fatty matter, which is suspended in minute globules, inclosed in a membrane composed of a cheesy substance. When the milk is allowed to settle, these globules, being lighter than the general mass, gradually rise to the surface in the form of cream. In the process of churning, these globules are broken by the mechanical agitation, aided by the action of the lactic acid which is formed from the sugar of the milk. When the globules are thus ruptured, the contents cohere in a mass and assume the familiar form of butter. Until this acidity takes place, butter cannot be formed by mere mechanical force. The invariable practice, therefore, is to allow the cream, whether separated from the milk or not, to stand until the formation of this acid has at least begun; for when once commenced it is rapidly accelerated by the air, which is introduced in the process of churning.

Butter is made either from cream only, or by churning the whole milk and cream together. The best butter is obtained from the cream which rises during the first twelve hours after milking, and the next best by churning the whole milk. In the former case the new milk, after being carefully strained, is poured into shallow vessels of glazed earthenware, glass, tinned iron, wood, lead, or zinc, of which the three first-named sorts are the best. The wooden vessels are objectionable from the difficulty of cleansing them thoroughly; and the two last from the noxious salt which is produced by the action of the acid of the milk on the metal. When it is intended to extract as nearly the whole of the butter from the milk as is practicable, the first skimming takes place at the end of twenty-four hours, and is followed up by one or more skimmings at further intervals. The cream is stored in jars, which should be kept in a place separate from the milk-room, that the milk in the coolers may not be prematurely acidulated by the proximity of the sour cream. The latter is either stirred repeatedly, or poured from one vessel to another, to prevent the formation of a tough coat upon it before enough is accumulated for a churning. In large dairies it is usual to churn daily. Three days is as long as the cream can ordinarily be kept with safety to the quality of the butter. When a cow has recently calved, her milk is comparatively rich in butter and poor in curd; but by and by the relative proportions of these constituents gradually change places, the cream diminishing and the milk becoming thicker. A very sensible change in the quality also usually takes place when a cow again becomes pregnant. In not a few cases the cream is so affected by this circumstance, that double or treble the length of time is required to churn it that sufficed before, and the butter is at the same time of inferior quality. If cows are flurried and heated, either by gadding in the pasture, or by being overdriven in bringing them home for milking, their milk becomes peculiarly liable to corrupt, the yield of butter is sensibly lessened, and its quality is impaired. The success of the process of churning depends much on the temperature of the cream being nicely regulated. A mean temperature of 60° Fahrenheit seems to be the best. The temperature of the cream usually rises about 10° during the process of churning. About 55° is therefore the desirable starting point. Advantage is derived from rinsing the churn with cold water in summer and with warm water in winter. The addition to the cream of small quantities of cold or hot water, as the case requires, is also found beneficial. Box or barrel churns are preferred when the cream only is churned, the former being best adapted for small dairies, and the latter for large ones. When the whole milk and cream are churned together, it is indispensable that acidity and coagulation should first take place. The time required to produce butter in this case is much longer than with cream alone, three hours being an average period. The plunge churn is most appreciated for this practice; and in large dairies it is usually worked by steam, water, or horse-power. Forty strokes of the piston per minute is found the best rate of working.

In Devonshire a method of treating the milk has long been in use by which what is called "clouted cream" is produced. To effect this, the new milk is strained into shallow earthenware pans, into each of which half a pint of water has previously been placed to prevent the milk adhering to the pan in the subsequent process of scalding. After standing twelve hours, these vessels are placed over a charcoal fire, or on a hot plate, or are immersed in cold water in a shallow boiler, which is then heated until the temperature of the milk rises to 180°, after which they are again replaced in the milk-room (great care being taken to preserve the surface of cream unbroken), and allowed to stand the usual time. The effect of this scalding is to separate the whole of the cream from the milk, and greatly to facilitate its conversion into butter. This is readily accomplished by placing the cream in a small tub, and working it with the hand or a piece of flat wood. This thickened or "clouted" cream is frequently eaten in the state of half-formed butter, in which it is removed from the milk. It has then a very rich appearance and agreeable flavour. The butter made from it is asserted by some persons to keep better and to be altogether superior to that made without scalding; whereas others assert, and with good show of truth, that it contains an undue proportion of cheesy matter, and that in consequence it is more liable to rancidity than other butter.

A mode of procedure in use in some Lancashire dairies has been much commended. In milking the cows, the first drawn and larger portion of the milk is set aside, and the cream in due time skimmed from it in the usual way. The strippings or afterings, which are known to contain the greater part of the butter obtained at any one milking, are kept separate, and mixed with the cream of the other portion at the time of churning. The labour of churning is less in this way than when the whole of the milk is subjected to that process, and at the same time a larger yield of butter is said to be obtained than when only the cream is churned.

Although the process of churning, in a popular sense, completely separates the butter from the other parts of the milk, this is not done so thoroughly as to exclude the retention of some oily matter in the whey, and, on the other hand of a portion of caseous matter in the butter. Cheese, being a nitrogenous substance, is peculiarly susceptible of putrefaction, and hence even the smallest portion of it when left in butter is sure, in a very short time, to corrupt and to impart to the whole mass a rancid flavour. Besides this liability to taint, arising from an element inherent in itself, butter, in common with other fatty substances, has a peculiar affinity for smells of all kinds. If cream or butter be kept in the same apartment with tainted meat, or other decaying matter, or is stored in vessels that have previously contained any rancid substance, or is exposed to unsavoury odours from the proximity of dung-heaps, stables, etc., it is sure to retain unmistakeable tokens of having been in such evil neighbourhood. The inherent tendency to rancidity is to be combated by carefully washing the newly churned butter in repeated baths of pure cold water, and by working a little salt into the mass while the washing is in progress. By this means not only the whey but the greater part of the caseous matter above referred to can be removed. If the butter is to be used fresh, it is immediately made into rolls or pats; but if it is to be cured, fine salt, at the rate of half an ounce to the pound, is thoroughly incorporated with it, and the mass, after lying a day, is again worked over, and then tightly packed into a perfectly clean air-tight vessel. In domestic use the most convenient vessels are jars of glazed earthenware. That intended for market is put into casks called half-firkins, firkins, and tubs, containing respectively twenty-eight pounds, fifty-six pounds, and eighty-four pounds. These should be of well-seasoned oak, and made perfectly tight, as otherwise the butter is sure to be tainted. From the facilities which railways afford for cheap and rapid carriage, a very great proportion of our home-made butter is now sent to market in a fresh or slightly powdered state.

The unpleasant flavour imparted to milk or butter when cows are fed on turnips or cabbages can be removed or avoided; 1*st*, by cooking these esculents and giving them in mixture with chopped straw, in quantities not exceeding sixty pounds a day, given at two feeds; or, 2*d*, by adding to each gallon of the new milk a table-spoonful of a saturated solution of nitre, or the same quantity of a solution prepared by dissolving half an ounce of chloride of lime in one gallon of water.

The average yearly product of butter per cow in the butter dairies is usually estimated at 170 to 200 pounds. This is in addition to the new milk used in rearing the heifer calves required to keep up the stock, and to the butter consumed in the farmer's family. With uniform good feeding an average of 227 pounds per cow per annum has been obtained in a dairy of forty cows belonging to Mr. David Young, Lochtyside (near Kirkcaldy, Fife), of which a most interesting account is given in Morton's *Cyclopædia*, from which we quote the following particulars. The quantity of milk yielded on an average by Mr. Young's cows is nine quarts daily for ten months, or 680 gallons annually. The average proportion of milk, cream, and butter, to each other, is one gallon of cream to nine of milk, and three pounds of butter to one gallon of cream, or one pound of butter to three gallons of milk as it comes from the cow. The following is a tabular view of the annual produce and cost of each cow:—

Expense from May 1 to October 1.

2 acres of grass, at 45s.	£4	10	0
Clover and tares	1	0	0
Draff in summer	0	6	5½

From October 1 to May 1.

14 tons 4 cwt. of turnips, at 7s. 6d.	£5	6	6
5 bushels of linseed, at 7s.	1	15	0
Draff in winter	1	2	1
Interest on £14, at five per cent	0	14	0
Carriage of milk, and tolls	0	15	0
Attendance, fuel, etc.	0	10	0
Total,	£15	19	0½

Produce per Cow=680 gals. of milk.

227 lbs. of butter, at 10½d.	£9	18	7½
600 gals. of skimmed milk, at 4½d.	11	5	0
50 gals. of butter milk, at 2¼d.	0	9	4½
Calf at a week old	0	15	0
Total value of produce . . .	£22	8	0
Deduct expense of food, etc. . .	15	19	0½
Net profit per cow	£6	8	11½

3*d*. *Cheese Dairies.*

Cheese-making is by far the most difficult department of dairy management. Although the art is universally practised, and the raw material is everywhere substantially the same, there is perhaps no equally common product which varies so much in its quality and market value, from mere diversity in the skill with which it is made. The difficulty of producing really good cheese arises from the peculiar susceptibility in milk to be influenced by a great variety of external causes, and the extreme facility with which its component parts enter into chemical changes of the most decisive kind. An average sample of milk has been found to consist of—

Caseine	4·48
Butter	3·13
Milk sugar	4·77
Saline matter	0·60
Water	87·02
	100·00

The caseine, which forms the chief ingredient of cheese, and which is almost exactly of the same composition as animal flesh, is held in solution in the milk by means of an alkali. Any acid which removes this alkali converts the caseine into an insoluble curd, which when dried forms cheese. When milk is allowed to stand until it sours, coagulation takes place from the action of the acid which is formed spontaneously in itself. But there are various substances which, when added to new milk, have the property of forming lactic acid, and thus of causing it to coagulate speedily. The substance which is invariably used for this purpose in British dairies is *Rennet,* prepared for the most part from the stomachs of sucking calves. To adapt them for this purpose, these stomachs, usually called bags or vells, as soon as taken from the animal are turned inside out, carefully freed from all impurities, and salted. They are then packed one upon another, with a layer of salt between each, into a deep earthenware vessel, covered over with salt, and excluded from the air by a close-fitting lid. In the best English dairies the skins are invariably kept for a year before being used. About a month before the rennet is needed, a sufficient number of the skins are from time to time taken out of the jar, and when the brine has drained from them, they are spread out upon a table, powdered on both sides with fine salt rolled with a paste roller, distended with a splint of wood, and hung up to dry. The rennet, provincially called *steep* or *yearning,* is an infusion of these cured stomachs. A portion of the dried bag, at the rate of a square inch to 10 gallons of milk, is put the day before it is needed into a cup containing half a pint of lukewarm water and a teaspoonful of salt; and it is by mixing this infusion with the milk that coagulation is obtained. It would appear that the power of producing this effect is due to a certain degree of decay having begun in the skin. If this has gone too far, the milk is not merely curdled, but an unpleasant taste is imparted to it, and the cheese so made corrupts prematurely, and is unwholesome. The careful cleaning and salting regulates this principle; and when skilfully managed, a sweet and wholesome curd is obtained. In some dairies, as much of this rennet is infused at one time as serves for several weeks, or even months; but the practice of the best dairies is in favour of its daily, or at most weekly, preparation. To produce cheese of the best quality, it is indispensable that the rennet be sweet and good; that only so much of it, and no more, be added to the milk, as will suffice to produce perfect coagulation; and that this take place at the proper temperature. Too much rennet makes a tough curd and a poor ill-flavoured cheese. From 80° to 85° appears to be the proper temperature of the milk when the rennet is mixed with it, and from an hour to an hour and a quarter the time which it should take to coagulate.

A cheese-dairy farm must be provided with suitable buildings, apparatus, and utensils. The buildings required are byres for the whole of the cows, a calf-house, yards for the heifers, and piggeries. The byres should not be less than 17 feet in width, distributed as follows:—

Passage in front of stalls . .	3½ feet
Manger	2
Stalls	6
Urine grip	1½
Passage behind	4
	17

It is usual to rear one heifer calf for each three cows, and to have the heifers to calve for the first time at 3 years old; so that the young stock of all ages are equal in number to the cows. As many pigs are kept as suffice to consume the whey; the proportion, in summer, being one pig to two cows. The dairy comprises a milk-room, working-room, salting and drying room, and cheese-room. The working-room is provided with two boilers; a smaller one for heating water, and a larger one for heating whey. There are also lead tanks for containing the fresh whey, and a cistern in which, after being scalded, it is stored for the pigs. The cheese-tub is of wood or brass—the latter being best, as it admits of being thoroughly washed and burnished; whereas, a wooden vessel, being porous, is exceedingly apt to retain minute particles of milk or whey, which souring in the wood, become a source of mischief to the future contents. The other utensils are lever presses; cheese vats of elm, turned out of the solid and hooped with wood; pans of tinned iron or brass for heating milk by immersion in hot water; cheese-ladder; curd-breaker; curd mill, thermometer, etc.

The cows are milked twice a-day; at 5 A.M. and 5 P.M. The whole available hands are engaged at this work, that it may be accomplished speedily. Usually, each person has seven or eight cows to his or her share, and occupies about ten minutes in the milking of each of them. The milk is carried to the dairy as fast as it is drawn from the cows, and is there consigned to the care of the dairy-maid, who proceeds in her treatment of it according to the variety of cheese which it is designed to produce.

The kinds of cheese in best estimation and of greatest market value are *Stilton*, *Cheddar*, *Cheshire*, and *Gloucester*. The first variety is made in Leicestershire, and contains the cream of one milking added to the new milk of the next. The Cheddar and Cheshire cheeses are made from new milk, or rather from milk in which all its own cream is retained.

Gloucester cheese is usually deprived of a small portion of its cream. Double and single Gloucester differ only in the former being twice the thickness and weight of the latter, and consequently taking longer to ripen. The Scotch variety called *Dunlop*, and the *Gouda* of Holland, are full-milk cheeses, but are much inferior in quality, and sell for a much smaller price than the same class of English cheeses. As there are good grounds for supposing that this inferiority is entirely, or chiefly due to unskilfulness in the manufacture, the Ayrshire Agricultural Association, in the summer of 1854, sent a deputation into the counties of Gloucester, Wilts, and Somerset, to inquire into the methods of cheese-making there practised. The following is an extract from their report :—

"We are indebted to Mr. Titley, cheese factor, Bath, for an introduction to Mrs. Harding, Marksbury, and her nephew, Mr. Joseph Harding, Compton Dando, who makes first-rate Cheddar cheese. In their dairies, as well as in the other establishments which we visited, we were fortunate not only in seeing the manufacture of the best cheese of their respective kinds, but also in meeting with people who were ready to give clear explanations of the various processes, and excellent reasons for what they were doing.

"There is an appearance of ease and simplicity about the method of making Cheddar cheese, as we saw it practised in Somersetshire. In the dairies of Mr. Harding and his aunt a regular system is followed; and those undeviating guides, the thermometer and the clock, are frequently referred to in the different stages of the process. The more that a regular system is introduced into the manufacture of cheese—subject to such modifications as the superintendent may occasionally think necessary for varying circumstances—there is the greater probability of obtaining uniform results.

"The points of excellence aimed at in these dairies are the manufacture of the best quality of cheese in the most cleanly manner, and with the smallest amount of labour. In their attempts to accomplish this, Mr. and Mrs. Harding have been highly successful.

"In addition to the girls who do the work of the dairy, several men and boys are employed to milk the seventy-three cows belonging to Mrs. Harding at Marksbury. The men carry the milk, but they do not enter the dairy in doing so. It is poured through a sieve into a receiver outside, from which a pipe conveys it through the wall to the cheese tub, or to the coolers. A canvas bag is also placed over the inside end of the pipe, so that a double precaution is used against impurities entering with the milk.

"Immediately after the morning milking, the evening and morning milk are put together into the tub. The temperature of the whole is brought to 80 degrees by heating a small quantity of the evening milk. Mrs. Harding, who has had long experience in cheese-making, can tell the precise temperature within two or three degrees by merely passing her hand through the milk. Her grand-niece, who now relieves her of most of the duty of superintendence, can usually tell very nearly; but even with individuals whose senses are acute there is a liability to deception from the varying heat of the hand when it is put into the milk, in different states of the weather. The thermometer, therefore, is found to be the surest guide, and it is regularly used.

"In spring and towards winter a small quantity of anatto is used to improve the colour of the cheese. It is put into the milk along with the rennet at seven o'clock. After the rennet is added, an hour is requisite for coagulation. At eight o'clock the curd is partially broken and allowed to subside a few minutes in order that a small quantity of whey may be drawn off to be heated. This whey is put into a tin vessel and placed in a boiler in an adjoining apartment, to be heated in hot water. The curd is then most carefully and minutely broken, Mrs. Harding and her niece performing this part of the work with utensils called shovel breakers. The servants are never intrusted with this duty. When the curd is completely broken, as much of the heated whey is mixed with it as suffices to raise it to 80 degrees, the temperature at which the rennet was added. Nothing more is done to it for an hour.

"A little after nine o'clock the work is resumed. A few pailfuls of whey are drawn off and heated to a higher temperature than at eight o'clock. The curd is then broken as minutely as before; and after this is carefully done, an assistant pours several pailfuls of heated whey into the mass. During the pouring in of the whey the stirring with the breakers is actively continued, in order to mix the whole regularly, and not to allow any portion of the curd to become overheated. The temperature at this time is raised to 100 degrees, as ascertained by the thermometer, and the stirring is continued a considerable time until the minutely broken pieces of curd acquire a certain degree of consistency. The curd is then left half an hour to subside. At the expiry of the half hour the curd has settled at the bottom of the tub. Drawing off the whey is the next operation, and the ease with which it is performed would astonish an Ayrshire dairy manager. The greater proportion of the whey is lifted in a large tin bowl, and poured through a hair sieve into the adjoining coolers. As it runs into the leads it appears to be very pure. When the whey *above the mass of curd* is thus removed, a spigot is turned at the bottom of the tub, and the remainder is allowed to drain off, which it does very rapidly without any pressure being required. To facilitate this part of the work the tub is made with a convex bottom, and the curd is cut from the sides of the tub and placed on the elevated centre. It is carefully heaped up, and then left for an hour with no other pressure than its own weight.

"After this interval it is cut across in large slices, turned over once on the centre of the tub, and left in a heap as before for half an hour. The whey drips away towards the sides of the tub, and runs off at the spigot; and, no pressure being applied, it continues to come away comparatively pure.

"After undergoing these simple and easy manipulations, and lying untouched during the intervals that have been mentioned, the curd is ripe for the application of pressure. But great care is taken not to put it into the vat to be pressed at too high a temperature. If the heat be above 60 degrees, and it usually is higher at this time, the curd is broken a little by the hand and thrown upon a lead cooler until it is brought down to the desired temperature."

When curd has by such means as these been brought to a somewhat firm consistency, it is enveloped in coarse linen cloths and put into perforated wooden vats, which are placed in a lever press and subjected to gradually increased pressure until the whey is expelled, and the cheese has acquired sufficient consistency to retain its shape when turned out to the shelves of the drying room. Very rich cheeses are usually supported for some weeks after leaving the press by being tightly bound round with a fillet of stout linen cloth. During the first day's pressing, the incipient cheese is frequently taken out of the vat, has its edges pared, receives dry cloths, and is reversed in the vat to keep its sides uniform. In the Cheshire dairies iron skewers are thurst into the curd through the perforations of the vat, and then withdrawn, to form drains for the readier emission of the whey. Salt is applied sometimes by crumbling down the curd after its first hour in the press, and mixing fine salt with it at the rate of 1 lb. of salt to 42 lbs. of curd, and then returning it to the vat. This crumbling is effected by passing it through a simple curd mill, which tears it into minute fragments. In other cases the salt is merely rubbed into the cheese externally at each changing of the cloths while it is in the press, and for some days after its removal to the drying room. As soon as its degree of dryness and firmness admits, it is placed in the cheese-room, and is then wiped with a cloth and turned at first daily, and afterwards twice weekly until it is ready for market. The cheese-room is kept at a temperature of 60°, and has light and currents of air excluded from it. The darkness is a protection from flies, and a still and moderately warm atmosphere promotes its ripening.

When the process of making new-milk cheese is skilfully conducted, it consists not only of the caseine, but includes nearly all the butter of the milk. A portion of the latter is, however, carried off in the whey, from which it is recovered by a simple process. The whey is heated in a boiler to 180°, at which point a small quantity of sour buttermilk is stirred into it, which has the instantaneous effect of causing all the buttery matter to rise to the surface, from which it is skimmed off and put into a jar. As soon as the buttermilk is put in, the fire is withdrawn to prevent the whey from reaching the boiling point. The whey thus deprived of its cream is run into a cistern, whence it is dealt out to the pigs. The whey-cream is kept for three or four days until it thickens, and is then churned like ordinary cream. About half a pound of this whey butter is obtained weekly from each cow. It is worth about three-fourths of the value of cream butter.

A gallon of good milk produces 1 lb. of cheese. The average produce per cow per annum is from 3 to 5 cwts., exclusive of the milk used in rearing calves.

CHAPTER XVI.

LIVE STOCK—SHEEP.

WHEN Fitzherbert so long ago said, "Sheep is the most profitablest cattle that a man can have," he expressed an opinion in which agriculturists of the present day fully concur. But if this was true of the flocks of his time, how much more of the many admirable breeds which now adorn the rich pastures, the grassy downs, and heath-clad mountains of our native country. Their flesh is in high estimation with all classes of the community, and constitutes at least one-half of all the butcher meat consumed by them. Their fleeces supply the raw material for one of our most flourishing manufactures. They furnish to the farmer an important source of revenue, and the readiest means of maintaining the fertility of his fields.

Section 1.—*Breeds.*

The distinct breeds, and subvarieties of sheep found in Great Britain are very numerous. We have no intention of noticing them in detail, but shall rather confine our observations to those which, by common consent, are the most valuable for their respective and appropriate habitats. They may be fitly classed under these three heads, viz. the heavy breeds of the low country, those found on our downs and similar localities, and the mountain breeds.

1st.—*Heavy Breeds.*

Of the first class, the improved *Leicesters* are still the most important to the country. They are more widely diffused in the kingdom than any of their congeners. Although, from the altered taste of the community, their mutton is less esteemed than formerly, they still constitute the staple breed of the midland counties of England. Leicester rams are also more in demand than ever, for crossing with other breeds. It is now about a century since this breed was produced by the genius and perseverance of Bakewell, in whose hands they attained a degree of excellence that has probably not yet been exceeded by the many who have cultivated them since his day. The characteristics of this breed are extreme docility, extraordinary aptitude to fatten, and the early age at which they come to maturity. The most marked feature in their structure is the smallness of their heads, and of their bones generally, as contrasted with their weight of carcase. They are clean in the jaws, with a full eye, thin ears, and placid countenance. Their backs are straight, broad, and flat, the ribs arched, the belly carried very light, so that they present nearly as straight a line below as above, the chest is wide, the skin very mellow, and covered with a beautiful fleece of long, soft wool, which weighs on the average from 6 to 7 lb. On good soils, and under careful treatment these sheep are currently brought to weigh from 18 to 20 lb. per quarter at 14 months old, at which age they are now usually slaughtered. At this age their flesh is tender and juicy; but when carried on until they are older and heavier, fat accumulates so unduly in proportion to the lean meat, as to detract from its palatableness and market value.

Lincolns.—These were at one time very large, ungainly animals, with an immense fleece of very long wool. By crossing them with the Leicesters the character of the breed has been entirely changed, and very greatly for the better. It is now, in fact, a subvariety of the Leicester, with larger frame and heavier fleece than the pure breed. Sheep of this kind are reared in immense numbers on the wolds and heaths of Lincolnshire, and are sold in the wool, and in very forward condition, when about a year old, to the graziers of the fens and marshes, who ultimately bring them to very great weights.

Cotswolds, sometimes called Glo'sters or New Oxfords, are also large and long-woolled sheep, with good figure and portly gait. Great improvement has been effected in this breed during the last twenty years, in consequence of which they are rising rapidly in public estimation. The qualities for which they are prized are their hardiness, docility, rapid growth, aptitude to fatten, and the great weight to which they attain. Their chief defect is that they yield mutton somewhat coarse in the grain and with an undue preponderance of fat. But in addition to their great merits as a pure breed they are especially valuable for the purpose of crossing with Downs and other short-woolled sheep. Of this we shall speak more particularly when we come to notice the *Cross-breeds.*

Teeswaters.—This breed, found formerly in the vale of the Tees, used to have the reputation of being one of the largest and heaviest of our native breeds. They had lighter fleeces than the old Lincolns, but greater aptitude to fatten. Like them, however, they have been so blended with Leicester blood, as to have lost their former characteristics. As now met with, they constitute simply a subvariety of the latter breed.

The *Kents* or *Romney Marsh Sheep*, are another distinct long-woolled breed, which have much in common with the old Lincolns, although they never equalled them either in the weight or quality of their fleece. They, too, have been much modified by a large infusion of Leicester blood; but as their distinctive qualities fit them well for a bleak and humid habitat, there is now an aversion to risk these by further crossing. As they now exist they are a great improvement upon the old breed of the Kentish marshes; and this, in the first instance at least, was the result of crossing rather than selection.

2d.—*Down and Forest Breeds.*

The breeds peculiar to our chalky downs, and other pastures of medium elevation, next claim our notice.

South Downs.—Not long after Robert Bakewell had begun with admirable skill and perseverance to bring to perfection his celebrated Leicesters, which, as we have seen, have either superseded, or totally altered the character of, all the heavy breeds of the country, another breeder, Mr. John Ellman of Glynde, in Sussex, equal to Bakewell in judgment, perseverance, and zeal, and wholly devoid of his illiberal prejudice and narrow selfishness, addressed himself to the task of improving the native sheep of the downs, and succeeded in bringing them to as great perfection, with respect to early maturity and fattening power, as they are perhaps susceptible of. Like Bakewell, he early began the practice of letting out rams for hire. These were soon eagerly sought after, and the qualities of this improved flock being rapidly communicated to others, the whole race of down sheep has more or less become assimilated to their standard. These improved south downs have, in fact, been to all the old *forest*, and other fine-woolled breeds, what the Leicesters have been to their congeners. Many of them have entirely disappeared, and others only survive in those modifications of the improved south-down type, which are to be found in particular localities. These down sheep possess certain well-marked features, which distinguish them from all other breeds. They have a close-set fleece of fine wool, weighing, when the animals are well fed, about four pounds; their faces and legs are of a dusky brown colour, their neck slightly arched, their limbs short, their carcase broad and compact, their offal light, and their buttocks very thick and square behind. They are less impatient of folding, and suffer less from a pasture being thickly stocked with them than any other breed. It is in connection with this breed that the practice of folding as a means of manuring the soil is so largely carried out in the chalk districts of England. It is well ascertained that the injury done to a flock by this practice exceeds the benefit conferred on the crops. Now that portable manures are so abundant, it is to be hoped that this pernicious practice of using sheep as mere muck machines will be everywhere abandoned.

These sheep are now usually classed as *Sussex downs* and *Hampshire downs*, the former being the most refined type of the class, both as regards wool and carcase, and the latter as compared with them, having a heavier fleece, stronger bone and somewhat coarser and larger frame.

The *Shropshire* sheep, while partaking of the general characteristics of the Southdown, is so much heavier both in fleece and carcase, and is altogether so much more robust an animal that it now claims to be ranked as a separate breed. The qualities just referred to as distinguishing it from other downs seem, however, to be the result of selection rather than of crossing with other breeds, and thus the Shropshire sheep, while a pure down, is yet of so distinct a type from the high bred "Southdown" that it is well entitled to be recognised as a distinct and very valuable breed, as has been done by the Royal Society, which now assigns it a separate class at its annual meetings. Shropshire rams are now eagerly sought after, and that county now possesses many breeders of eminence who have their annual sales of these animals.

These breeds are peculiarly adapted for all those parts of England where low grassy hills occur, interspersed with, or in proximity to, arable land. In such situations they are prolific, hardy, and easily fattened at an early age. It is to their peculiar adaptation for crossing with the long-woolled breeds, that they are indebted for their recent and rapid extension to other districts.

Dorsets.—This breed has, from time immemorial, been naturalised in the county of Dorset, and adjacent parts. They are a whitefaced, horned breed, with fine wool, weighing about four pounds per fleece. They are a hardy and docile race of sheep, of good size, and fair quality of mutton. But the property which distinguishes them from every other breed in Great Britain is the fecundity of the ewes, and their readiness to receive the male at an early season. They have even been known to yean twice in the same year. Being, in addition to this, excellent nurses, they have long been in use for rearing house-lamb for the London market. For this purpose the rams are put to them early in June, so that the lambs are brought forth in October, and are ready for market by Christmas. But for this peculiarity, they would ere now have shared the fate of so many other native breeds, which have given place either to the Leicesters or Southdowns, according to the nature of the pastures. So long, however, as the rearing of early house-lamb is found profitable, there is a sufficient inducement to preserve the Dorset breed in their purity, as they are unique in their property of early yeaning.

3*d.*—*Mountain Breeds.*

Cheviots.—As we approach and cross the Scottish border we find a range of hills covered with coarser herbage than the chalky downs of the south, and with a climate considerably more rigorous. Here the Southdown sheep have been tried with but indifferent success. This, however, is not to be regretted, seeing that the native Cheviot breed rivals them in most of their good qualities, and possesses in addition a hardihood equal to the necessities of the climate. This breed, besides occupying the grassy hills of the border counties, is now found in great force in the north and west Highlands of Scotland. In the counties of Sutherland and Caithness, where they were introduced by the late Sir John Sinclair, they have thriven amazingly, and in the hands of some spirited breeders have attained to as great perfection as in their native district. During the last thirty years, this breed has undergone very great improvement in size, figure, weight of fleece, and aptitude to fatten. In proof of this, it is enough to mention that Cheviot wedder lambs are now in the border counties brought to market when weaned, and are transferred to the low country graziers, by whom they are sent fat to the butcher at sixteen months old, weighing then from 16 to 18 lb. per quarter. This is particularly the case in Cumberland, where Cheviot lambs are preferred by the low country farmers to all other breeds, and by whom they are managed with great skill and success. It is not at all unusual with them to realise an increase of from 20s. to 25s. per head on the purchase price of these lambs, after a twelvemonth's keep. This fact is peculiarly interesting from the proof which it affords of a hitherto unsuspected capacity in Cheviots, and probably in other upland breeds, to attain to a profitable degree of fatness and weight of carcase, at almost as early an age as the lowland breeds, when the same attention and liberal feeding is bestowed upon them. Such a system is moreover greatly more profitable both for breeder and grazier than the old one. It is every way better for the former to occupy his pastures with breeding stock only, and to get quit of his lambs as soon as they are fit for weaning. It is better for the grazier to get hold of them when full of their lamb-flesh, as by transferring them at once to good keep, he can carry them forward without a check to the earliest stage at which he can realise with a profit. Very great pains are now bestowed on the improvement of this breed; in proof of which it may be mentioned that at the autumn fairs, such as Hawick, Moffat, etc., where great numbers of rams are presented for sale, £10 a head is not unfrequently paid to the more noted breeders for their choicest animals. In August 1851 Mr. Brydon of Moodlaw, whose flock of Cheviots has long enjoyed the reputation of being one of the very best in the country, sold 148 rams by public auction, at an average price of £7, 9s. per head. The competition for these choice specimens of Cheviot sheep was so keen that one was sold for £37, and several more from £20 to £30. There is no breed equally well adapted for elevated pastures, consisting of the coarser grasses, with a mixture of heath; but whenever, from the nature of the soil or greater elevation, the heaths unmistakeably predominate, a still hardier race is to be preferred, viz.

The *Blackfaced* or *Heath Breed.*—They are accordingly found on the mountainous parts of Yorkshire, Lancashire, Cumberland, and Westmoreland; over the whole of the Lammermuir range, the upper part of Lanarkshire; and generally over the Highlands of Scotland. Both male and female of this breed have horns, which, in the former, are very large and spirally twisted. The face and legs are black, with an occasional tendency to this colour on the fleece; but there is nothing of the brown or russet colour which distinguishes the older fine-wooled races. The choicest flocks of these sheep are found in Lanarkshire and in the Lammermuirs, where considerable pains are now bestowed on their improvement. Their chief defects are coarseness of fleece, and slowness of fattening until their growth is matured. In most flocks the wool, besides being open, and coarse in the staple, is mixed with *kemps* or hairs which detract from its value. Rams with this defect are now carefully avoided by the best breeders, who prefer those with black faces, a mealy mouth, a slight tuft of fine wool on the forehead, horns flat, not very large, and growing well out from the head; with a thickset fleece of long, wavy, white wool. Greater attention is now also being paid to their improvement in regard to fattening tendency; in which respect we do not despair of seeing them brought nearer to a par with other improved breeds. Whenever this is accomplished we shall possess in the breeds now enumerated, and their crosses, the means of converting the produce of our fertile plains, grassy downs, rough upland pastures, and heath-clad mountains, into wool and mutton of the best quality, and with the utmost economy of which the circumstances admit.

A branch of this family of the heath breeds called Herdwicks, having its headquarters in Cumberland, although found also in Westmoreland and Lancashire, is frequently much extolled. We are of opinion, that in all their good qualities they are excelled by the best style of pure blackfaced sheep as met with in Tweeddale and the Lammermuirs.

4*th.*—*Cross-Breeds.*

We have thus enumerated the most important of our pure breeds of sheep, but our list would be defective, were we to omit those cross-breeds which are acquiring increased importance every day. With the extended cultivation of turnips and other green crops there has arisen an increased demand for sheep to consume them. Flock-masters in upland districts, stimulated by this demand, happily bethought them of putting rams of the improved low-country breeds to their smaller ewes, when it was discovered that the lambs produced from this cross, if taken to the low country as soon as weaned, could be fattened nearly as quickly, and brought to nearly as good weights, as the pure low-country breeds. The comparatively low prime cost of these cross-bred lambs is a farther recommendation to the grazier, who finds also that their mutton, partaking at once of the fatness of the one parent, and of the juiciness, high flavour, and larger proportion of lean flesh of the other, is more generally acceptable to consumers than any other kind, and can always be sold at the best price of the day. The wool, moreover, of these crosses, being at once long and fine in the staple, is peculiarly adapted for the manufacture of a class of fabrics now much in demand, and brings in consequence the best price of any British-grown wool. The individual fleeces, from being close set in the pile, weigh nearly as much as those of the pure Leicesters. On all these accounts, therefore, these sheep of mixed blood are rapidly rising in public estimation, and are produced in ever increasing numbers. This is accomplished in several ways. The occupiers of uplying grazings in some cases keep part of their ewe flock pure, and breed crosses from another part. They sell the whole of their cross-bred lambs, and get as many females from the other portion as keeps up the number of their breeding flock. This system of crossing cannot be pursued on the highest class of farms, as ewes bearing these heavier crossed lambs require better fare than when coupled with rams of their own race. The surplus ewe lambs from such high-lying grazings are an available source of supply to those of a lower range, and are eagerly sought after for this purpose. Others, however, take a bolder course. Selecting a few of the choicest hill-country ewes which they can find, and putting these to a first-rate Leicester ram, they thus obtain a supply of rams of the first cross, and putting these to ewes, also of the first cross, manage in this way to have their entire flock *half-bred*, and to go on continuously with their own stock without advancing beyond a first cross. They, however, never keep rams from such crossed parentage, but always select them from the issue of parents each genuine of their respective races. We know several large farms on which flocks of crosses betwixt the Cheviot ewe and Leicester ram have been maintained in this way for many years with entire success; and one at least in which a similar cross with south-down ewes has equally prospered. Many, however, prefer buying in females of this first cross, and coupling them again with pure Leicester rams. In one or other of these ways cross-bred flocks are increasing on every side. So much has the system spread in Berwickshire, that whereas, in our memory, pure Leicesters were the prevailing breed of the county, they are now all but confined to a few ram-breeding flocks. The cross-breed in best estimation in England is that betwixt the Cotswold and Southdown, which is in such high repute that it bids fair to be ere long established as a separate breed. In Scotland the cross betwixt the Leicester ram and Cheviot ewe is that which seems best adapted to the climate and other conditions of the country, and is that accordingly which is most resorted to.

Section 2.—Management of Lowland Sheep.

As the management of sheep is influenced mainly by the nature of the lands upon which they are kept, we shall first describe the practice of Lowland flock-masters, and afterwards that pursued on Highland sheep-walks.

On arable farms, where turnips are grown, and a breeding stock of sheep regularly kept, it is usual to wean the lambs about the middle of July. When this has been done, the aged and faulty ewes are drafted out, and put upon good aftermath, or other succulent food, that they may be got ready for market as soon as possible. In many districts it is the practice to take but three crops of lambs from each ewe. A third part of the breeding flock, viz. the four-year-old ewes, is thus drafted off every autumn, and their places supplied by the introduction of a corresponding number of the best of the ewe-lambs of the preceding year's crop. These cast or draft ewes are then sold to the occupiers of richer soils in populous districts, who keep them for another season to feed fat lambs. Such parties buy in a fresh stock of ewes every autumn, and, as they phrase it, "feed lamb and dam." In other cases the ewes are kept as long as their teeth continue sound, and after that they are fattened and sold to the butcher directly from the farm on which they have been reared. When the ewes that are retained for breeding-stock have been thus overhauled, they are put to the worst pasture on the farm, and run rather thickly upon it. Attention is necessary, for some days after weaning, to see that none of them suffer from gorging of the udder. When it appears very turgid in any of them, they are caught and partially milked by hand; but usually the change to poorer pasturage, aided by their restlessness and bleating for want of their lambs, at once arrests the flow of milk. The time of admitting the ram is regulated by the purpose for which the flock is kept, and by the date at which fresh green food can be reckoned upon in spring. When the produce is to be disposed of as fat lambs, it is of course an object to have them early; but for a holding stock, to be reared and fattened at fourteen to sixteen months old, from 20th September to 20th October, according to the climate of the particular locality, is a usual time for admitting rams to ewes. A fortnight before this takes place the ewes are removed from bare pasture, and put on the freshest that the farm affords, or better still, on rape, failing which one good feed of white turnips per diem is carted and spread on their pastures, or the ewes are folded for part of the day on growing turnips. The rams are turned in amongst them, just when this better fare has begun to tell in their improving appearance, as it is found that in such circumstances they come in heat more rapidly, and with a greatly increased likelihood of conceiving twins. On level ground, and with moderate sized enclosures, one ram suffices for sixty ewes. Sometimes a large lot of ewes are kept in one flock, and several rams, at the above proportion, turned among them promiscuously. It is better, however, when they can be placed in separate lots. The breasts of the rams are rubbed with ruddle, that the shepherd may know what they are about. Those who themselves breed rams, or others who hire in what they use at high prices, have recourse to a different plan, for the purpose of getting more service from each male, and of knowing exactly when each ewe may be expected to lamb; and also of putting each ewe to the ram most suitable to her in point of size, figure, and quality of flesh and fleece. The rams in this case are kept in pens in a small inclosure. What is technically called a *teaser* is turned among the general flock of ewes, which, on being seen to be in heat, are brought up and put to the ram that is selected for them. They are then numbered, and a note kept of the date, or otherwise a common mark varied for each successive week, is put on all as they come up. The more usual practice is to mark the breast of the ram with ruddle, as already described, for the first seventeen days that they are among the ewes—that being the time of the periodic recurrence of the heat—and then to use soot instead. When lambing-time draws near, the red-rumped ewes, or those that conceived from the first copulation, are brought into the fold, and the remainder after the lapse of the proper interval. If all goes on well, six weeks is long enough for the rams to remain with the flock. The ewes are then put to more moderate fare, taking care, however, not to pinch them, but to preserve the due medium betwixt fatness and poverty. Under the first-mentioned extreme, there is great risk of losing both ewe and lamb at the time of parturition; and under the second, of the ewe shedding her wool, and being unable to nourish her lamb properly either before its birth or after. When there is a considerable breadth of grass-land, the *grit* or inlamb ewes are run thinly upon it, so long as the weather continues moderate. As the pasturage fails, or winter weather sets in, they receive a daily feed of turnips or hay, or part of both. In districts where the four-course rotation is pursued, and wheat sown after seeds, there is a necessity for keeping the ewes wholly on turnips and chopped hay or straw. In this case they are made to follow the fattening sheep, and to eat up their scraps, an arrangement which is suitable for both lots. A recently introduced practice is better still, namely, to feed the ewes at this season on a mixture of one part by measure of pulped turnips or mangel-wurzel to two of chopped straw, which is served out to them in troughs set down in their pastures. From the large quantity of straw which ewes are thus induced to eat, they can be allowed to take their fill of this mixture and be kept in a satisfied and thriving state with a very moderate allowance of roots. As their time to lamb draws near, the mess should be made more nourishing by increasing the proportion of roots and by adding to it ground rape-cake, bean-meal, and bran, at the rate of from $\frac{1}{4}$th to $\frac{1}{3}$d of a pound of each of these articles to each ewe daily.

The period of gestation in the ewe is twenty-one weeks. No lambs that are born more than twelve days short of this period survive. Before any lambs are expected to arrive, a comfortable fold is provided, into which either the entire flock of ewes, or those that by their markings are known to lamb first, are brought every night. This fold, which may either be a permanent erection, or fitted up annually for the occasion, is provided all round with seperate pens, or cribs, of size enough to accommodate a single ewe, with her lamb or pair. The pasture or turnip fold to which the flock is turned by day is also furnished with several temporary but well-sheltered cribs, for the reception of such ewes as lamb during the day. It is of especial consequence that ewes producing twins be at once consigned to a separate apartment, as, if left in the crowd, they frequently lose sight of one lamb, and may refuse to own it, when restored to them, even after a very short separation. Some ewes will make a favourite of one lamb, and wholly repudiate the other, even when due care has been taken to keep them together from the first. In this case the favourite must either be separated from her, or be muzzled with a piece of network, to prevent it from getting more than its share of the milk in the shepherd's absence. Indeed the maternal affection seems much dependent on the flow of milk, as ewes with a well-filled udder seldom trouble the shepherd by such capricious partialities. So soon as the lambs have got fairly afoot, their dams are turned with them into the most forward piece of seeds, or to rape, rye, winter-oats, or water-meadow, the great point being to have abundance of succulent green food for the ewes as soon as they lamb. Without this they cannot yield milk abundantly; and without plenty of milk it is impossible to have good lambs. It is sometimes necessary to aid a lamb that has a poor nurse with cow's milk. This is at best a poor alternative; but if it must be resorted to, it is only the milk of a farrow cow, or at least of one that has been calved six months, that is at all fit for this purpose. To give the milk of a recently calved cow to a young lamb is usually equivalent to knocking it on the head. Ewe milk is poor in butter, but very rich in curd, which is known to be also, in a measure, the character of that of cows that have been long calved, and are not again pregnant. We have found the Aberdeen yellow bullock turnip the best for pregnant and nursing ewes. Mangel-wurzel is much approved of by the flock-masters of the southern counties for the same purpose. It is of importance, at this season, to remove at once from the fold and pens all dead lambs, and filth of every kind, the presence of putrefying matter being most hurtful to the flock. Should a case of puerperal fever occur, the shepherd must scrupulously avoid touching the ewe so affected; or if he has done so, some one should take his accoucheur duties for a few days, as this deadly malady is highly contagious, and is often unconsciously communicated to numbers of the flock by the shepherd's hands. Unnecessary interference with ewes during parturition is much to be deprecated. When the presentation is all right, it is best to leave them as much as possible to their natural efforts. When a false presentation does occur, the shepherd must endeavour to rectify it by gently introducing his hand after first lubricating it with fresh lard or olive-oil. The less dogging or disturbance of any kind that ewes receive during pregnancy, the less risk is there of unnatural presentations. As soon as lambs are brought forth, the shepherd must give them suck. When they have once got a bellyful, and are protected from wet or excessive cold for two or three days, there is no fear of their taking harm from ordinary weather, provided only that the ewes have plenty of suitable food. Lambs are castrated, docked, and ear-marked, with least risk when about ten days old. Ewes with lambs must have good and clean pasturage throughout the summer. For this purpose they must either be run thinly among cattle, or have two or more inclosures, one of which may always be getting clean and fresh for their reception, as the other gets bare and soiled. We have not found any advantage in allowing lambs yeaned in March to run with their dams beyond 20th July. A clover edish, or other perfectly clean pasture, is the most suitable for newly weaned lambs. Such as abound in *tath*, as it is called in Scotland, that is, rank herbage growing above the droppings of sheep, or other animals, are peculiarly noxious to them. Folding upon rape or vetches suits them admirably, so that fresh supplies are given regularly as required. Sheep, when folded on green rye or vetches, require a good deal of water, and will not thrive unless this is supplied to them.

All sheep are liable to be infested with certain vermin, especially by "fags," or "kaids," and by lice. To rid them of these parasites, various means are resorted to. Some farmers use mercurial ointment, which is applied by parting the wool, and then with the finger rubbing the ointment on the skin, in three or four longitudinal seams on each side, and a few shorter ones on the neck, belly, legs, etc. Those who use this salve dress their lambs with it immediately after shearing their ewes, and again just before putting them on turnips. More frequently the sheep are immersed, all but their heads, in a bath, in which arsenic and other ingredients are dissolved. On being lifted out of the bath, the animal is laid on spars, over a shallow vessel, so placed that the superfluous liquor, as it is wrung out of the fleece, flows back into the bath. If this is done when the ewes are newly shorn, the liquor goes farther than when the process is deferred until the lambs are larger and their wool longer. It is good practice to souse the newly shorn ewes, and indeed the whole flock at the same time, in a similar bath, so as to rid them all of vermin.*

The object being to bring these young animals to early and profitable maturity, every pains must be taken not only to preserve their health, but to insure their rapid and uninterrupted progress. For this end it is necessary to provide ample supplies of food suitable for the particular season. As turnips constitute their staple winter fare, it is necessary to have a portion of these sown in time to be fit for use in September. Young sheep always shew a reluctance to take to this very succulent food, and should therefore be put upon it so early in autumn that they may get thoroughly reconciled to it while the weather is yet temperate. Rape, or cabbage, suits admirably as transitionary food from grass to turnips. When this transference from summer to winter fare is well

* The mercurial and arsenical salves and washes commonly in use are believed often to have a hurtful effect on the health of the flocks to which they are applied, and have sometimes caused very serious losses. The discovery of a safe and really efficient salve or wash would be a great boon to flock-masters.

managed, they usually make rapid progress during October and November. Some farmers recommend to give the *hoggets*, as they are now called, a daily run off from the turnip-fold to a neighbouring pasture for the first few weeks after their being put to this diet. We have found it decidedly better to keep them steadily in the turnip-fold from the very first. When they are once taught to look for this daily enlargement, they become impatient for it, and do not settle quietly to their food. If possible not more than 200 should be kept in one lot. The youngest and weakest sheep should also have a separate berth and more generous treatment. Turnips being a more watery food than sheep naturally feed upon, there is great advantage in giving them from the first, along with turnips, a liberal allowance of clover hay cut into half-inch chaff. When given in this form in suitable troughs, and in regular feeds, they will eat up the whole without waste, and be greatly the better for it. To economise the hay, equal parts of good oat straw may be cut up with it, and will be readily eaten by the flock. A liberal supply of this dry food corrects the injurious effects which are so often produced by feeding sheep on turnips alone, and at the same time lessens the consumption of the green food. We believe also that there is true economy in early beginning to give them a small daily allowance, say ¼ lb. each, of cake or corn. This is more especially desirable when sheep are folded on poor soil. This extraneous food both supplies the lack of nutrition in the turnips, and fertilises the soil for bearing succeeding crops. An immense improvement has been effected in the winter feeding of sheep by the introduction of machines for slicing turnips. Some careful farmers slice the whole of the turnips used by their fattening sheep, of whatever age; but usually the practice is restricted to hoggets, and only resorted to for them when their milk-teeth begin to fail. In the latter case the economy of the practice does not admit of debate. When

Mr. Pusey states the difference in value betwixt hoggets that have had their turnips sliced and others that have not, at 8s. per head in favour of the former from this cause alone, we do not think that he over-estimates the benefit. Those who slice turnips for older sheep, and for hoggets also as soon as ever they have taken to them, are, we suspect, acting upon a sound principle, and their example is therefore likely to be generally followed. There is no doubt of this, at least, that hoggets frequently lose part of the flesh which they had already gained from the slicing of the turnips being unduly delayed. By 1st December, their first teeth, although not actually gone, have become so inefficient, that they require longer time and greater exertion to fill themselves than before; and this, concurring with shorter days and colder weather, operates much to their prejudice. When the slicing is begun, it is well to leave a portion of growing turnips in each day's fold, as there are always some timid sheep in a lot that never come freely to the troughs; and they serve moreover to occupy the lot during moonlight nights, and at other times when the troughs cannot be instantly replenished. As the sheep have access to both sides of the troughs, each will accommodate nearly as many as it is feet in length. There should therefore be provided at least as many foot-lengths of trough as there are sheep in the fold. These troughs are usually placed on low cross feet, with a top rail to keep the sheep from getting into them. It is better to raise them about 18 inches from the ground on feet standing well out, to prevent them from being overturned. This preserves the food from being dirtied and wasted, better than a top-rail. When corn or cake is given, it is best to use separate troughs for it of smaller dimensions, and furnished with a roof to keep it clean and dry.

Much discussion has taken place of late years, as to whether sheep can be fattened more economically in the open field or under cover. When the soil is at all dry, the preponderance of evidence is in favour of the former practice. There can be no doubt, however, of the propriety of providing some temporary shelter for fattening sheep against severe winter weather. This is done to some extent by forming the whole or part of the fold fence of wattled hurdles. A double row of common hurdles, set about a foot apart, and having the interstices daily stuffed with fresh straw, forms at once a screen from the weather, and a rack for dry fodder. In very inclement weather, a rude shed can be constructed with stout double hurdles, stuffed between with litter, and having others laid across them, similarly covered, with spadefuls of earth thrown on here and there to prevent the straw from being blown away. We have already, when treating of turnip-culture, pointed out the advantage of having all that are to be consumed after Christmas secured in some way against bad weather and running to seed. To clear the ground in time for the succeeding grain-crop, a portion of the turnip-crop is usually stored on some piece of grass or fallow where the flock is folded until the pastures are ready to receive them. As the date of this varies exceedingly, it is well to lay in turnips for a late season, and rather to have some to spare than to be obliged to stock the pastures prematurely. If corn or cake has been given in the turnip field, it must be continued in the pasture. Hoggets that have been well managed will be ready for market as soon as they can be shorn, and may not require grass at all. They usually, however, grow very rapidly on the first flush of clovers and sown grasses, especially when aided by cake or corn. When the soil is of poor quality, it is expedient to continue the use of such extra food during summer. The best sheep are generally sent to market first, and the others as they attain to a proper degree of fatness. Store sheep or cattle are then purchased to occupy their places until the next crop of lambs is weaned.

Lowland flocks are for the most part shorn in May, although many fat sheep are sent to market out of their wool at a much earlier date. Indeed railway transit has made it practicable to forward newly shorn sheep to market so quickly that there is now little risk of their suffering from exposure to bad weather, and accordingly few fat sheep are now sent to market *rough* after the 1st of April. But in the case of nursing ewes, and store sheep of all kinds, it is highly inexpedient to deprive them of their fleeces until summer weather has fairly set in. Accordingly the latter half of May and the first half of June are, in average seasons, the best shearing time, beginning with the hoggets and ending with the ewes.

Section 3.—*Management of Mountain Sheep.*

We have already taken notice of the extent to which Cheviot sheep have of late years been introduced in the Highlands of Scotland. Many of the immense grazings there are rented by farmers resident in the south of Scotland, who only visit their Highland farms from time to time, and intrust the management of their flocks and shepherds, which rival in numbers those of the ancient patriarchs, to an overseer, whose duty it is to be constantly on the grounds, to attend in all respects to the interests of his employer, see his orders carried into effect, and give him stated information of how it fares with his charge. We are happy at being enabled to submit to the reader the following account of Highland sheep-farming, with which we have been favoured by a gentleman who is extensively engaged in this business.

"The hills in the north of Scotland are mostly stocked with Cheviot sheep, except in the shires of Perth and Argyll, where the blackfaced breed are still considered the most suitable; and a considerable quantity of cattle also are reared. The farms in the high districts are often of great size, some of the largest extending even to 50,000 or 60,000 acres. The land, however, some few valleys excepted, is of a very barren description, much broken with rocks and large stones, or else, as in some parts of Sutherland, extending in vast ranges of moss, covered with the different heaths. It requires generally about three acres to keep a sheep through the season; they never get hay or any foreign feeding during winter, but some of the highest hirsels have sometimes to be driven off to lower ground in severe storms. As the sheep lie scattered over such a great extent of ground, their management entails much more fatigue on the shepherd than in more fertile districts. Many of these shepherds have been brought from the border counties; their wages are from £16 to £18, with house, two cows' grass, ground for potatoes, and 65 stones of oatmeal. The natives of the district get something less. In some cases the grazing of 60 or 70 sheep is given instead of money, but on account of the trouble they cause at sortings, wages in cash are now generally preferred. The number of sheep in a hirsel is about 500, but in some cases twice that number are under the charge of one man.

"One of the most trying seasons for the shepherd is lambing-time, which begins about 20th or 25th April. The number of lambs reared on Mr. Sellar's farm* is much above an average. Low-lying sheltered districts may commonly rear 15 or 16 lambs for every 20 ewes put to the tup; but on the high grounds, although the ewes there are much more careful of their lambs, yet from exposure to the weather and various casualties, there are seldom produced more than 13 or 14 lambs for every 20 ewes. On account of the difficulty of rearing lambs in these high districts, the farmers there find it more profitable to keep most of their land under wedders, and purchase what lambs they require from the low-lying farms near the coast, many of which are now under a ewe stock; there are not yet, however, enough of wedder lambs bred to supply this demand, as large lots are annually driven north from the border markets. The sale wedders (almost all of which are three years old) are clipped as early as possible, say about the middle of June, the ewes, etc., in the beginning of July. Plenty of clippers are to be had from the villages at 1s. per day with victuals. The weight of the fleeces varies much; the average may be about 4 lbs. of smeared wool. A great part of the wool and sheep of the northern counties is sold at the Inverness and Fort-William markets, or consigned to commission-agents in Liverpool. The highest prices for both are obtained by the Sutherland farmers. Everything is sold by character, no stock or samples of any kind are shewn; and it is said that no lawsuit has occurred from any

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* See *Farm Reports, or Accounts of the Management of Select Farms.* Sutherland. By Patrick Sellar.

disputed bargain. The principal lots of sheep are brought into Dumfries, Cumberland, and other western counties, and there has been an increasing demand of late years from Ireland. Those unsold are driven to Falkirk, travelling there from the most northern farms in about four weeks, at an expense of 1s. 6d. per head; some few lots have of late years been sent south by the west-coast steam-boats.

"Few Highland farms, like Mr. Sellar's, contain any arable land; and one of the greatest difficulties the farmer has to contend with is getting the lambs wintered. The ewe-lambs are thought hardier than the wedders; it is also of consequence to have them thoroughly inured to the pasture and climate; so they are commonly kept at home, and either placed on the most suitable hirsels, or left following their mothers through the whole season; the loss during winter amounting to from 4 to 6 out of every 20. Great part of this loss is caused by braxy, which prevails over the whole Highlands, and is often worst in those places which, from their lowness and richness, are most suitable for wintering lambs. No preventive has yet been found.* Poverty and casualties make up the rest of the loss. About the beginning of November, all the wedder lambs are driven off to turnips grown on the east coasts (a few lots of them go to sheltered grazings). They are taken there from great distances, even from Lewis, and often suffer much from bad weather and fatigue during the journey. The expense of wintering them there is from 1¾d. to 2d. per week, but the loss seldom exceeds 2 out of every 20. They return to the hills again in March and April. The average loss of old sheep during a season may be about 2 out of every 20.

"There are some fine lots of tups bred in Sutherland, which have taken prizes in every district; large numbers also are taken every year from the border counties. In some wide-lying hirsels one tup is required for every 30 ewes; 45 being about the average number. All the sheep are smeared with tar and butter, at a cost of 4½d. or 5d. each; no substitute has yet been found for it, and attempts to keep them white have

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* We have been informed by a gentleman who has recently entered upon sheep farming in the west of Ireland on a large scale, that the small farmers in his neighbourhood regularly shear their lambs in August, and assign as their reason for this apparently barbarous practice, that hoggets so treated stand the winter better, and are more exempt from braxy and other diseases than those that are allowed to retain their lamb's wool. The limited experiments hitherto made by our informant and several graziers of his acquaintance, have so far confirmed the propriety of this strange treatment.

not been successful. The rents vary from 2s. to 2s. 9d. per sheep; on some low rich farms they are still higher. The capital required of late years has been 20s. or 25s. for each sheep kept."

The following remarks are from another extensive Highland sheep-farmer:—

"The management of flocks in the Highlands is much the same as on high and exposed farms in the higher districts of Roxburghshire, Dumfriesshire, and Selkirkshire, as regards the ewe hirsels; the ewe lambs either not being weaned, or that only for eight or ten days, so that they may continue to follow their mothers. The wedder lambs are sent to the wedder ground about the beginning of August, and herded on the part of it considered most adapted for their keep, till about the middle of October, when they are sent to turnips mostly in Ross-shire, where they remain till the middle of March or beginning of April. This is one of the heaviest items of expense in Highland farming, amounting to fully 4s. per head; and thus, upon a farm equally stocked with ewes and wedders, adds just about one-third to the rental of the farm. On the return of the wedder hogs, they are put to particular parts of the wedder ground, at large amongst the other ages of wedder stock, where they remain until drawn out when three years old at the usual season to send to market; with this exception, that the year following (when they are dinmonts), the smallest of them, those that are not considered capable of wintering at home, say to the extent of two or three to the score, are again drawn out and sent with the hogs to turnips.

"Mr. Sellar, in his Report of the County of Sutherland, gives a very minute and detailed account of the mode of management as practised on his farms. This, however, does not apply to extensive West Highland farms, which have no arable farms attached, no fields to bring in the diseased or falling-off part of the stock to, nor is it ever practicable to shift any part of the stock to different parts of the farm from that on which they have been reared."

Sheep Farming on the hills drained by the Tweed.

The farms occupied by Cheviot sheep on the hills inclosing the valley of the Tweed and its tributaries, and many similar localities elsewhere, usually include a portion of arable land, which is chiefly valued for the opportunity which it affords of providing a supply of turnips on which the ewes and young sheep are partially fed for six weeks or so immediately preceding the lambing season. The practice is to admit the flock to the turnip fold for four or five hours daily, and then turn them off to some neighbouring piece of heather or rough ground. On such farms the pastures are more devoid of nourishing herbage of any kind during the months of February and March than even in midwinter. A daily feed of turnips at this season, when the sheep are in reduced condition from previous privation, is therefore invaluable. Besides the direct benefit which the flocks derive from being fed on turnip at this season, farther advantage accrues to them from their ordinary pastures getting cleaned and quickened during their temporary but total removal from them.

The Aberdeen-yellow is the variety of turnip most suitable to cultivate in such situations. Being wanted for spring use, care must be taken to preserve them from being destroyed by the severe frosts that so usually prevail in these high-lying districts. This is done by covering them with earth early in November by working a double-mouldboarded plough betwixt the rows. Besides protecting the turnips from frost and the depredations of vermin, it is believed that the bulbs increase more in size after being earthed up than they would otherwise do at this late season.

The sown grasses on such farms are usually made into hay, which supplies the flock with fodder during snow-storms. The aftermath is also of great service in aiding late lambs, and other weakly sheep. As the culture of grain crops on such elevated grounds is usually anything but remunerative, the farmer may actually be at more expense in growing turnips at home than if he were to board his flock for the same length of time in some low-country farm. He is compensated, however, by having his flock less disturbed, and better attended to than if they were sent from home.

It is not at all unusual for one farm to be stocked partly with Cheviots, and partly with blackfaced sheep. The lowest and grassiest grounds are assigned to the pure Cheviots, and if there are enclosed fields of tolerably good grass, a portion of the ewes—the oldest class—is taken to breed crosses from the Leicester ram. The medium grounds, consisting partly of rough herbage mixed with heather, and partly of higher portions producing heather alone, are stocked with blackfaced ewes which are crossed with Leicester rams, while on the highest and bleakest parts, covered chiefly with heather, pure blackfaced sheep are bred.

We begin our description of the management of such flocks with autumn, and assume that the yearly cast of lambs and aged ewes has been disposed of, only so many of the ewe-lambs being retained as are required to keep up the breeding stock. A former practice was to keep these ewe-lambs or hoggets by themselves on the best portions of the respective walks, or *rakes* as they are called on the borders. Now, however, they are kept apart from their dams only so long (eight or ten days) as suffices to let the milk dry up; whereupon they are returned to the flock or *hirsel* to which they belong, and at once associate again, each with its own dam. The hoggets, under the guidance of the ewes, are thus led about over the ground, according to varying seasons, and under the promptings of an instinct which far surpasses the skill and care of the best shepherd. The latter, indeed, restricts his interference chiefly to keeping his flock upon their own beat, and allows them to distribute themselves over it according to their own choice. When thus left to themselves each little squad usually select their own ground, and may be found—the same individuals, about the same neighbourhood—day after day. This plan of grazing the hoggets and ewes together has been attended with the best results. There are far fewer deaths among the former than when kept separate, and being from the first used to the pasturage and acquainted with the ground, they get inured to its peculiarities, and grow up a healthy and shifty stock, more easily managed and better able to cope with trying seasons than if nursed elsewhere, and brought on to the ground at a more advanced age. Each hogget and its dam may be seen in couples all through the winter and spring, and with the return of summer it is a pretty sight to see these family groups grown into triplets by the addition to each of a little lamb.

As the autumn advances, the flock-master makes his preparations for smearing or bathing. The smearing material is a salve composed of tar and butter, which is prepared in the following manner:—Six gallons of Archangel tar and 50 lb. of grease-butter are thoroughly incorporated, and as much milk added as makes the salve work freely. This quantity suffices for 100 sheep. This salve destroys vermin, and by matting the fleece is supposed to add to the comfort and healthiness of the sheep. It adds considerably to the weight of the fleece, but imparts to it an irremediable stain, which detracts seriously from its value per lb. A white salve introduced by Mr. Ballantyne of Holylee, is now in repute on the borders. It is prepared as follows:—30 lb. butter, 14 lb. rough turpentine, and 3 lb. soft soap, are melted and mingled in a large pot; 2 lb. soda, and ½ lb. arsenic are then dissolved in a gallon of boiling water, and this along with 12 gallons more of cold water is intimately mixed with the other ingredients, and yields enough for dressing 100 sheep, at the rate of a quart to each. Some persons believing the arsenic an unsafe application, substitute for it the juice from 10 lb. of tobacco-paper. Instead of the rough turpentine, some also use half a gill of spirit of tar for each sheep; this ingredient being mixed in each quart-potful at the time of application. It is much to be desired that our Excise laws were so far altered as to admit of the importation of tobacco, or at least of tobacco juice, duty free when to be used in the prepartion of salves or baths for sheep. As it is, the high duty almost debars the store farmer from the use of tobacco as a vermifuge, although it is the safest and most efficacious that he knows of.

In applying these salves, the sheep are brought to the homestead in daily detachments, according to the number of men employed, each man getting over about sixty in a day. A sheep being caught and laid upon a stool, the wool is parted in lines running from head to tail, and the tar salve spread upon the skin by taking a little upon the fingers and drawing them along. In using the white salve each shepherd has a boy assistant who pours the liquid salve from a tin pot with a spout, while he holds the wool apart. This white salve destroys vermin, and is believed to nourish the wool and to promote its growth. It does not, however, cause the fleece to adhere like the tar ointment; and hence, the better to defend the hoggets from wet and cold, some flock-masters after salving them put a piece of coarse woollen cloth over the back of each, and sew it to the fleece all round the edges with worsted thread. This "brat" as it is called prevents the wool from parting over the spine, and protects the animal from wet and cold far more effectually than smearing the fleece with tar-salve. Where the *bratting* plan has been adopted, the usual rate of mortality has been reduced, and the vigour of the flock increased. This salving and bratting must all be accomplished before the 20th November, about which time the rams are admitted to the flock. Before this is done another preliminary is required. As the ewe hoggets graze with the flock, it is necessary to guard them from receiving the male, for which purpose a piece of cloth is sewed firmly over their tails, and remains until the rams are withdrawn. This is called *breeking* them. On open hilly grounds about forty ewes are sufficient for each ram. To insure the vigour and good quality of the flock it is necessary to have a frequent change of blood. To secure this by purchasing the whole rams required would be very costly, and therefore each flock-master endeavours to rear a home supply. For this purpose he purchases every autumn, often at a high price, one or two choice rams from some flock of known excellence, and to these he puts a lot of his best ewes carefully selected from his whole flock. These are kept in an enclosed field until the rutting season is over, and after receiving a distinctive mark are then returned to their respective hirsels. From the progeny of these selected ewes a sufficient number of the best male lambs is reserved to keep up the breeding stock of the farm. The rams are withdrawn from the flock about 1st January, and are then kept in an enclosed field where they receive a daily feed of turnips.

Except in heavy falls of snow and intense frosts, the flocks subsist during the entire season on the natural produce of their pastures. It is necessary, however, to be provided for such emergencies both as regards food and shelter. For this purpose each shepherd has at suitable parts of his beat several *stells* or artificial shelters, such as are described at p. 516, and beside each of them a stack of hay from which to fodder the flock when required. So long as the sheep can get at heather or rushes by scraping away the snow with their feet, they will not touch the hay, but when the whole surface gets buried and bound up, they are fain to take to it. The hay is laid out in handfuls over the snow, twice a day, at the rate of 22 lb. to each score of sheep. Much vigilance, promptitude, and courage, are required on the part of shepherds in these wild and stormy districts, in getting their flocks into places of safety on the breaking out of sudden snow-storms. Where turnips are grown they are reserved for spring use, and are given to the ewes as already mentioned, for a few weeks before the lambing season commences, so as to encourage a flow of milk. This indulgence is bestowed only upon the Cheviots; the hardier blackfaces not only not requiring this artificial aid, but in general doing better without it. If the supply of turnips is ample the whole of the Cheviot ewes get a daily feed, but if this indulgence cannot be afforded to the whole flock, the shearling ewes and such older ones as are in poorer condition than the average of the flock are drawn out from the general hirsel, and receive the benefits of the succulent food for the full period named above; the older and stronger ewes being kept upon the hill until near the lambing time. This turnip fare not only benefits the flock while they receive it, but their usual pasture in the meantime gets clean, and freshens against their return to it, which takes place as soon as lambs begin to drop. The flock-master usually endeavours to store a portion of his turnip crop, and to retain it for daily distribution, in a convenient enclosure, to such of the flock as stand in need of such indulgence, after the flock at large have been replaced on their respective *rakes.*

It is at this season that advantage is taken of any dry weather that occurs to set fire to the roughest portions of the old heather, and other coarse herbage, which being thus cleared off, a fresh, young growth comes up, which yields a sweeter pasture to the flocks for several succeeding years. Careful shepherds are at pains to manage the muir-burning so as to remove the dry, effete herbage in long, narrow strips, and thus to secure a regular intermixture of old and young heath.

The lambing season is one of much anxiety to the master: and to his shepherds and their faithful sagacious dogs one of incessant toil. They must be a-foot from "dawn till dewy eve," visiting every part of their wide range several times a day, to see that all is right, and to give assistance when required. The ewes of these hardy mountain breeds seldom require man's assistance in the act of parturition, but still cross presentations and difficult cases occur even with them. Deaths occur also among the newly-dropt lambs, in which case the dam is brought home, and a twin-lamb (of which there are usually enough to serve this purpose) put in the dead one's place. The dead lamb's skin is stript off, and wrapt about the living one, which is then shut up beside the dam in a small crib or *parik*, by which means she is usually induced in a few hours (and always the sooner the more milk she has) to adopt the supposititious lamb. As the lambing season draws to a close, each shepherd collects the unlambed ewes of his flock into an inclosure near his cottage, and examines them one by one to ascertain which are pregnant. To the barren ones he affixes a particular mark, and at once turns them again to the hill, but the others are retained close at hand until they lamb, by which means he can attend to them closely with comparatively little labour. The lambs are castrated and docked at from 10 to 20 days old. For this and for all sorting and drafting purposes an ample fold and suit of pens, formed of stout post and rail, is provided on some dry knoll convenient for each main division of the flock. To this the flock is gently gathered, and penned off in successive lots of 10 or 12, taking care that each lamb has its own dam with it before it is penned, and to do this with as little dogging and running as possible. The male lambs of the pure blackfaced breed when designed to be kept as wedders are not castrated until they are eight or ten weeks old, partly because when done sooner their horns have a tendency to get so crumpled as to grow into their eyes, and partly because a bold horn is thought to improve the appearance of an aged wedder.

On these elevated sheep-walks, shearing does not take place until July. It cannot, in fact, be performed until the young wool has begun to grow or *rise*, and so admit of the shears working freely betwixt the skin and the old matted fleece. The sheep are previously washed by causing them to swim repeatedly across a pool with a gentle current flow-ing through it. They are made to plunge in from a bank raised, either naturally or artificially, several feet above the surface of the water. This sousing and swimming in pure water cleanses the fleece far more effectually than could be supposed by persons accustomed only to the mode pursued in arable districts. Shearing takes place three or four days after washing, and in the interim much vigilance is required on the part of the shepherd to prevent the sheep from rubbing themselves under banks of moss or earth, and so undoing the washing. To diminish the labour to the shepherd, and disturbance to his flock, consequent on frequent gathering, each hirsel is if possible shorn in one day. For this end the shepherds from neighbouring farms assemble, and by turns assist each other. Abundance of good cheer is provided for them by the masters on such occasions, which are usually characterised by much hilarity and keen discussion of the merits of their respective flocks. Each man usually shears about sixty sheep a day. It is neither practicable nor expedient to shear these mountain sheep so closely as the fat denizens of lowland pastures. At these great *clippings* each shearer is provided with a low-legged sparred stool, having a seat at one end, or with a bench built of green turf, which are arranged in a row close in front of a pen, in which the unshorn sheep are placed. The shearers being seated, each astride his stool or bench, with their backs to the pen, a man in it catches and hands over a sheep to each of them. The sheep is first laid on its back upon the stool, and the wool shorn from the under parts, after which its legs are bound together with a soft woollen cord, and the fleece removed first from the one side and then from the other, by a succession of cuts running from head to tail. The fleeces are thrown upon a cloth and immediately carried to the wool-room, where, after being freed from clots, they are neatly wrapped up and stored away by young women. Before the shorn sheep are released, each receives a mark or *buist* by dipping the owner's cypher in melted pitch, and stamping it upon the skin of the animal. To discriminate different ages and hirsels, these marks vary in themselves, or are affixed to different parts of the sheep. Once or twice a year all stray sheep found upon the farms of a well-defined district are brought to a fixed rendezvous, where their marks are examined by the assembled shepherds, and each is restored to its proper owner.

Weaning takes place in August or early in September. A sufficient number of the best ewe-lambs of the pure breeds are selected for maintaining the flock, and are treated in the way already noticed. With this exception, the whole of the lambs are sold either to low-country graziers, or as fat lambs to the butcher. The wedder lambs usually go to the former, and the ewe lambs of the cross betwixt blackfaced ewes and Leicester rams to the latter. These ewes being excellent nurses, make their lambs very fat in favourable seasons, in which case they are worth more to kill as lambs than to rear.

Immediately after the weaning, the ewes which have attained mature age are disposed of, generally to low-country graziers, who keep them for another year, and fatten lamb and dam. To facilitate the culling out of these full-aged ewes, each successive crop of ewe-lambs receives a distinctive ear-mark, by which all of any one age in the flock can be at once recognised.

Section 4.—*Wool.*

Wool is such an important part of the produce of our flocks, that it seems proper to offer a few remarks upon it before leaving this subject. We here insert with much pleasure the following communication from John Barff, Esq. of Wakefield, with which we have been favoured:—

"I willingly give you a reply to your various inquiries regarding wool as far as I am able. As to the kinds grown in the various counties of the United Kingdom, this I cannot fully answer, as there are some counties' wools which have not come much under my inspection; but generally I may remark, that wherever the turnip can be cultivated and has been introduced, the Leicester, Lincolnshire, Coteswold, and the half-breds from Down and Cheviot, are to be found; and in the same counties, in several instances, you have several kinds, if we except Lincolnshire and Leicestershire, which have entirely the longwool sheep. The great bulk also of York, Warwick, Oxford, Cambridge, Gloucester, Northampton, and Nottingham shires, have this description of sheep, but they have also Downs and half-breds. Kent has its own sheep called Kents; the wool being much finer than the real longwool sheep, running in quality and weight of fleece between these latter and the Down, something like your half-breds from Cheviot ewes by Leicester rams. They have somewhat of a similar sheep in Devon, Cornwall, Hereford, and Shropshire, but the quality in the two former counties scarcely so fine as the two latter, or the Kent wools. Norfolk has the original Down and the half-bred; Surrey, Suffolk, Essex, Sussex, and Hampshire, are nearly all Down wools, though in these counties, upon some of their best lands, where they can cultivate the turnip, the half-bred are being introduced; and I need to you scarcely say, the Leicester sheep, as well as half-breds and Cheviots, are to be found in Durham, Northumberland, Berwickshire, Roxburghshire, Lothians, and other parts of Scotland where the turnip is cultivated, and in those parts where it is not, and on the hills, the Cheviot and blackfaced prevail. The blackfaced are used for low padding cloths, carpets, and horse-rugs. The Down wools were formerly all used for cloths and flannels; but now, from the improvement in worsted machinery, one-third is used for worsted yarns, and goods; and as the portion suitable for combing purposes is more valuable for this purpose than for cloths or flannels, the grower aims at getting it as deep-stapled as possible; and this has led to a great increase in the weight of the fleece, but at the same time a deterioration in the quality. The Leicester, Lincolnshire, half-bred, and Coteswold, as well as the Kents and Devons, are entirely used for worsted yarns and goods; and a very small portion of the wools imported come in competition with them. The nearest approach is a little imported from Holland and Denmark; but they partake more of your cross from a blackfaced ewe by a Leicester ram. The Irish wools are either the long-woolled sheep similar to the Leicester, the mountain sheep similar to your Cheviot, or the small Welsh sheep. The Irish wools are generally open haired, and have not the richness of the Leicester or our English; and are not so much esteemed or valuable as English wool of apparently the same quality by ½d. to 1d. per lb. Richness of handle is now very desirable, as there is a demand for what are called *glossy* yarns, which wools fed on pasture or good new seeds can only produce, and cannot be obtained from the wools grown on chalk or hard lands, such as our midland counties, viz., Oxford, Bedford, and Northampton, generally produce.

"In every fleece of wool there are two or three qualities, not more than two or three in the blackfaced, four or five in the longwoolled sheep, five or six in the half-bred, and seven or eight in a Down fleece; and I may say every fleece undergoes this sorting or separation before being put into any process of manufacture. Of course the more there is of the best quality in any fleece, the more desirable and valuable the fleece is; in blackfaced, to be free from dead hair or kemps; and we find in all the other wools, that the closer the staple and *purly* the wool, the more it yields of the finer qualities, whilst the open-haired makes more of the lower quality. The breeder should, therefore, in selecting his tups with a view to good wool, choose them with a close purly staple. A great deal of the excellence, however, of wool depends upon the nature of the soil on which the sheep are fed. Upon the chalk and sandy hard lands, we always find the worst qualities of wool of its kind, whilst the best comes from the rich good lands, where there is plenty of old grass or seeds. Thus the wools of Roxburghshire, as a general rule, are better than Berwickshire or Lothian; Leicester, Lincolnshire, Nottingham, and Warwickshire, superior to Oxford, Cambridge, Bedford, or Northampton; and, in Downs, Sussex and Surrey better than Essex and Norfolk, from their downs being more grassy and the land better. The principal quality required in wool is a rich soft handle, as such is always found to improve in every process it is put through in the various stages of its manufacture, whilst the wools grown on chalk or hard lands, and which have a hard bristly handle, get coarser as they progress in the manufacture.

"With regard to the salves or baths used for destroying vermin, we do not know what kinds are used in the different localities, but of those used with you we dislike the spirit of tar and tobacco. Wilson of Coldstream's dip appears to answer, and one called Ballantyne's used in Selkirkshire; but in all these a great deal depends upon their being properly attended to, and being put on at the proper season. If put on in the autumn, we don't perceive that they have been used, and whenever we have to make a complaint on this head, we find it arises from the baths having been used in spring."

To the above interesting information we add the following items from Mr. Southey's valuable pamphlet:—

"The manufacture of wool, besides being our oldest branch of in-door industry, may justly be considered as characteristic of the British Isles, and it has now reached an amount, as well as acquired a degree of importance, by no means duly appreciated. It is also more generally diffused throughout the country, although it flourishes most in the West Riding of Yorkshire ; but, at the same time, other English counties have a proportionate share, and in Scotland it equally forms a prominent feature in the industrial enterprise of the inhabitants. To meet the growing demand for a continuous supply, consequently requires a large, and indeed, as fashions go, a varied producing power, and this fortunately we possess within ourselves, without being dependent, as in reality we are for cotton, upon foreign sources.

"When the manufacture of woollens commenced among us, the chief reliance of the undertakers was upon home production, but being once fairly started, this supply was found to be beneath the actual requirements. Parties concerned were thus compelled to call in foreign aid, and among other expedients resorted to, we became a kind of tributary to Spain, whence in 1815 we imported 6,927,934 lbs. of wool, besides 3,137,438 from Germany ; but in 1849 our importations of the same article from Spain dwindled down to 127,559 lbs., and in the interval we ourselves became extensive exporters of certain qualities to Germany ; notwithstanding we thence still continue to receive some supplies of the most marketable kind. To illustrate this striking change in the sources of our external supply, I beg to subjoin the following comparative statement of wools, imported at a remote and recent period :—

	1815.	1849.
	lbs.	lbs.
"Spain	6,927,934	127,559
Germany	3,137,438	12,750,011
Other parts of Europe	3,416,132	11,432,354
South America	45,838	6,014,525
Cape of Good Hope	23,363	5,377,495
British India	...	4,182,853
Australian Colonies	73,171	35,879,171
Other Parts	10,291	1,004,679
	13,634,167	76,768,647

"In 1699 it was computed that there were twelve millions of sheep in England and Wales, valued besides the skin at 7s. 4d. each and the wool yearly shorn, worth, at 3s. 4d. per fleece, £2,000,000, at which amount our exportation of woollens was then rated. This subject was afterwards much neglected, nor had we any satisfactory elucidations upon it till Mr. Luccock published his *Treatise on English Wools*, drawn up with great diligence and research, and at the time entitled to much respect, but owing to the want of materials, evidently defective in many of its parts.

"Mr. Luccock estimated that the total produce of our flocks in 1800 was 384,000 packs of 240 lbs. each, or 92,544,000 lbs.; and Mr. James Hubbard, an experienced and extensive wool-stapler of Leeds, when the subject was before the memorable committee of the House of Lords, and a searching inquiry going on, satisfactorily demonstrated, that supposing Mr. Luccock's estimate to have been tolerably correct at the time it was made in 1828, the period to which his own researches were immediately directed, our total production of wool could not be less than 463,169 packs, being only an increase of 20 per cent. and corresponding in the aggregate to 111,623,729 lbs. Relying upon these data, and taking into account the high price which this commodity subsequently attained, as well as the greater weight of both fleece and carcase, thus yielding to the farmer more profit than at any former period, Mr. M'Culloch, writing in 1846, came to the conclusion that the total production of wool, in the British Isles, was then not less than 540,000 packs or 130,140,000 lbs.

"Considering that these data, however respectable, did not afford any just conception, under our altered circumstances, either of the increased number of sheep among us, or the advantage gained through the additional weight of fleece, I addressed letters of inquiry upon these two points to some of our most eminent breeders in the kingdom, and at the same time caused others to be forwarded, and to the same effect, to every part of the country, by long-established staplers and practical men, who readily volunteered to join me in so useful and reasonable a research.

"From all the evidence before me, founded upon information gathered from authentic sources, two important facts result,—1*st*, That our flocks in England, Wales, and Scotland, have gradually increased within the last twenty years; and 2*d*, That the fleece throughout is materially improved in weight.

"As far as I can judge, we annually clip forty millions of sheep, while the fleeces of fifteen millions more, slaughtered, pass through the hands of fellmongers to the consumer. Hence it would follow that we have the yearly fleeces of fifty-five millions of domestic sheep to work upon, averaging, it may be safely admitted, 5 lbs. each. The basis of our manufactures, as far as regards home-grown wool, would thus be about 275,000,000 lbs., which little more than confirms my Bradford correspondent's estimate, and to these are to be added seventy-seven millions of pounds more imported. From these two amounts are to be deducted,—1*st*, 4,000,000 lbs. of British wool exported, and 2*d*, 12,500,000 lbs. of Colonial re-exported, thus leaving the balance annually consumed in our looms and for domestic purposes at about 335,000,000 lbs., or nearly one-half of the total amount of the cotton which we import." *

Certain enterprising brokers have of late years instituted at Edinburgh, Leith, and Glasgow, monthly sales by auction of wool and skins, which are found to be so great a convenience both to manufacturers and farmers, that the amount of business transacted at them is already very large and is rapidly increasing.

* *The Rise, Progress, and Present State of Colonial Sheep and Wools*, by Thomas Southey. London, 1850.

CHAPTER XVII.

LIVE STOCK—GOATS, ETC.

Section 1.—*Goats.*

GOATS never occupied an important place among the domesticated animals of the British Islands, and, with the exception of Ireland, their numbers have been constantly diminishing. By the statistical returns it appears that in 1849 there were 1,777,111 goats in Ireland, which in 1850 had increasd to 1,876,096. This increase is said to be "entirely owing to the impoverished state of the country, which has obliged persons to sell their cows, and to replace them with goats, on whose milk they subsist instead of that of cows." The value of goat's milk, as a source of household economy, is much greater than is usually supposed. This is so well shewn by Cuthbert W. Johnston, Esq., in the *Farmer's Magazine* for April 1852, that we shall quote from his article:—

"The comfort derived by the inmates of a cottage from a regular supply of new milk, need hardly be dwelt upon. Every cottager's wife, over her tea, every poor parent of a family of children fed almost entirely on a vegetable diet, will agree with me, that it is above all things desirable to be able to have new milk as a variation to their daily food of bread and garden vegetables. The inhabitant of towns and of suburban districts, we all know, is at the mercy of the milk dealer; the milk he procures is rarely of the best quality, and under the most favourable circumstances he receives it with suspicion, and his family consume it with sundry misgivings as to its wholesomeness.

"Having personally experienced these difficulties, and having about three years since commenced the attempt to supply my family with goat's milk, and as our experience is cheering, I desire in this paper to advocate the claims of the milch goat to the attention of the cottager, and the other dwellers in the suburban and rural districts.

"Few persons are perhaps aware of the gentleness and playfulness of the female goat—how very cleanly are its habits, how readily it accommodates itself to any situation in which it is placed. Confined in an outhouse, turned on to a common or into a yard, tethered on a grass plat, it seems equally content. I have found it readily accommodate itself to the tethering system, fastened by a leathern collar, rope, and iron swivel, secured by a staple to a heavy log of wood. The log is the best (and this with a smooth even surface at the bottom), because it can be readily moved about from one part of the grass plat to another. The goat too uses the log as a resting place in damp weather. The goat should be furnished with a dry sleeping place, and this, in case of its inhabiting open yards, can be readily furnished; any thing that will serve for a dry dog-kennel will be comfortable enough for a goat.

"The milk of the goat is only distinguishable from that of the cow by its superior richness, approaching, in fact, the thin cream of cow's milk in quality. The cream of goat's milk, it is true, separates from the milk with great tardiness, and never so completely as in the case of cow's milk. This, however, is of little consequence, since the superior richness of goat's milk renders the use of its cream almost needless. The comparative analysis of the milk of the cow and goat will shew my readers how much richer the latter is than that of the former; 100 parts of each, according to M. Regnault, gave on an average,—

	Cow.	Goat.
"Water	84·7	82·6
Butter	4·0	4·5
Sugar of milk and soluble salts	5·0	4·5
Caseine (cheese), albumen, and insoluble salts	3·6	9·0

"So that, while the milk of the cow yields 12·6 per cent of solid matters, that of the goat produces 17·10 per cent, goat's milk yielding rather more butter, rather less sugar of milk, but considerably more caseine (cheese) than that of the cow.

"It must not be supposed that the *taste* of the milk of the goat differs in any degree from that of the cow; it is, if anything, sweeter, but it is quite devoid of any taste which might very reasonably be supposed to be derivable from the high-flavoured shrubs and herbs upon which the animal delights to browse.

"The amount of the milk yielded by the goat varies from two quarts to one quart per day; it is greatest soon after kidding time, and this gradually decreases to about a pint per day,—a quantity which will continue for twelve months. This is not a large supply, it is true; but still it is one which is available for many very useful purposes; and, be it remembered, that when mixed with more than its own bulk of lukewarm water, it is then in every respect superior to the milk supplied by the London dairymen.

"In regard to the best variety of goat to be kept, I would recommend the smooth-haired kind, which are quite devoid of beards or long hair. In this opinion I am confirmed by an experienced correspondent, Mr. W. H. Place of Hound House near Guildford, who remarked, in a recent obliging communication,—'I found that the short-haired goats with very little beards were the best milkers; but from these I seldom had more than four pints a-day at the best (I should say three pints were the average), and this quantity decreases as the time for kidding approaches (the goat carries her young 21 to 22 weeks). They should not be fed too well near the time of kidding, or you will lose the kids. In winter I gave them hay, together with mangel-wurzel, globe and Swedish turnips, carrots, and sometimes a few oats, and these kept up their milk as well as anything, but of course it was most abundant when they could get fresh grass. The milk I always found excellent, but I never had a sufficient quantity to induce me to attempt making butter except once, as an experiment: my cook then made a little, which was easily done in a little box-churn; the butter proved very good. I found the flesh of the kids very tender and delicate.'

"I can add little to Mr. Place's information as to their food; mine have generally fed out of the same rack as a Shetland pony, with whom they are on excellent terms. The pony throughout the summer is soiled with cut-grass, and I notice that the goats pick out the sorrel, sow thistle, and all those weeds which the pony rejects.

"In the garden (if they are, by any chance, allowed to browse), I notice that they select the rose-trees, common laurels, arbutus, laurestinas, and the laburnum. Of culinary vegetables they prefer cabbages and lettuces; they also bite pieces out of the tubers of the potato. They carefully pick up the leaves, whether green or autumnal, of timber trees; of these they prefer those of the oak and elm, and delight in acorns and oak-apples. We are accustomed to collect and store the acorns for them against winter; spreading the acorns thinly on a dry floor, to avoid the mouldiness which follows the sweating of acorns laid in a heap. As I have before remarked, none of these astringent substances affect the taste of their milk; and I may here observe, that with ordinary gentleness, there is no more difficulty, if so much, in milking a goat than a cow.

"The he-goat engenders at a year old. The she-goat can produce when seven months old. She generally yeans two kids. The manure of the goat is perhaps the most powerful of all our domestic animals.

"Such are the chief facts which I have deemed likely to be useful in inducing the extended keeping of the milch-goat. It is an animal that, I feel well assured, may be kept with equal advantage by the cottager and the dwellers in larger houses. It is useless to compare it with the cow, or to suppose that the goat can supplant it in situations where the cow can be readily kept; but in the absence of pastures, and in places where there is too little food for cows, I feel well convinced that, with ordinary care and attention, and a moderate firmness in overcoming the prejudices of those unaccustomed to the goat (and without these are found in the owner, live stock never are profitable), the value and the comfort of a milch-goat are much greater than is commonly known.

"The waste produce of a garden is exceedingly useful in the keep of a goat. By them almost every refuse weed, all the cuttings and clearings which are wheeled into the rubbish yard, are carefully picked over and consumed. To them the trimmings of laurels and other evergreens, pea-haulm, and cabbage stalks, etc., are all grateful variations of their food. In winter a little sainfoin, hay, or a few oats, keeps them in excellent condition. In summer, the mowings of a small grass-plot, watered with either common or sewage water, as described in the following little account, will, with the aid of the refuse garden produce, keep a goat from the end of April until October."

Section 2.—Angora Goat and Alpaca in our Colonies.

The fleece of the Angora Goat is in such demand for the manufacture of certain fabrics, that the attention of flockmasters in Australia and the Cape Colony is being directed to the breeding of these useful animals. There is now also a good prospect of a still more important addition to the live stock of Australia being secured, by the introduction of the Peruvian Alpaca. Through the indomitable zeal and energy of Mr. Ledger, a flock of these animals, numbering 256, was landed at Sydney in December 1858. They have since increased considerably in numbers, and appear to thrive in their new settlement. When it is considered that these animals produce an annual fleece of about 7 lbs., worth 2s. 6d. per lb., their successful introduction into our Australian colonies becomes a matter for national congratulation.

Section 3.—*Hogs.*

Although occupying a less prominent place in the estimation of the farmer than the ox and sheep, the hog is nevertheless an animal of great value. He is easily reared, comes rapidly to maturity, is not very nice as to food, consuming offal of all kinds, and yields a larger amount of flesh in proportion to his live weight, and to the food which he has consumed, than any other of our domesticated animals whose flesh is used for food. To the peasantry he is invaluable, enabling the labouring man to turn the scraps even from his scanty kitchen, and from his garden or allotment, to the best account. On such fare, aided by a little barley or pollard, he can fatten a good pig, and supply his family with wholesome animal food at the cheapest possible rate.

The breeds of swine in Great Britain are numerous, and so exceedingly blended that it is often impossible to discriminate or classify them properly. The original breeds of the country seem to be two, viz., "*The old English Hog,*" tall, gaunt, very long in the body, with pendent ears and a thick covering of bristles. The representatives of this old breed are found chiefly in the western counties of England, especially in Lancashire, Yorkshire, and Cheshire, where hogs of immense size are still reared, but greatly improved as compared with their ancestry. Their bones are smaller, their hair finer and thinner set, their skin thinner and with a pink tint, the ears still pendulous but much thinner, the carcase much thicker, and their propensity to fatten greatly increased. This large breed is exceedingly prolific, and the sows are excellent nurses, it being quite common for them to farrow and rear from 12 to 18 pigs at each litter. They are somewhat tardy in arriving at maturity, and do not fatten readily until that is the case. After sixteen months old, they, however, lay on flesh very rapidly, grow to very great weights, and produce hams of excellent quality, with a large proportion of lean flesh in them. The Berkshire and Hampshire hogs seem originally to have been from the same stock, but by some early cross acquired the thicker carcase, prick-ears, shorter limbs, and earlier maturity of growth, by which they are characterised. The other native breed is found in the *Highlands and Islands of Scotland.* They are very small, of a dusky brown colour, with coarse bristles along the spine, and prick-ears. They are exceedingly hardy and subsist on the poorest fare, being often left to range about without shelter, and support themselves as they best can on the roots of plants, shell-fish, seaweed, and dead fish cast up by the tide.

The improved breeds now so abundant have been obtained by crossing these old races with foreign hogs, and chiefly with the *Chinese* and *Neapolitan.* Our modern *white breeds,* with prick-ears, short limbs, fine bone, delicate white flesh, and remarkable propensity to fatten at an early age, are indebted for these qualities to the Chinese stocks. The improved *black breeds,* of which the Essex may be selected as the type, and which possess the qualities just enumerated in even a greater degree, are a cross from the Neapolitan. They are characterised by their very small muzzle, fine bone, black colour, and soft skin nearly destitute of hair. They can be brought to profitable maturity at from eight to twelve months old, the white breeds at from twelve to sixteen months. Both kinds are peculiarly suitable for producing small pork to be used fresh, or for pickling. The flesh of these smaller breeds produces, however, excellent bacon when used in that manner, and at less cost than that of the larger breeds, for this reason, that it is only from the flesh of a hog that has reached maturity that bacon of the first quality can be produced; and as these have reached that point at an age when the others are but ready for beginning the fattening process, it follows that the carcase of the former, in a state fit for curing, is produced at less cost than that of the latter. Sows of the Neapolitan breed and its crosses are better mothers and nurses than the Chinese. Both kinds require peculiar care, to prevent the pregnant sow from becoming hurtfully fat. Unless kept on poor and scanty fare they inevitably become useless for the purpose of breeding. The Berkshire hog combines the good qualities of the larger and smaller breeds already referred to so happily, that he deservedly enjoys the reputation of being as profitable a sort for the farmer as can be found. With proper treatment he arrives at maturity at about sixteen months old, yields a good weight of carcase for the food which he has consumed, and his flesh is well adapted for being used either as fresh meat, pickled pork, or bacon, according to the age at which he is slaughtered. A very profitable hog is also obtained by coupling sows of the larger breeds with males of some of the smaller *races*.

It too frequently happens that less care is bestowed on the breeding of pigs than of the other domesticated animals. From the early age at which they begin to breed, there is need for constant change of the male, to prevent the intermingling of blood too near akin. These animals, too, are exceedingly sensitive to cold, and often suffer much from the want of comfortable quarters. Whether for fattening hogs, or sows with young pigs, there is no better plan than to lodge them in a roomy house with a somewhat lofty *thatched* roof, the floor being carefully paved with stone or brick, and the area partitioned off into separate pens, each furnished with a cast-iron feeding-trough at the side next the dividing alley, and with adequate drainage, so that the litter in them may be always dry. The period of gestation with the sow is sixteen weeks, and as her pigs may be weaned with safety at six weeks old, she usually farrows twice in the year. In this climate it is desirable that her accouchement should never occur in the winter months. It is a common arrangement to have a pig-shed so placed that the store pigs lodged in it can have access to the cattle-courts, where they grub amongst the litter, and pick up scattered grains that have escaped the thrashing-mill, and fragments of turnips and other food dropped by the cattle. On such pickings, and the wash and offal from the farm kitchen, aided by a few raw potatoes, Swedes, or mangel, and in summer by green vetches, a moderate number of store pigs can be got into forward condition, and afterwards fattened very quickly, by putting them into pens and improving their fare. There is no cheaper way of fattening hogs than by feeding them on boiled or steamed potatoes, mashed and mixed with a portion of barley or pease-meal. When barley-meal alone is used, it should be mixed with cold water, and allowed to soak for twelve hours before being given to the hogs. A few morsels of coal should be frequently thrown into their troughs. These are eaten with evident relish, and conduce to the health of the animals.

An interesting account of the most approved methods of cutting up, curing, and disposing of carcases of pork, is given in the *Journal of the Royal Agricultural Society*, vol. xi. p. 585.

Section 4.—*Rabbits.*

It has been usual, in agricultural works, to take some notice of rabbits. We have so often witnessed the destruction of crops, and consequent vexation and quarrels caused by these creatures, that we regard them only as noxious vermin. It may be true that there are in various parts of the country tracts of sand so barren that it is more profitable to stock them with rabbits than anything else. Those who choose, whether for pleasure or profit, to keep such stock, ought, however, to be compelled to restrain them within the hutch or warren; for certainly they are intolerable anywhere else. A more useful and manageable class of live-stock claims our attention, viz.—

Section 5.—*Poultry,*

which we consider worthy of more attention than farmers generally bestow upon it. There are, indeed, few farm-yards untenanted by fowls of some sort, and few homesteads without a place called a poultry-house. It is rare, however, to meet with an instance where the breeding and management of poultry is conducted with the care and intelligence so frequently bestowed on other kinds of live stock. Now, if poultry is kept at all, whether for pleasure or profit, it is surely worth while to use rational means for securing the object in view. To have good fowls, it is necessary to provide a dry, warm, well-ventilated house, in which they may roost and deposit their eggs. This house must be kept clean, and its tenants regularly supplied with abundance of suitable food. Constant and careful attention is also absolutely indispensable. On farms of the lesser sort, this duty is usually undertaken by the farmer's wife or daughters. It will, however, in most cases, be better to entrust the entire charge of the poultry to some elderly female servant, who shall give her undivided attention to it. As unremitting attention and trustworthiness are the qualities chiefly required in the office of a henwife, and the actual work connected with it is not very heavy, it affords a fitting opportunity for pensioning a faithful domestic, or the widow of some esteemed farm-labourer, who is getting too old for heavier labour.

The kinds of poultry most suitable for a farm-yard are the common fowl, geese, and ducks. Turkeys and guinea-fowl are difficult to rear, troublesome to manage, and less profitable than the other sorts. Of the common fowl there are now many excellent and distinct breeds. The *Cochin China* or *Shanghae* is the largest breed we have. They are hardy and very docile; their flesh is of good quality when young; their eggs, of a buff colour, are comparatively small, but excellent in flavour, and are produced in great abundance. The hens resume laying very soon after hatching a brood; sometimes so soon as three weeks. They are the more valuable from the circumstance that their principal laying season is from October to March when other fowls are usually unproductive. The *Dorkings*, of which there are several varieties, as the speckled, the silver, and the white, are not excelled by any breed for general usefulness. The hens are peculiarly noted for their fidelity in brooding, and their care of their young. The *Spanish fowls* are very handsome in their plumage and form, have very white and excellent flesh, and lay larger eggs than any other breed. The *Polish* and *Dutch every-day layers*, are peculiarly suitable where eggs rather than chickens are desired; as the hens of both these breeds continue to lay for a long time before showing any desire to brood.

A competent authority recommends that, except in situations where 2s. can be got for a good chicken, the return should be sought for chiefly in eggs. He gives the following statement of the cost and produce of a given number of fowls:—

"The following is the weekly consumption of food, and the average produce of eggs of four hens of the Dutch every-day laying variety:—

	s.	*d.*
1·4 gallons of barley, at 20s. per quarter . .	0	6
26 eggs, at 1s. per score	1	3½
Profit . .	0	9½

being upwards of 150 per cent. The consumption of food in this case is very great, being upwards of 1½d. each per week. We are at present trying experiments with the Spanish breed. We find that three hens and a cock consume in a week—

½ gallon of oats, at 14s. per quarter . . .	1·3125
½ stone of barley-meal, at 8d. per stone . .	4·
	5·3125

or rather more than 1¼d. each per week. If the fowls had a free range, we would calculate on keeping them on one-fourth of this amount."*

A suitable stock of fowls being selected, pains must be taken to preserve their health and other good qualities by breeding only from the best of both sexes, and these not too near akin. A very simple plan for securing this is to select a cock, and not more than six or eight hens, of the best that can be got, to entrust these to the care of some neighbouring cottager, whose dwelling is sufficiently apart to prevent intercourse with other fowls, and then to use only the eggs from these selected fowls for the general hatching. There are many advantages in such a course. The whole stock of fowls can thus be had of uniform character, and superior quality. If it suit the fancy or object of the owner, his fowls may be of several distinct breeds without any risk of their intermingling; the select breeding stocks can be kept up by merely changing the cock every second year, and not more than one cock to thirty hens need be kept for the general stock, as it is of no consequence whether their eggs are impregnated or no. Besides having the run of the barn-door, cattle-courts, and stack-yard, fowls are greatly benefited by having free access to a pasture or roomy grass-plot. If the latter is interspersed with evergreen shrubs so much the better, as fowls delight to bask under the sunny side of a bush, besides seeking shelter under it from sudden rain. Their court should also be at all times

* *Essay on the Rearing and Management of Poultry,* by William Trotter; in Royal Agricultural Society's Journal, vol. xii. p. 198.

provided with clean water, and a heap of dry sand or coal-ashes, in which they wallow, and free themselves from vermin. To keep them in profitable condition, they require, besides scraps from the kitchen, and refuse of garden stuffs, etc., a daily feed of barley or oats at the rate of a fistful to every three or four fowls. In cold weather, they are the better of having some warm boiled potatoes thrown down to them, as also chopped liver or scraps of animal food of any kind. There is an advantage in having the poultry-house adjoining to that in which cattle-food is cooked in winter, as, by carrying the flue of the furnace up the partition-wall, the fowls get the benefit of the warmth thus imparted to their roosting-place. Saw-dust, dried peat, or burnt clay, are suitable materials for littering poultry-houses, and are preferable to straw. By strewing the floor with such substances two or three times a week, each time carefully removing the previous application, and storing it with the mingled droppings of the fowls *under cover*, a manure little inferior to the best guano can be secured. When 100 common fowls, a score of geese, and a dozen or two of ducks, are kept, the quantity and value of the manure produced by them, if kept by itself and secured from the weather, will surprise those who have not made trial of such a plan.

Of late years, the breeding of poultry has in various parts of the kingdom become quite a passion. Not only have many separate treatises been published entirely devoted to this subject, but every agricultural periodical now bears evidence to the popularity of this pursuit. Our national agricultural societies, and many of the provincial ones, now offer numerous and liberal prizes to poultry. It is in connection with these shows that the public have been made aware of the extraordinary enthusiasm with which a numerous portion of the community have engaged in poultry-breeding. At the Birmingham show, held in December 1852, no less than 1200 pens of poultry were exhibited. A pen of Spanish fowls, consisting of a cock and four hens, was claimed by a purchaser, although the reserve price put upon it by the owner was fifty guineas. For a single Cochin China cock £25 was refused. But the importance of the show is best shewn by the receipts in money, which were—

For admission of visitors	£1842	19	0
Sale of catalogues	279	4	0
Do. of poultry.	1636	15	6
	£3758	18	6

Similar results occurred in connection with the more recent metropolitan show, when 695 pens of poultry were brought forward. On the first day of exhibition, each visitor was charged 5s, and yet, at this rate, several hundreds sought admission. Next day, at 1s. each, there were upwards of 5000 visitors, a greater number the following day; and on the fourth and last day of the show, they reached nearly to 12,000. The prize Cochin China cock and hen were sold for forty-seven guineas; a hen and pullet of the same breed brought eighteen guineas each; another pair twenty-five guineas; a pen of Poland fowls twelve guineas; and several pens of Aylesbury ducks from £10 to £14. The whole sales on this occasion realised upwards of £1000. It is known that even these extraordinary prices have since been exceeded; a prize Cochin China cock having actually been sold for £100. Not a few farmers who were fortunate in early securing good specimens of the popular breeds of poultry, have found the breeding of them more remunerative than that of bullocks. This will, of course, last only until the present poultry-mania abates; but in the meantime, greatly improved breeds of this interesting and useful kind of live stock have been diffused over the country; more judicious modes of treating them than were formerly practised have been made known, and our markets will henceforward be more fully supplied with eggs and fowls of superior quality.

Section 6.—Treatment of Live Stock under Disease.

Time was when every such treatise as the present was expected to contain a description of the diseases to which the domesticated animals are most subject, and instructions for their treatment under them. But now that farriery is discarded, and veterinary medicine is taught in colleges, the handling of such a subject is obviously beyond the province of a practical farmer. A few general observations is all therefore that we offer regarding it. The province of the stock-master obviously is to study how to prevent disease, rather than how to cure it. For this end let him exercise the utmost care, first, in selecting sound and vigorous animals of their respective kinds, and then in avoiding those errors in feeding and general treatment, which are the most frequent causes of disease. When cases of serious disease occur, let the best professional aid that is available be instantly resorted to; but in all those cases which farmers usually consider themselves competent to treat, we advise that they should trust rather to good nursing, and to the healing power of nature, than to that indiscriminate bleeding and purging which is so commonly resorted to, and which, in the majority of cases, does harm instead of good. Those farmers who have the most implicit faith in their phlemes and physic balls, must admit that their treatment often fails, and that even when their patients do recover, they appear to have suffered more from the depletion than from the disease. We have proved this system fully, and know but too well its pernicious effects. We are glad, therefore, to be able to direct the attention of the owners of live stock to a safer and better one. Thirteen years ago, at the urgent recommendation of a friend, we obtained a copy of

Gunther's *Manual of Homœopathic Veterinary Medicine*, and a supply of the medicines there prescribed. Ever since doing so, we have relied upon this system alone, in treating such cases of disease as have occurred amongst our live stock. These have been both numerous and varied, including not a few of pleuro-pneumonia in cattle; and the success has exceeded our most sanguine expectations. We shall not attempt to discuss the merits of a system of medicine which is at present so keenly controverted by members of the medical profession. We have simply to state, that we have had ample proof in our personal experience of the power of minute (but appreciable) doses of a variety of medicines, *when administered on the principle, that "like cures like,"* to arrest and cure disease in the lower animals; and we earnestly recommend to veterinary surgeons, and to the owners of live stock, to give this system a full and impartial trial.

CHAPTER XVIII.

IMPROVEMENT OF WASTE LANDS.

NOTWITHSTANDING the great progress which agriculture has made, and the immense amount of capital, energy, and skill, which for generations have been brought to bear upon the improvement of our soil, there are still large portions of the surface of our country lying in their natural state, and usually classed under the head of *Waste Lands,* in contradistinction to those which are under tillage, or have at some time been subjected to the plough. Of this (so called) waste land, but a limited portion is absolutely unproductive. Much of it is capable of being converted into arable land, and doubtless will in course of time be so dealt with, but in the meantime, this class of waste lands, and very much more that will never be tilled, is of great and steadily increasing value as sheep-walks. Even for this purpose most of it is susceptible of great improvement, and would well repay for it. These lands are comprised under the following descriptions: 1*st,* Those hilly and mountainous parts of Great Britain which, from their steep and rugged surface and ungenial climate, are unfit for tillage; 2*d,* Those which lie uncultivated owing to natural poverty of soil, its wetness, or the degree to which it is encumbered with stones; 3*d,* Bogs and mosses; 4*th,* Lands so near the sea-level as to be more or less liable to be submerged; and 5*th,* Blowing sands.

Section 1.—*Improvement of High-lying Sheep Pastures.*

The lands referred to under the first of these heads are of very great extent, embracing the whole of the mountainous parts of Scotland and Wales, and much of the high grounds in the north of England and south of Scotland. These high grounds afford pasturage for innumerable flocks of sheep of our valuable mountain breeds. The business of sheep-farming has received a great stimulus of late years from the ever-growing demand for sheep to consume the green crops of arable districts. These upland sheep-walks are accordingly rising in value, and their improvement is becoming every day of increasing importance. The improvement of these hill grazings embraces these leading features, viz., drainage, shelter, and enclosure. Until of late years our hill flocks were peculiarly liable to rot and other diseases arising from the presence of stagnant and flood water upon their pastures. Many grazings that had at one time an evil reputation on this account now yield sound and healthy sheep, solely from the care with which they have been drained. To guard against the pernicious effects of flooding, the courses of brooks and runnels, which in heavy rains overflow their grassy margins, are straightened, deepened, and widened, to such an extent as is required to carry off all flood water without allowing it to overflow. Some grounds are naturally so dry that this is all that is required to render them safe. But, in general, the slopes and hollows of hilly grounds abound with springs, and deposits of peat, and with flats on which water stagnates after rain. On well-managed grounds such places are covered with a net-work of open drains or shallow ditches, about 30 inches wide at top, and half as many deep, by which superfluous water is rapidly carried off. The cutting of these drains costs from 6s. to 8s. per 100 rods (of six yards each). In pastoral districts there are labourers who are skilled in this kind of work, and to whom the laying out of the lines is frequently entrusted, as well as the execution of the work. Where the ground slopes considerably, they are careful to avoid a run directly down the declivity, as a strong current of water in such circumstances gutters the bottom of the drain, and chokes those below with the debris thus produced. In cutting these drains two men work together. After ripping the turf on either side at the proper width, one man, by means of a large triangular spade, nearly of the same width and depth as the drain, and having a cross handle to the shaft, which he grasps with both hands, cuts out sod after sod, by first striking it down to the full depth, and then using it as a lever, while his assistant pulls out the pieces by striking a dung-drag into them, and deposits them in a regular row, green side uppermost, along one side of the drain. The bottom is afterwards cut even and shovelled out. When such drains have been properly made, it is necessary to have them statedly overhauled and kept in good order.

Next in importance to drainage is good and sufficient shelter. This, in the absence of natural coppices of birch or hazel, is provided by means of clumps and belts of fir plantation. These should always be of such extent that the trees may shelter each other as well as the sheep. Trees planted in a mass always shoot up faster than in narrow strips, and restrain the snow-drift which passes through the latter. A shepherd who knows the ground well should always be consulted about the sites of such plantations. The conditions requisite are, that the soil be such as trees will grow in; that it be so far removed from any brook, ravine, or bog, as to be accessible to the flock from all sides; that there be rough herbage, such as heather, gorse, or rushes, near at hand, which the sheep may be able to get at in deep snow; that it be contiguous to the sheep-walk; and placed so as to afford defence against the most prevalent winds. A less costly shelter is formed by building what are called *stells*, which consist of a simple dry-stone wall, enclosing a circular space, twenty yards or so in diameter, with an opening on one side; or forming a cross, in one angle of which the sheep find shelter from whatever point the wind blows. A haystack is a necessary adjunct to such defences.

It is a further point of importance to have such grazings surrounded with a ring fence, consisting either of dry-stone walls, turf walls with wire a-top, or a simple wire fence. This prevents trespass; and the sheep having freedom to range, without watching, up to the boundary, more of them can be kept on the ground than when they are ever and anon turned back by the shepherd. These needful and inexpensive improvements are now generally attended to over the wide pastoral districts of the Scottish border counties. In the remote Highlands they are still much neglected. There are few agricultural improvements which yield so quick and certain a return as these.

Section 2.—Reclaiming of Muiry Soil.

The improvement of the second class of these unreclaimed lands is now much facilitated by the readiness with which portable manures can be obtained for them. Draining and enclosing here necessarily demand the first attention. In some cases the land is so encumbered with stones, that careful trenching of the whole surface is the only way of getting rid of them. In Aberdeenshire, many thousands of acres formerly useless, have been converted into valuable arable land by this means.

In nearly all parts of the country there are extensive tracts of this muiry soil, producing only a scanty and coarse herbage, which are susceptible of remunerative improvement. We are happy at being able to submit to the reader the following detailed account of a recent and successful instance of this, which has been kindly furnished to us by George A. Grey, Esq. of Millfield Hill, Northumberland.

THE RESULT OF PARING AND BURNING MOORLANDS.

"It is said that 'necessity is the mother of invention.' I was told by some of my friends that I had given too high a price for this estate, and that it would be a dearer farm to me now than when I rented it from Lord Grey. To overcome this opinion or fact, I thought of several plans of making it more remunerative, and decided on that which I am now about to describe,—

"On the high part of the farm, at an elevation of from 400 to 500 feet above the sea, I had upwards of 100 acres of moorland of a poor description, which had never been under plough. This consisted of short heath, bilberry bushes, and dry white bent grass, and a soft dry deep moss, delightful as a Turkey carpet under foot, and excellent excursive ground for old hunters, with a small portion of spratty grass and rushes in the damp hollows. The soil is of a free turnip and barley loam on the rotten whinstone. By planting on the west side, and in some places suitable for shelter, I reduced the quantity to about 100 acres. This I divided into three fields of about 33 acres each.

"My great dread was the length of time which such a rough dry surface would require to decompose sufficiently to allow of cultivation, having seen heathery moors in many parts of Scotland lying for two, three, and four years before crops could be obtained, owing to the great cover of coarse vegetation preventing the furrow from lying over, and keeping the land so open and dry through summer that if a *braird* of corn or green crop was obtained, it would wither away in dry weather.

"I had heard of paring and burning, but knew nothing of the process. I, however, obtained the necessary information very much from Mr. Langlands of Bewick, who had practised it to a considerable extent. With what I saw there I was so much pleased, that I determined to proceed at once.

"I also saw Mr. Langlands' work done by a paring-plough, such as is used in the south of England, with a wide plate to cut a furrow of 10 or 12 inches in width. On the point of this is an upright piece of steel which cuts and divides the heath,—the mould-board turns the furrow over flat on its back, and from end to end of the landing the furrows lay side by side like planks from a saw-mill, and were about half an inch in thickness.

"I must, however, remark, as a caution to others against falling into the same error as I did, that this land had been in tillage at some former time, and was in ridges with a regular surface, so that when the plough was *set*, it cut the whole furrow at a uniform depth, and was drawn by two horses with ease, and at an expense of about eight shillings per acre.

"I got this plough and gave it a fair trial, but from my land never having been laid smooth, it cut one part as thin as was wished, and the next yard, perhaps six or twelve inches thick, which caused a great extra expense in drying, lifting, and burning, and wasted more soil than was necessary or desirable. Also my land having a great deal of small whinstone below the turf, the steel plate frequently got injured and broken. It was therefore with great reluctance laid aside, and the ordinary method of paring by hand adopted, which is slower and much more expensive, but very perfect. It saves soil, and cheapens the burning operation, the paring being so thin when the heath, etc., was divided, that light could be seen through the sod, which was only held together by the roots and fibres.

"I began to No. 1 field in July 1849. I let the paring and burning to a company at 25s. per acre, but they made low wages, and after getting more than their work came to, gave up the job. I then got some experienced hands to pare, and paid them the usual wages, at that time 9s. per week, and gave them their food, say 13s. per week, the work being very hard. The total cost of this averaged me 24s. 9d. per acre. A portion of the top part of No. 1 was left undone owing to the lateness of the season. This was dry benty turf. It was ploughed in the common way and grew no oats in 1850. It was again ploughed and much harrowed and rolled, and sown with the remainder of the field in 1851 with rape, and has grown only a few plants at wide distances. It is still in such a dry undecomposed state, that although it is on the high part of the field where sheep draw to lie, I do not expect that it will grow a crop of corn next year; while a portion which was pared down the middle of it grew good corn and rape.

"A portion of No. 2 field was also ploughed in the ordinary way. This was moist land, growing shorter and sweeter grass than any other. It grew a very thin irregular crop of oats in 1850, not within three quarters per acre of the pared land, but is now (1851) bearing a good crop of oats, that field being a second time in oat crop. To return:

"I had a fair crop of rape in the autumn of 1849 on a considerable portion of No. 1, where it was sown in tolerable season during all August, after that it appeared to be too late. All was, however ploughed up at once to secure the ashes, and was well harrowed and sown with oats in the spring of 1850. The pared land turned out to be much too thickly sown at four bushels per acre. Corn tillers so much on such land, that in some parts it prevented it from coming to maturity. I have since sown much thinner, say three bushels per acre, and even in some degree I find the same fault, there being from five to eight stems from one root. My crop of 1850 turned out to be 30 bushels per acre, but it was on the point of being cut when the high wind in August devastated this district, and that lying high and fully exposed to the wind, suffered most severely. I should say it was not below six quarters per acre, and the quality of the grain good.

"In June and July 1850, I pared No. 3 by the same hands who finished my work the previous year. I let the burning of it to an Irishman at 2s. 6d. per acre, binding him to burn it closely piled up in good-sized heaps like hay-cocks to prevent the escape of the ashes in the shape of smoke into the atmosphere.

"This, with the paring, cost me on 36 acres 19s. 6d. per acre. I got 20 acres of it ploughed and sown with white turnips, broadcast in July and August. I had a close nice crop, though the roots were small, which kept a large flock of sheep for several weeks. This had the good effect of treading down the land and making it plough up better for oats.

"Nos. 1 and 2 were limed at the rate of 7 loads per acre. In June 1851, No. 1 was sown broadcast with rape, by mixing 4 lb. of rape seed with one bushel of oat shellings for an acre, and sowing them out of a grass-seed machine. The crop is very close and fine, and has kept twenty scores of sheep from an early day in August to this date (September 27th).

"No. 2 in 1851 was again sown with oats, which are a very fine crop, as is also No. 3. My men think them nine quarters per acre. They are very thick and tall, and have very long large heads; and the grain is plump and good, the stalks being strong, the crop is not lodged so as to injure the yield. I estimate it at certainly 7½ quarters per acre, but shall calculate it at 6 quarters.

"I sow on that land the sandy oat, being early, not liable to lodge nor to shake in moderately high winds, although it was not proof against that of 1850.

"Previously to breaking up, I drained with pipes all the land which required drying, of which I shall give a statement, along with the expenses and profits of the whole.

"The result shews, that if I had some years ago, when prices of grain were good, done as *a tenant* what I have done now, I should have been amply repaid by the first or second crops, and have had my farm for the remainder of a twenty-one years' lease worth fully £100 a year more than when I began.

"The result of my experience is, that I neither agree with the generality of Scotchmen nor with many Southerns; the former of whom are of opinion that burning wastes the vegetable matter, which should be kept to decompose and enrich the soil, not considering that at once the land receives a rich dressing of ashes quite equal to two quarters of bones, or 4 or 5 cwt. of the best guano; and that, during the several years which such a slow process would require to take place, the land might be much more enriched by growing, and having eaten upon it fine crops of rape and turnip, and by producing heavy corn crops which would in a much shorter space be returned to it in the shape of manure, and also that, by the process of burning, the land is freed from the larvæ of insects, such as grubs, slugs, wireworms, etc. etc., which are engendered among the rough grass, and fostered for a length of time under the rough, dry, undecomposed turf. To say nothing of the length of time which the speculator is kept out of a large amount of capital and interest, instead of having the former returned with the latter after the first or at most the second year.

"And the latter of whom (the Englishmen) are too much in the habit of repeating the operation of burning, even after the land has lain in grass only for a few years, when it might as well be ploughed and cultivated without such expense, thereby unnecessarily reducing the soil, there not being the same difficulties to be overcome, nor the same advantage to be gained from it.

"I should certainly burn all land with a rough harsh surface, and should as certainly plough and sow all land with a sweet grassy face upon it.

"In my opinion there are few farms in this country which do not contain certain portions of land capable of remunerative improvement, and I have shewn that such improvement is quite within the scope of a tenant with a lease, without which no man can farm well, at least in the Northumbrian system. Would it not be better, then, for landlords, tenants, and the country generally, were tenants to employ labourers on works so speedily remunerative to themselves, rather than run to their landlord whenever they feel the screw, and ask for abatement of rent, or to be allowed to plough out some piece of valuable old grass, or otherwise cross crop their land, with a view of obtaining some temporary advantage, but in the end to the inevitable injury of all concerned?

"EXPENSES OF PARING, BURNING, ETC.

"No. 1. Thirty-three acres pared and burned, at 25s. per acre		£41 5 0
Thirty-three acres limed, seven loads per acre, at 3s. 4d. per load . .		38 10 0
Cartage of ditto, at 3s.		34 13 0
Draining, where required, 3 feet deep, 27 feet apart, with two-inch pipes, etc., cost about £3 : 10s. per acre.		27 1 0
Two and a half years' rent lost, at 5s. per acre per annum		20 12 6
Seed oats (1850), thirty-three acres, with four bush. per acre, at 13s. per boll		14 6 0
Harvesting (1850)—sixty-seven acres cut by two Irishmen, per acre averaging 1s. 6d. per day, and food, say 2s. 3d. per day . . .	£0 4 6	
½ binder, 3s.	0 1 6	
	£0 6 0	
No. 1. Proportion of 67 acres cutting, at 6s. per acre		9 18 0
Carting, six carts per set, three days, at 8s. per day each	£7 4 0	
Forker 3s., stacker 3s., boy 1s. . .	1 1 0	
No. 1. Proportion of total carting	£8 5 0	4 1 4
Thrashing nine stacks—nine bolls coals—say	£0 4 0	
Carting of do.	0 2 0	
Two men at 1s. 6d. per day . . .	0 3 0	
Women—		
High barn . . . 2		
Low do 1		
Straw do 3		
At stack 1		
Chaff-house . . . 1		
—8, at 8d.	0 5 4	
Carry forward .	£0 14 4	£190 6 10

	£ s. d.	£ s. d.
Brought forward .	£0 14 4	£190 6 10
Two boys and horses at stack, at 3s. 6d	0 7 0	
Cost of thrashing per day	£1 1 4	
No. 1. Proportion of three days' thrashing, at £1 : 1 : 4 per day, £3 : 4s.	£1 11 6	
Rape seed (1851)	1 4 0	
		2 15 6
Total expenses,		£193 2 4
Returns :—		
No. 1. (1850) Thirty-three acres, at 5 bolls per acre, or 165 bolls, at 13s. per boll	£107 5 0	
No. 1. Proportion of straw to infield lands not to return to new lands, sixty-seven acres at 15s.	25 9 9	
Eight score ewes 7 weeks on rape, at 6d. per week	28 0 0	
Twelve score dinmonts and gimmers seven weeks, at 5d. per week . .	35 0 0	
Twelve score ewes (put to turnips) eight weeks, at 6d. per week . .	48 0 0	
A quantity of meat left and spring eatage not counted	0 0 0	
Total returns,		243 14 9
		£50 12 5

	£ s. d.
No. 2. Thirty-four acres paring and burning, at 25s.	£42 10 0
Thirty-four acres limed, seven loads per acre, at 3s. 4d. per load . .	39 13 4
Cartage of do	35 14 0
Draining as in No. 1	104 9 1
Two years' rent lost, at 5s. per acre per annum	17 0 0
(1850) Proportion of harvesting as in No. 1	10 4 0
Carry forward .	£249 10 5

Brought forward .				£249	10	5			
Carting proportion as in No. 1 . .				4	3	8			
Thrashing proportion as in No 1 .				1	12	6			
(1851) Seventy acres cut by three Irishmen per acre averaging 1s. 6d. per day, and food, say 2s. 3d.	£0	6	9						
Binding	0	1	6						
No. 2. Proportion of cutting seventy acres at . .	£0	8	3	14	0	6			
							£269	7	1
Seed oats, 34 bolls (for two years), at 13s. per boll				£22	2	0			
No. 2. Proportion of (1851) carting, six carts per set, eight days at 8s. each, forker 3s., stacker 3s., boy 1s. . .				10	13	8			
No. 2. Proportion of thrashing (1851) . .				4	13	3			
							37	8	11
Total outlay,							£306	16	0
Return :—									
(1850) Thirty-four acres, five bolls per acre, at 13s.				£110	10	0			
(1850) Proportion of straw as in No. 1				26	5	3			
(1851) Thirty-four acres, eight bolls per acre, at 15s. per boll . . .				204	0	0			
No. 2. Proportion of (1851) seventy acres straw, at 30s. per acre				51	0	0			
Total returns,							391	15	3
							£84	19	3

No. 3. Thirty-six acres pared and burned, at 19s. 6d. per acre	£35	2	0
Thirty-six acres limed, seven loads per acre, at 3s. 4d. per load . .	42	0	0
Cartage of do. at 2s. 6d. per load .	31	10	0
Draining, as above	93	19	2
Carry forward .	£202	11	2

Brought forward .	£202	11	2			
Seed oats, 3 bush. per acre, at 13s. per boll	11	14	0			
One and a half years' rent lost, at 5s. per acre per annum	13	10	0			
Harvesting proportion as in No. 2 .	14	17	0			
Cartage proportion as in No. 2 . .	11	6	4			
Thrashing proportion as in No. 2 .	4	18	9			
Outlay,				£258	17	3
Return :—						
No. 3. (1850) Eight scores gimmers on turnips six weeks, at 4d. per week .	£16	0	0			
Twelve scores ewes three weeks, at 4d.	12	0	0			
Thirty-six acres oats, eight bolls per acre, at 15s.	216	0	0			
Straw proportion as in No. 2 . . .	54	0	0			
Return,				298	0	0
				£39	2	9
Return of No. 1				£50	12	5
Return of No. 2				84	19	3
Return of No. 3				39	2	9
				£174	14	5
Fencing				35	0	0
Total return,				£139	14	5

"*P.S.*—I have not charged for spreading the lime, but charged all the carting as if it had been hired, whereas most of it was carted by my own carts, which carry much larger loads than hired carts, and the difference will more than outbalance the cost of laying on.

"I credit the land with the straw, as the dung will not be returned to that land, it being sufficiently rich with the ashes and lime, etc., to grow turnips and rape crops without manure, and those being eaten on, will make it almost too rich for corn crops.

"Any further information I shall be glad to give to the best of my power.

(Signed) "G. A. Grey.

"Millfield Hill, *Dec.* 1. 1851."

Section 3.—Reclaiming of Bogs.

The reclamation of extensive bogs, or deposits of peat, is a more arduous undertaking, requiring a considerable expenditure of capital and longer time before a return is obtained from it. The extent of land of this description in Great Britain and Ireland is very great. Very exaggerated statements of the profits to be derived from its improvement have often been published, and not a few persons have incurred serious loss by rashly undertaking this kind of work. On the other hand, when bogs are favourably situated with reference to a command of marl or other calcareous matter to assist in their decomposition and consolidation, and of manure to enrich them, their reclamation has proved a very profitable speculation. The well-known instance of Chat Moss in Lancashire affords so interesting an example of this that we shall here quote from a recent description of it.

"Chat Moss, well known as that black barren swamp between Liverpool and Manchester, contains 6000 acres, one-half of which is in the township of Barton, and the remainder in the townships of Bedford, Astley, and Worsley.

"The principal part of this moss, which lies in Barton township, belongs to the Trafford family, and is entailed, but the ancestor of the present Sir Thomas de Trafford appears to have obtained, at the latter end of the last century, an Act of Parliament to grant a ninety-nine years' lease of 2500 acres to a Mr. Wakefield, who about the year 1805 disposed of his interest in it to the late William Roscoe of literary celebrity, who spent a large sum in a fruitless endeavour to improve it, failing in which, the lease was sold in 1821 to other parties. J. A. Brown, Esq., of Woolden Hall, bought 1300 acres; the late Edward Baines, M.P. for Leeds, purchased the remaining 1200 acres. The most extensive and successful efforts at improving this moss have been made on a part of the 1200 acres bought by Mr Baines, who, besides occupying the part operated upon by Mr. Roscoe, improved a considerable breadth himself, and let several portions to other parties, who have made considerable progress in improving small portions. The most extensive operations, however, upon the whole, have been carried out by a company to whom Mr. Baines, in 1828, granted a lease of 550 acres for 68 years, the remainder of the original term, at a nominal rent for the first year, increasing gradually, till at the end of five years the rent attained its maximum of £165 per annum, for the 550 acres. This company, which was formed at the time the Liverpool and Manchester Railway was in progress of being made on the property, consisted, amongst others, of some practical farmers, and originated with William Reed, who for the three first years was the manager, and resided on this farm which they called Barton Moss farm. During that period I had the pleasure of paying my friend Reed a visit, and of witnessing the skill and success attending his enterprise and various experiments.

"Travelling by the railway from Liverpool towards Manchester the Barton Moss farm is on the right hand, excepting a narrow strip of about six acres which is on the left, and abuts on the line for a quarter of a mile on each side of the Barton Moss station, which is seven miles from Manchester. The long narrow belts of fir and other trees and the quickthorn hedges which run north and south, give it an appearance that would lead a casual observer to suppose that it was sound land, or at least that the moss was not so deep under it, as on the other parts over which the railway passes; its depth, however, is the same, and an iron rod may be thrust down by the hand to the depth of eighteen feet in almost any part of it.

"The first operation, that of draining, had been effected by opening side drains at intervals of fifty yards, into which were laid covered ones six yards apart, at right angles with, and emptying into the open side drains.

"The moss being in a semifluid state, it was necessary to proceed slowly with draining, taking out only one graft or depth at a time, allowing it to remain a week or a month, according to the state of the weather, before taking out the second graft; this admitted of the sides becoming consolidated, and of the second graft being taken out without the moss closing in. It was again allowed to remain as before, till sufficiently dry to admit of the third being removed.

"The open drains were made 3 feet wide and 3 feet 6 inches deep, and the covered drains 16 inches wide and 3 feet deep; the last graft of the latter being only about 6 inches wide at the top, tapering to 4 inches at the bottom, and being taken out of the middle of the cut, left a shoulder on each side. The sod or graft first taken out had by this time become tough and dry, and was placed with the heath side downwards in the shoulder, thus leaving the narrow spit at the bottom open for a depth of about 14 inches; the other square sod being put on the top completed the drain.

"The cost of this mode of draining, including the side drains, was about 38s. per acre. The drains first put in required to be renewed in a few years, in consequence of the moss becoming so much consolidated and reduced in height that the plough, as well as the horses' feet, broke through the roof, although the horses were shod with 'pattens' or boards of about 10 inches square, with the angles taken off. The second draining, however, was more permanent, and would probably not have required renewing for many years, but for the moles, which have been very troublesome in working down to the drains, and filling them up in various places; so that the operation of draining has required to be partially renewed in every field, and in many of them entirely so; and thus these little animals have been the cause of a very considerable increase in the cost of labour. It has subsequently been found advisable to put the under drains in at 4 yards, instead of 6 yards asunder, and the advantage in one crop has been quite sufficient to pay the extra cost. A two-horse engine was erected, which drives the thrashing-machine, straw-cutter, and crushing-mill; and the escape-steam from it steams the horses' food.

"The buildings were erected principally of timber, covered with asphalted felt.

"After draining, making roads, and burning off the heath plant, the land was scarified lengthwise of the fields, by an implement, with knives shaped like coulters, reversed, sharp on the convex side, fixed in two bars, and drawn by three horses yoked abreast.

"The tough surface was by this means cut at every four inches; the land was then ploughed across the scarifying; a roller, surrounded with knives, was next passed across the ploughing; after this the land was well harrowed till sufficiently reduced.

"The next operation was that of marling, for which purpose a railway was constructed, at the joint expense of Mr. Baines and the company, from the river Irwell on the south, running through a bed of marl, and through Mr. Baines' farm, as well as the Barton Moss farm, to the Liverpool and Manchester railway, with which it is connected at the Barton Moss station. The length of this railway is about a mile and three quarters; it affords the opportunity of getting manure from Manchester, either by the river or by the railway, as well as the supply of marl or gravel. Further, to facilitate their operations, the company constructed also a *movable* railway, to be laid down along the cross roads and on the fields, upon which about a cubic yard of marl was taken on each waggon, directed to the very spot where it was wanted: thus the marling could be proceeded with in all weathers, and much more rapidly than perhaps such work ever was done before, or could now be done, except by similar means.

"The iron for the rails was rolled expressly for the purpose, and weighed 14 lb. per yard. It was fitted longitudinally on the apex of a triangular wooden sleeper.

"The permanent way cost £520 per mile, and the movable one £280. The latter was in twelve feet lengths, and the pair of rails, with the sleepers and cross-ties, weighed 1 cwt. 3 qrs. It was shifted from place to place on the land by two men at a cost of 2s. 6d. per acre.

"From 60 to 100 cubic yards of marl were put on an acre, and in the following summer the land was manured, also by means of the movable railway, at the rate of fifty tons of black Manchester manure per acre, and planted with potatoes, which were followed by wheat, sown with red clover and rye-grass, for mowing for one or two years; then oats and potatoes, etc., as before. These were all flourishing crops, the wheat in particular looked bright and beautiful. The potatoes were sold for £25 and £30 per acre, which more than paid the whole cost of improvement. Mr. John Bell, resident bailiff, has made many valuable experiments relative to the improvement of raw moss, one of which has resulted in a discovery likely to be of considerable importance, which is, that a mixture of lime and salt applied a while before seeding, with the addition of a good dressing of guano, in the proportion of four tons of lime and five cwt. of salt per acre, qualifies it to produce a crop of potatoes or oats equal to that after the application of 60 yards of marl per acre. It is essential that the mixture should be spread while it is hot. Mr. Evens (one of the proprietors) is convinced that the peat on the surface ought never to be burned; he has always found that, when the heath sod is turned down to decay, much better crops have been obtained than when it has been burnt off, or than when the top has been taken away either for fuel or other purposes. What are termed moss-fallows, that is, parts which have had the moss taken off for fuel, will never bear so good a crop as the upper surface, however deep the moss may be underneath."—(See *Notes on the Agriculture of Lancashire, with Suggestions for its Improvement*, by Jonathan Binns.)

Nearly a century ago the late Lord Kames, on becoming proprietor of the estate of Blair-Drummond, in the county of Perth, began the improvement of a large tract of worthless moss, by a totally different process from that now detailed. In this case the moss had accumulated upon a good alluvial clay soil. Instead, therefore, of attempting to improve the moss itself, it was floated off piecemeal into the neighbouring Firth of Forth. The supply of water required for this purpose was obtained from the river Teith, from which it was raised to the requisite height by a powerful water wheel. Being conveyed through the moss in channels, successive layers of peat were dug and thrown into these channels, which were shifted as occasion required, until the whole inert mass was removed. A thin stratum next the clay was burnt, and the ashes used as manure. An immense extent of moss has thus been got rid of on that estate, and on others in the neighbourhood, and "an extensive tract of country, where formerly only a few snipes and muirfowl could find subsistence, has been converted, as if by magic, into a rich and fertile carse of alluvial soil, worth from £3 to £5 per acre."

Section 4.—Reclaiming of Fen Lands.

We next notice the fen lands of England. "In popular language, the word *fen* designates all low wet lands, whether peat-bog, river alluvium, or salt marsh; but in the great Bedford level, which, extending itself in Cambridgeshire and five adjoining counties, is the largest tract of fen land in the kingdom, the farmer always distinguishes, and it is thought conveniently and correctly, between fen land and marsh land. By the former they mean land partly alluvial, and formed by river floods, and partly accumulated by the growth of peat. Such lands are almost invariably of a black colour, and contain a great per-centage of carbon. By marsh lands they mean low tracts gained from the sea, either by the gradual silting up of estuaries, or by artificial embankments." Low-lying peat occurs in small patches in nearly every maritime county of Britain, being usually separated from the sea or from estuaries by salt marsh or alluvium. There is a large extent of such land in Somersetshire, yet but partially drained, and a still larger breadth in Lancashire where its improvement makes steady progress. In Kent, on the sea-board of Norfolk, on both shores of the Humber, and stretching along the sides of its tributaries, there are immense tracts of this description of land. But these are all exceeded in importance by the "great level of the fens, which occupies the south-eastern quarter of Lincolnshire, the northern half of Cambridgeshire, and spreads also into the counties of Norfolk, Suffolk, Huntingdom, and Northampton. Its length is about 70 miles, its breadth from 3 or 4 to 30 or 40 miles, the whole area being upwards of 1060 square miles, or 680,000 acres. On the map the fens appear like an enlargement of the Wash, and in reality have the aspect of a sea of land, lying between that bay and the high lands in each of the above-named counties, which seem to form an irregular coast line around it." This fen country has for centuries been the scene of drainage operations on a stupendous scale. The whole surface of the great basin of the fens is lower than the sea, the level varying from four to sixteen feet below high-water mark in the German Ocean. The difficulty of draining this flat tract is increased, from the circumstance that the ground is highest near the shore and falls inland towards the foot of the slope. These inland and lowest grounds consist of spongy peat, which has a natural tendency to retain water. The rivers and streams which flow from the higher inlands discharge upon these level grounds, and originally found their way into the broad and shallow estuary of the Wash, obstructed in all directions by bars and shifting sand-banks. These upland waters being now caught at their point of entrance upon the fens, are confined within strong artificial banks, and so guided straight seaward. They are thus restrained from flooding the low grounds, and by their concentration and momentum, assist in scouring out the silt from the narrow channel to which they are confined. The tidal waters are at the same time fenced out by sea-banks, which are provided at proper intervals with sluice doors, by which the waters escape at ebb-tide. To shew the extent of these operations, it may be mentioned that the whole sea-coast of Lincolnshire, and part of Norfolk, a line of a least 130 miles, consists of marsh lands lower than the tides, and is protected by barrier banks, besides which there are hundreds of miles of river embankments. When this does not provide such a drainage as to admit of cultivation, the water is lifted mechanically by wind or steam mills into the main aqueducts. The number of windmills formerly at work on the whole of the fens between Lincoln and Cambridge probably exceeded 700; at present there are about fifty mills in the Lincolnshire part of the level, and perhaps 170 in the Bedford level and adjacent fens, or a total of 220. The number of steam-engines may be estimated at sixty. They lift the water (almost universally by scoop-wheels, not pump) from six to sixteen or twenty feet, and the area of land thus drained may be computed at not less than 222,000 acres.

The first use of steam-engines for the purpose of draining was in Deeping fen, where, in 1824-5, two, of eighty and sixty horse-power respectively, were erected. By means of these two engines upwards of 20,000 acres have now a good drainage, whereas formerly, forty-four wind-mills, with an aggregate power of 400 horses, failed to keep them sufficiently dry. The scoop-wheel of the larger engine is twenty-eight feet in diameter, and the float-boards are five feet wide. It was intended to have a "dip" of five feet, but the land has subsided so much in consequence of the draining that it seldom has a dip of more than two feet nine inches. The water is lifted on an average seven feet high. When both engines are at work they raise 300 tons weight of water per minute.

The soil of the fens consists for the most part of dark coloured peat, from one to eight or ten feet in depth. The surface in general is not pure peat, but is mixed with silt or other soil. Under this there is in general a stratum of brown spongy peat, which sometimes rests upon gravel, but for the most part upon clay, which usually contains a portion of calcareous matter. The removal of the water has, of course, been the primary improvement; but subsidiary to this, the rapid amelioration and great fertility of the fen lands is largely due to this fortunate conjunction of clay and peat. The early practice of the fen farmers was to pare and burn the surface, grow repeated crops of rape, oats, wheat, etc., and burn again. The subsidence of the soil, subsequent to the draining and repeated paring and burning, brought the surface nearer to the subjacent clay, which the cultivators by and by began to dig up and spread over the surface. This practice is now universal, and its continued use, together with careful cultivation and liberal manuring, has changed a not very productive peat into one of the most fertile soils in the kingdom. Nowhere in our country has the industry and skill of man effected greater changes than in the fens. What was once a dismal morass, presenting to the view in summer a wilderness of reeds, sedges, and pools of water, among which the cattle waded, and in winter almost an unbroken expanse of water, is now a fertile corn land. The fen men, who formerly lived upon the adjacent high lands, and occupied themselves with fishing, fowling, and attending to their cattle, have now erected homesteads upon the fen lands, divided them by thorn hedges, and brought them into the highest state of cultivation.

We referred at the outset to the distinction betwixt *fen* land and *marsh* land. In the district called Marsh-land in Norfolk, extending between the Ouse and the Nen; in that called South Holland, in Lincolnshire, stretching between the Nen and the Welland; northward of Spalding, and also north-east of Boston, there is a considerable tract of marine clay soil. In Marsh-land this is chiefly arable land, producing large crops of wheat and beans; but in Lincolnshire it forms exceedingly fine grazing land. This tract lies within the old Roman embankment, by which the district was first defended from the ocean. Outside this barrier are the proper marsh lands, which have been reclaimed in portions at successive periods, and are still intersected in all directions by ranges of banks. The extraordinary feature of this tract is, that the surface outside the Roman bank is three or four feet higher than that in the inside, and the level of each new enclosure is more elevated than the previous one. The land rises step by step, as the coast is approached, so that the most recently reclaimed land is often twelve or even eighteen feet higher than the lowest fen land in the interior, the drainage from which must nevertheless be conveyed through these more elevated marshes to the sea.

The extent of this kind of land already rescued from the sea is very great, and is constantly augmenting. The whole Wash may, in fact, be regarded as a broad expanse of marsh in course of formation. A considerable portion of it is already so much raised as to be left bare at low water. The "Norfolk Estuary Scheme," now in progress, contemplates the enclosure of a large tract of these sands, and the "Victoria Level," if ever executed, will confine the waters to a channel four miles wide, running down the centre of the Wash, and add 150,000 acres to our territory. This would not be all, for if these works are accomplished, they will lower the water in all the fen rivers and afford a natural drainage to the whole of the great level.

Lands, such as some of those which we have just been describing, are often greatly improved, or rather may be said to be *made*, by means of a peculiar mode of irrigation, called "warping." It is practicable only in the case of land lying below the level of high tide in muddy rivers. It is little more than a century since it was first practised in England, the first instance of it being near Howden, on the banks of the Humber. But although the practice is comparatively new in Britain, it has long been in use on the Continent of Europe, particularly in Italy, and is thus described by Mr. Cadell:—"In the Val de Chiana, fields that are too low are raised and fertilised by the process called *colmata*, which is done in the following manner:—The field is surrounded by an embankment to confine the water. The dike of the rivulet is broken down so as to admit the muddy water of the high floods. The Chiana itself is too powerful a body of water to be used for this purpose; it is only the streams that flow into the Chiana that are thus used. This water is allowed to settle and deposit its mud upon the field. The water is then let off into the river at the lower end of the field, by a discharging course called *scolo*, and in French *canal d'ecoulement*. The water-course which conducts the water from a river, either to a field for irrigation or to a mill, is called *yora*. In this manner a field will be raised 5½ and sometimes 7½ feet in ten years. If the dike is broken down to the bottom, the field may be raised to the same height in seven years; but then in this case, gravel is also carried in along with the mud. In a field of 25 acres, which had been six years under the process of *colmata*, in which the dike was broken down to within 3 feet of the bottom, the process was seen to be so far advanced, that only another year was requisite for its completion. The floods, in this instance, had been much charged with soil. The water which comes off cultivated land completes the process sooner than that which comes off hill and woodland. Almost the whole of the Val di Chiana has been raised by the process of *colmata*."*

* *Journey in Carniola, Italy, and France*, by W. A. Cadell, Esq., F.R.S.

This process of warping is now systematically practised on lands adjoining the Humber and its tributaries, and by means of it vast tracts of sterile, sandy, and peaty soils are yearly converted into arable land of the very best quality. The warping of such lands has this farther advantage, that it raises their level, and thus admits of their more perfect drainage. The operation is conducted thus:—

"The first step in the process is to erect a sluice on the bank of the Trent, or other tidal channel, and cut a main drain to the fields which are to be flooded. The sluice-doors point outwards, so as to exclude the tides, except when held open by rods and staples provided for the purpose, and the drain ought to have an area equal to three times that of the sluice, in order to prevent any considerable resistance to the flow of water. The land is then surrounded by an embankment of variable altitude, according to the level of the surface, and from two to three feet wide at the top, the usual slope of the banks being from 15 to 18 inches on each side for every 12 inches perpendicular rise. The tide flows rapidly in, and meeting with no obstruction to detain its current, holds in suspension the particles of sediment with which it is loaded; but directly it leaves the narrow channel, and spreads itself over the broad surface, the rapidity of motion is lost, and the atoms of warp, no longer projected forward, sink quietly to the bottom. A deposit is thus formed greatest near the mouth of the drain, and in order to equalize the amount of warp over the whole ground, the water is conducted to different parts of the compartments by smaller drains called 'inlets.' When the deposit is raised sufficiently high next to the end of these channels, the current is carried forward by extending the banks of the inlets in different directions, and thus, by a skilful and careful guiding of the water, the whole of the land is warped to an equal height. The water is conducted by a temporary drain, first to the further side of the plot, and, when the deposit there is sufficiently high, is allowed to escape at intervals along the side of this drain until the whole area is equally raised. The tide having thrown down much of its mud, returns by the warping-drain into the river, scouring out the sediment which might have accumulated in the drain." . . . . "Generally speaking, the spring-tides only are used, as they have sufficient volume of backwater to keep the warping-drains clear and open. The land is raised from one to three feet in one or two years." . . . . . . "The expense of warping is very variable: When the cost of the large drains and other works is included, the calculation would probably be £12 to £20 per acre; but on lands contiguous to the public warping-drains the expense of flooding is only about £2 : 2s. Within the last thirty years all the peat-lands within three miles of the Trent (in the isle of Axholme) have been warped, the drainage greatly improved, and the soil, from being almost worthless, made worth from £60 to £100 per acre." Taking both sides of Trent, about 16,000 acres have, since the year 1800, been covered with the richest soil to an average depth of two feet, and the process is still extending. (See *Prize Report on the Farming of Lincolnshire*, by John Algernon Clarke, in vol. xii. of *Royal Agricultural Society's Journal*, from which, and from article on "Fen Lands," by the same gentleman, in *Morton's Cyclopædia of Agriculture*, the foregoing information has been gleaned or quoted.)

Section 5.—*Blowing Sands.*

On many parts of our sea-coasts, and especially in the Hebrides, there occur extensive tracts of blowing sands which are naturally not only sterile themselves, but a source of danger to better lands adjoining them, which in some instances have been quite ruined by the sand deposited upon them by the winds. This mischief is effectually prevented by a process beautifully simple and useful, namely, planting the sand-banks with sea bent-grass (*Arundo arenaria*), the matting fibres and stems of which not only bind the sand, but clothe it with a herbage which is relished by cattle, and which, being able to resist the severest winter weather, furnishes a valuable winter forage in those bleak situations. This bent-grass can be propagated by seed, but in exposed situations it is found better to transplant it. This operation is performed betwixt October and March, as it succeeds best when the sand is moist, and evaporation slow.

CHAPTER XIX.

GENERAL OBSERVATIONS.

ACCORDING to the method proposed at the outset, we now offer a few observations on several topics connected with our subject.

Section 1.—*Of the Tenure of Land.*

The extent of land in Great Britain occupied by its owners for agricultural purposes bears a very small proportion to the whole area. The yeoman class is still numerous in several parts of England, but must have diminished greatly from that continuous amalgamation of small estates into large ones which has formed a marked feature in our social history for the past 50 years. This change, although to be regretted on public grounds, has had a favourable influence on the cultivation of the soil, for it almost invariably happens, that a larger produce is obtained from land when it is occupied by a tenant, than when it is cultivated by its proprietor. As a matter of fact, the land of the country is now, with trifling exceptions, let out to professional farmers in quantities varying from the rood-allotment of the village labourer to the square miles of the Highland grazier. Farms of all sizes are usually to be found in any district, and most important it is that this should be the case; but the extent of farms is chiefly determined by the amount of hired labour employed upon them, and the measure of personal superintendence on the part of the tenant which the kind of husbandry pursued upon them calls for. We accordingly find that in very fertile tracts, in the vicinity of towns, and in dairy districts, they seldom exceed 200 acres; where the ordinary alternate husbandry is practised, the average ranges from 300 to 400; in more elevated tracts, where a portion of natural sheep-walk is occupied along with arable land, it rises to 800 or 1000; while that of the sheep grazings of our hills and mountains is limited only by the capital of the tenant. About a century ago there occurred, in various parts of Great Britain, a similar amalgamation of small holdings into farms of the sizes which we have now referred to, as is at present in progress in Ireland. This enlargement of farms, and the employment of increased capital in their cultivation, insures a more rapid reclamation of waste lands, and general progress of agriculture up to a certain point, than would otherwise take place. But as every step in advance beyond this point implies an increase of acreable outlay, and the need for closer superintendence, it seems likely that, in future, the size of arable farms will not further increase, but may rather be expected to approximate to that which at present obtains in suburban districts.

Farms are held either by yearly tenancy, or under leases for a specified number of years. The latter plan is that upon which nearly the whole lands of Scotland are let; and it obtains also to a considerable extent in the northern counties of England, in West Norfolk, and in Lancashire. But with these and other exceptions, amounting altogether to about a tenth part, the farms of England are held by yearly tenancy, which can be terminated by either of the contracting parties giving to the other a six-months' notice to that effect. This precarious tenure has been attended by far fewer changes than a stranger could suppose, owing to the highly honourable conduct for which English proprietors as a class have long been noted. On all the large estates it is quite common to find families occupying farms of which their ancestors for generations, or even centuries, have been tenants. The mutual esteem and confidence which usually subsists betwixt such landlords and tenants is undoubtedly much to the credit of both, but not the less has the system, as a whole, operated unfavourably for all concerned; for however numerous and striking the exceptions, it is yet the fact that under this system of tenancy-at-will, less capital has been invested in the improvement of farms, less labour has been employed, and less enterprise displayed in their ordinary cultivation, less produce has been obtained from them by the occupiers, and less rents have been received for them by the owners, than in the case of similar lands when let on leases for a term of years. These diverse results ensue, not because tenants with leases are abler men or better farmers than their neighbours who are without them, but solely because the one system recognises certain important principles which the other ignores. It is contrary to human nature to expect that any body of men will as freely invest their capital, whether in the shape of money, skill, or labour, in a business yielding such slow returns as agriculture, with no better guarantee than the continued good-will of existing proprietors, or those who any day may succeed them, that they or their families shall reap the fruits of it, as they will do with the security which a lease for a term of years affords. It does, therefore, seem strange that a majority of the farmers of Great Britain should be tenants at will, and still more strange that they should be so of choice. It is nevertheless true, that a considerable portion of the tenantry of England are even less disposed to accept of leases than their landlords are to grant them. The latter cling to the system because of the greater control which they thereby retain over their estates, and the greater political influence with which it invests them: the former do so because low rents are one of its accompaniments. Since the removal of restrictions on the importation of foreign agricultural produce, there are indications that neither landlords nor tenants are so well satisfied with this system of tenancy-at-will as they once were. Not only is the granting of leases becoming more common than it has hitherto been, but there is a growing desire on the part of tenants to obtain the benefit of that guarantee for the realising of their capital which *tenant-right* affords to enterprising farmers who may have unexpectedly to quit their farms. In certain districts of England this claim, called *tenant-right*, has been recognised so long, that apart either from written stipulation or statutory enactment, it has, by mere usage, attained to something like a legal standing. In Lincolnshire, an away-going tenant can, by virtue of this usage, claim from his landlord or successor repayment, in certain definite proportions, of the cost of such ameliorations of a specified kind as he may have made during the last years of his occupancy, and the benefits of which his removal hinders him from realising in the natural way.

Tenant-right is certainly a valuable adjunct to tenancy-at-will, but still it does not meet the real exigencies of the case. There are feelings inherent in man's nature which cause him to recoil from exertions the fruits of which are as likely to be enjoyed by a stranger as by himself or his family. This repugnance, and its paralysing influence, is not to be removed by a mere "right" to pecuniary compensation. It is certainty of tenure—so far at least as human arrangements can be certain—which will really induce a farmer to throw his whole heart into his business. It is accordingly to this principle that leases owe their excellence, and by it also that the only weak point in them is to be accounted for. The first years of a lease are usually characterised by an energetic performance of various improvements, whereas, towards its close, there is usually such a withdrawing even of ordinary outlay, as is unfavourable to the interests of either landlord or tenant. There is at present a very generally entertained opinion that this inconvenience would be obviated by engrafting the system of tenant-right upon that of leases. A proposal to this effect would probably be well entertained by the holders of existing leases; but we believe that it would be anything but popular with in-coming tenants. This view of the matter is confirmed by the experience which we have of the effects of having the straw and dung produced on farms *steel-bow*—that is the property of the landlord, and transferred by him free of charge to entering tenants on condition that they leave them so to their successors. This arrangement is generally admitted to be better for all parties, than when away-going tenants have a "right" to claim payment for these commodities from their successors, or to sell them off the farm if they prefer to do so. Scottish experience is therefore unfavourable to the system of tenant-right, in the only instance of it which obtains there. We know of no practicable remedy for the injurious lowering of the condition of farms at the close of leases, but in the parties renewing their contract in time to prevent it.

It seems to be generally admitted, that twenty-one years is the proper duration for an agricultural lease. Such a term suffices to give confidence to the tenant in embarking his capital, and secures to the landlord his legitimate control over his property, and due participation in its varying value. It is generally felt by tenants that the lease or document in which their agreement with their landlord is engrossed might with advantage be much shortened, as well as simplified in its terms. When treating of the succession of crops, we have already expressed our views regarding those restrictive clauses which usually occupy a prominent place in such writings. Such restrictions are, of course, introduced with the view of guarding the property of the landlord from deterioration. But when he is so unfortunate as to meet in with incompetent or dishonest tenants they entirely fail to secure this object, and yet are a hindrance and discouragement to enterprising and conscientious ones. It is probable that the existence of the law of distraint, or hypothec, which gives to landlords a lien over the effects of their tenantry in security for the payment of the current year's rent, has had its influence in adding to the number and stringency of these clauses, and has encouraged the practice of letting lands by tender to the highest offerer. For the law in question, by rendering landlords to a considerable extent independent of the personal character and pecuniary circumstances of the occupiers of their land, has a direct tendency to render them less cautious who they deal with than they otherwise would be; and to induce them, when tempted by the promise of high rents, to trust more to this legal security than to the moral character, business habits, professional skill, and pecuniary competency, of candidates for their farms.

Section 2.—*Capital required for working a Farm.*

The amount of capital that is required in order that the business of farming may be conducted advantageously, is largely determined by the nature of the soil, etc., of each farm, the system of management appropriate to it, the price of stock and of labour, and the terms at which its rents are payable. In the case of land of fair quality, on which the alternate husbandry is pursued, and when the rents are payable as the produce is realised, £8 per acre may be regarded as an amount of capital which will enable a tenant to prosecute his business with advantage and comfort. In letting a farm, a landlord not only does a just and prudent thing for himself, but acts as a true friend to his proposed tenant, when he insists upon being shewn that the latter is possessed of available funds to an amount adequate to its probable requirements.

Section 3.—*Education of Farmers.*

The importance of the topics to which we have thus referred, is happily expressed by Mr. Pusey, when, after enumerating various agricultural desiderata, he says, "In some degree none of us carry out all that is in our power; but want of capital, or want of confidence in the tenure of farms are, I suppose, the two principal causes of this omission."

But the mere possession of capital does not qualify a man for being a farmer, nor is there any virtue inherent in a lease to insure his success. To these must be added probity, knowledge of his business, and diligence in prosecuting it. These qualifications are the fruits of good *Education* (in the fullest sense of that term), and are no more to be looked for without it than good crops without good husbandry. Common school instruction will, of course, form the groundwork of a farmer's education; but to this should be added, if possible, a classical curriculum. It has been the fashion to ask, "Of what use are Greek and Latin to a farmer?" Now, apart from the benefit which it is to him, in common with other men, to know the structure of language, and to read with intelligence the literature of his profession which more and more abounds in scientific terminology, we believe that no better discipline for the youthful mind has yet been devised than the classical course which is in use in our best public schools. Of this discipline we desire that every future farmer should have the advantage. But the great difficulty at present lies in finding appropriate occupation for such youths betwixt their fifteenth and twentieth years. In many cases the sons of farmers are during that period put to farm labour. If they are kept statedly at it, and are made proficient in every kind of work performed on a farm, it is a good professional training as far as it goes. The more common one—at least as regards the sons of the larger class of farmers—which consists of loitering about without any stated occupation, attending fairs and markets, and probably the race-course and hunting-field, is about the most absurd and pernicious that can well be imagined. Such youths are truly to be pitied; for they are neither inured to bodily labour, nor afforded the benefits of a liberal education. It need not surprise any one that such hapless lads often prove incompetent for the struggles of life, and have to yield their places to more vigorous men who have enjoyed the benefit of "bearing the yoke in their youth." Unless young men are kept at labour, either of mind or of body, until continuous exertion during stated hours, confinement to one place, and prompt obedience to their superiors, have ceased to be irksome, there is little hope of their either prospering in business, or distinguishing themselves in their profession. Owing to the altered habits of society, there is now less likelihood than heretofore of such young persons as we are referring to being subjected to that arduous training to bodily labour which was once the universal practice; and hence the necessity for an appropriate course of study to take its place. Many Scottish farmers endeavour to supply this want by placing their sons for several years in the chambers of an attorney, estate-agent, or land surveyor; partly in order that they may acquire a knowledge of accounts, but especially for the sake of the wholesome discipline which is implied in continuous application and subjection to superiors. It is also common for such youths to be sent to Edinburgh for a winter or two to attend the class of our accomplished professor of Agriculture, and perhaps also that of Chemistry and the Veterinary College. This is well enough in its way; but yet there is wanting in it an adequate guarantee that there is real study—the actual performance of daily mental work. The agricultural college at Cirencester appears to come more fully up to our notion of what is needed for the professional training of farmers than any other institution which we yet possess. We shall rejoice to see such opportunities of instruction as it affords multiplied in Great Britain. After enjoying the benefits of such a course of training as we have now indicated, young men would be in circumstances to derive real advantage from a residence with some experienced practical farmer, or from a tour through the best-cultivated districts of the country. We are well aware that what we have now recommended will appear sufficiently absurd to the still numerous class of persons who believe that any one has wit enough to be a farmer. But those who are competent to judge in the case can well afford to smile at such ignorance. They know that agriculture is at once an art, a science, and a business; that the researches of naturalists, chemists, geologists, and mechanicians are daily contributing to the elucidation of its principles and the guidance of its practice; and that while its pursuits afford scope for the acutest minds, they are relished by the most cultivated. As a business it shares to the full in the effects of that vehement competition which is experienced in every other branch of industry, and has besides many risks peculiar to itself. The easy routine farming of the olden time is gone for ever; and without a good measure of tact, energy, and industry, no man can now obtain a livelihood by it. It were well that all this were better known; for nothing has been more common than for parents who have sons that are too dull for scholars, or too indolent for trade, to put them to farming; or than for persons who have earned a competency in some other calling, to covet the (supposed) easy life of a farmer, and to find it to their sorrow a harassing and ill-requited one.

Section 4.—*Farm Labourers.*

The agriculture of a country must ever be largely affected by the condition and character of the peasantry by whom its labours are performed. An acute observer has recently shewn that in England a poor style of farming and low wages—good farming and high wages usually go together; and that a low rate of wages is significantly associated with a high poor-rate. The worst paid and worst lodged labourers are also the most ignorant, the most prejudiced, the most reckless, and insubordinate. The eminence of Scottish agriculture is undoubtedly largely due to the moral worth and intelligence of her peasantry. For this she is indebted to the early establishment of her parochial schools, and to the sterling quality of the elementary education, based upon the Bible, which the children of her tenantry and peasantry have for generations received in them together. These schools are unfortunately now inadequate to the increased population; but still in the rural districts of the Scottish lowlands it is a rare thing to meet with a farm labourer who cannot both read and write. Apart from higher benefits, the facilities which the services of such a class of labourers have afforded for the introduction and development of improved agricultural practices, the use of intricate machinery, and the keeping of accurate accounts, cannot well be over-rated. It is an interesting testimony to the value of a national system of Christian education that our Scottish peasantry should be in such request in other parts of the kingdom, as bailiffs, gardeners, and overseers. Let us hope that this inestimable blessing will speedily be enjoyed by our entire population.

The pernicious influence of the present law of Settlement and Removal upon the English labourer, is now attracting that attention which it so urgently demands. The proprietors and tenants of particular parishes in various parts of England, at present combine to lessen their own share of the burden of the poor-rate, by pulling down cottages and compelling their labourers to reside out of their bounds. The folly and cruelty of such short-sighted policy cannot be too strongly reprobated. These poor people are thus driven into towns, where their families are crowded into wretched apartments, for which they must pay exorbitant rents, and where they are constantly exposed to moral and physical contamination of every sort. From these comfortless abodes the wearied and dispirited men must trudge in all weathers to the distant scene of their daily labours. One cannot conceive of a prosperous agriculture co-existing with such a system; nor feel any surprise that thieving, incendiarism, and burdensome rates should be its frequent accompaniments. It is pleasant to contrast with this close-parish policy the conduct of some of our English nobility, who are building comfortable cottages and providing good schools for the whole of the labourers upon their princely estates.

Section 5.—What the Legislature should do for Agriculture.

The further progress of our national agriculture is undoubtedly to be looked for from the independent exertions of those immediately engaged in it; but important assistance might and ought to be afforded to them by the legislature, chiefly in the way of removing obstructions. What we desiderate in this respect is the repeal, or at least the important modification, of the law of distraint; the commutation of the burdens attaching to copyhold lands; the reformation of the law of settlement; the removal of the risk and costs which at present interfere with the transference of land; the establishment of a really *national* system of Christian education; the endowment of an adequate number of agricultural colleges, with suitable museums, apparatus, and illustrative farms; the authoritative collection and publication of agricultural statistics; and the compulsory adoption of a uniform standard of weights and measures. We desire also to see the *arterial* or *trunk-drainage* of the country undertaken by government. Until this is done, vast tracts of the most fertile land in the kingdom cannot be cultivated with safety and economy, nor attain to the productiveness of which they are capable. Our national interests surely require that its agriculture should be freed from such obstructions as these, and that it should receive the benefit of a fair share of such public provision as is made for training youths for the learned professions, and for the public service; and of such grants as are given in aid of scientific research, for the encouragement of the fine arts, and for the furtherance of manufactures and commerce.

Section 6.—Concluding Remarks.

On carefully comparing the present condition of British agriculture with what it was thirty years ago, the change for the better is found to be very great indeed. But on all hands indications are to be found, which warrant the anticipation, that the progress of discovery and improvement in future will be more steady, more rapid, and more general than it has hitherto been. There is not only a wider-spread and more earnest spirit of inquiry; but practical men, instead of despising the aids of science, seek more and more to conduct their investigations under its guidance. Experiments are made on an ever-widening scale, and upon well-concerted plans; their results are so recorded and published, that they at once become available to all, and each fresh investigator, instead of wasting his energies in re-discovering what (unknown to him) has been discovered before, now makes his start from a well-ascertained and ever-advancing frontier. Hitherto the knowledge of the husbandman consisted very much of isolated facts, and his procedure often little better than a groping in the dark. As the rationale of his various processes is more clearly discovered, he will be enabled to conduct them with greater economy and precision than he can do at present. A clearer knowledge of what really constitutes the food of plants, and of the various influences which affect their growth, will necessarily lead to important improvements in all that relates to the collection, preparation, and use of manures.

What may truly be called a revolution in agriculture is now in the act of rapid development in that application of steam-power to the tillage of the soil which is spreading on every side. Enough has already been accomplished to shew that under the combined influence of drainage and steam tillage, the clay soils of England will speedily have their latent fertility brought into play in a manner that will mightily augment our supplies of home-grown bread-corn and butcher meat. It may indeed now be reasonably anticipated that these hitherto impracticable soils will again take their place as our best corn-growing lands, and that those large portions of our country, where for a long time our national agriculture presented its poorest aspect, may ere long exhibit its proudest achievements.

In closing this rapid review of British Agriculture, it is gratifying and cheering to reflect that never was this great branch of national industry in a healthier condition, and never were there such solid grounds for anticipating for it a steady and rapid progress. The time has hardly yet gone by when it was much the way with our manufacturing and trading men, and our civic population generally, to regard our farmers as a dull, plodding sort of people, much inferior to themselves in intelligence and energy. Many of them seem now, however, to be awakening to the fact that their rural brethren possess a full share of those qualities which so honourably distinguish the British race. Nay, some of them may have experienced no little surprise when they became aware that in a full competition of our whole industrial products with those of other nations, as at Paris in 1855, the one department in which Britain confessedly outstripped all her rivals was not in any of her great staple manufactures, but in the live stock of her farms, and in her agricultural implements and machinery.

APPENDIX.

We have already directed attention to the most important features in the recent progress of British agriculture; but with the view of presenting the results of this progress in a more definite and interesting form, we have much pleasure in submitting to the reader the following report on the farming of East Lothian, which Mr. Patrick Sherriff, formerly of Mungoswells, kindly furnished to us about ten years ago, when preparing the article "Agriculture" for the eighth edition of the *Encyclopædia Britannica*. A similar report as at the present date, would present many proofs of important progress made during even so brief a period in that admirably farmed district; but its intrinsic interest, and our esteem for the author of it, alike prompt us to reproduce it here.

On the Agriculture of East Lothian.

"Haddingtonshire, or East Lothian, has long been celebrated as a grain-producing district, and this leading feature of its rural economy may perhaps have originated from the dry and early climate of the district. Here many practices which have distinguished Scotch husbandry were first introduced; and the farmers, profiting by the fortuitous circumstances under which they have been placed, are not slow in adopting discoveries which are likely to promote their interests. Accordingly, in this progressive age, the recent changes in the agricultural system have been very striking, and may be well illustrated by what has taken place in the parish of Dirleton since 1836, when the Rev. John Ainslie wrote an excellent description of the parish, and which forms a part of the new Statistical Account of Scotland.

"The parish of Dirleton is situated on the shores of the Firth of Forth, and in soil and climate may be considered a fair specimen of the parishes in the county which are bounded by the sea. The surface embraces soils of every texture from adhesive clay to drift sand; the latter, which exists to a considerable extent along the whole line of coast, is consigned to permanent pasture, and chiefly stocked with rabbits. The land under cultivation extends to between 5000 and 6000 acres. Since 1836, when the new Statistical Account of Scotland was published, no land has been reclaimed, in the common acceptation of the term, neither has any permanent pasture been subjected to the plough; and as the surface may be considered unchanged in extent as well as in aration, the increase of disposable produce which has since taken place must be regarded as the results of improved farming.

"From a statistical report of the parish of Dirleton for 1627, it appears that farms were then held by leases of considerable length, and at corn-rents. Afterwards rents payable in money seem to have been introduced; and in the early part of the present century, nearly all the land in the parish was so rented. During this period, when the lease of a farm expired, the increase of rent was great; generally keeping pace with, and often exceeding, the rise which had taken place in the price of agricultural produce during the war with France. The fall of prices which followed the return of peace and the passing of Peel's currency bill, joined to deficient crops for a succession of years, commencing with 1826, involved the occupiers of land in severe distress. Many individuals were unable to meet their liabilities, fell into arrears of rent, and ultimately became unable to cultivate the land in a proper manner for want of capital. This crisis brought about a return to corn-rents, payable in money at fiars prices; and at present there is only one farm in the parish differently rented. The change from money to corn-rents took place subsequent to 1830, and the new arrangements having been made with liberality and kindness on the part of landowners, and carried out with energy by the tenantry, the results have proved beneficial to the contracting parties as well as to the public. Ferrygate, one of the best farms in the parish, was held in 1836 at a mitigated rent of 406½ quarters, was re-let in 1852 at 525 quarters of wheat, payable in money at fiars prices. The farm of Chapel, having been leased in 1814, was rented in 1832 at £1150, and re-let in the following year at 260 quarters of wheat, the landlord engaging to drain the farm; and in 1852 the farm was again re-let at a rent understood to be 180 quarters of wheat and £495 of money, with the addition of 4 per cent upon any outlay which may be required for draining. Assuming 40s. per quarter as the price of wheat, this would indicate an advance of 64 per cent upon the previous letting. This farm had been unusually low rented in 1832, in consequence of a panic that then prevailed among farmers.

"In 1836 Mr. Ainslie states, 'now there is hardly one open field in the parish.' The original fences chiefly consisted of thorn hedges, there being few stone walls, with a ditch to carry off water. The hedges had been so long neglected, that, with their wide-spreading branches, they often resembled a row of trees; and a considerable portion of ground remained uncultivated under the branches of the hedges, as well as on the margin of the ditch opposite to the hedge. Within these sixteen years past, the ditches have been transformed into covered drains, and the straggling hedge into a straight line, the roots being regularly dug and freed from weeds. The hedge and ditch of 1836, with the uncultivated land on their margins, often occupied a space 18 feet in width; the fences of the present time seldom exceed 2 feet wide. Taking the fields of the parish, which were bounded by hedge and ditch, to average 25 acres in size, more than two per cent has been added to their arable surface of late years, and perhaps the fences of the present day do not occupy more than one-half per cent of the surface.

"Mr. Ainslie states, that 'the drainage of the parish is in the course of being made very complete. Springs have long since been laid dry, and tiles are now extensively employed to carry off the surface water. On the soft muirish land, a drain is made every second furrow or 36 feet asunder.' This drainage was soon found insufficient for drying the land, and in consequence drains were placed 16 or 18 feet distant; and on this scale the drainage of nearly all of the wet soils has been completed. About the time Mr. Ainslie wrote, tiles were occasionally brought a considerable distance by sea for the purpose of draining, but soon afterwards two works for the manufacturing and sale of tiles were erected within the parish; and on the draining of the neighbourhood being completed, they have been removed, and the ground on which they stood restored to fertility. Such has been the progress of knowledge in respect to draining, that a farmer in the parish who asked and obtained from his landlord a grant of £300 to complete the drainage of the lands which he occupied, and which had been previously drained on the system of deep cross cuts, actually expended this sum, and upwards of £2000 of his own capital in furrow-draining the farm.

"Mr. Ainslie mentions that in 1835 a few bones and about 100 tons of rape cake were used within the parish. The manures brought into the parish and applied to crop 1851, consisted of about 1600 tons of street manure, 277 tons of guano, 33 tons of rape cake, 30 tons of charcoal, 5 tons of sulphate of ammonia, 5 tons of bones, 2 tons of superphosphate of lime, and 2 tons of nitrate of soda. There were also 150 tons of oil-cake, and 37 tons of grain used in fattening animals, and which, like extraneous manures, increase the productiveness of the farm.

"In 1836, the parish contained nine stationary steam-engines for thrashing grain; in 1852 the number had increased to fourteen.

"The statistical account of 1836 shews that there were about 468 cattle and 2000 sheep fed within the parish, both kinds of stock being chiefly bred in other districts. The turnip and grass crops of 1850, aided by oil-cake and grain, fatted 779 cattle and 4070 sheep. When it is considered that permanent pasturage is unchanged in all respects, and that the home consumption of grass and turnip by milch cows and farm horses is nearly the same, the increase of animal food since 1836, resulting from improved farming, may be taken to exceed 100 per cent.

"The buildings connected with farms have generally been enlarged and improved since 1836. In several instances they have been entirely re-built, and in general they embrace substantial accommodation for the machinery and animals essential to high farming. In alluding to the peasantry, Mr. Ainslie states, that 'their cottages have also been materially improved in comfort and cleanliness. The pigsty and dunghill form no longer the foreground decorations; and in many places, especially in the village of Dirleton, have been supplanted by roses and evergreens. In some of the late-built cottages there are two rooms, an example well worthy of imitation, as eminently conducive to the morality, no less than to the comfort and health of the people.' The dwellings of two apartments, so properly commended by Mr. Ainslie, were soon followed by houses of three rooms; and more recently, cottages of one storey have been built for farm-servants, containing a kitchen, three sleeping apartments, dairy and scullery, with a sink and rain-water pipe. Each cottage has a garden, pigsty, and other conveniences; and there is a pump-well and bleaching-green common to all. In Somerville's Survey of East Lothian, published in 1812, the dimensions of a labourer's cottage are stated to be 20 feet by 17, with walls 7 feet high, and the area undivided. The dimensions of a good cottage of the present time are 21 feet by 31, outside measure, with walls eight feet high, and the area divided into four or more compartments. The improvement of the cottages has led to improved habits of personal cleanliness in the families of the labourers, as well as to improved floral taste. To 'the roses and evergreens' of Mr. Ainslie's time, have been added fuchsias and the most choice creepers, while more tender plants growing in pots are displayed inside of the large-sized windows. In one instance the buildings connected with a farm of moderate size must have cost in erecting between £4000 and £5000, exclusive of the haulage of materials. Such accommodation cannot fail of being favourable to the health of the indwellers, rational and irrational, of making farmers and labourers discharge their respective duties more cheerfully, and of increasing the rentals of landholders.

"The alternate system of white and green crop continues to be followed; but of late years summer fallow has been diminished in extent, and the growth of turnips increased. Less land is devoted to clover and ryegrass, in consequence of pasturing being generally restricted to one year; while the bean and pea have, to a considerable extent, been supplanted by the potato.

"The assistance which nature has of late years received from drainage and extraneous manures, combined with improved implements, increased skill and industry amongst farmers and labourers, have produced important results on the productiveness of the parish. We have ascertained by enumeration, that the production of meat has been doubled in fifteen years; and although this mode of estimating quantity is not practicable with all the other products of the parish, there is no doubt of the increased productiveness being great. On some farms where nearly the whole of the surface is annually dressed with extraneous fertilizers supplementary to the ordinary manure of the farm, where the home consumption is taken from the home produce, and where the growing of potatoes has been extensively substituted for the bean and pea, the marketable produce has been increased fourfold. High farming has not, however, been universally practised, and therefore it cannot be said that the disposable produce of the whole parish has been more than doubled in the time specified.

"The inhabitants are either employed in the cultivation of the soil, or are chiefly dependent for employment on those connected with agriculture. By the census of 1841 the population of the parish was 1497, and in 1851 the inhabitants numbered 1646. At the present time there is an increasing demand for agricultural labour; but the addition to the number of inhabitants does not shew forth all the increased employment arising from the improved state of agriculture since 1836. Many people residing beyond the parish must be employed in preparing and bringing forward the extraneous fertilizers and fattening auxiliaries now so extensively used, in the transport and manufacturing of the increased diposable produce of the land, as well as in the production and distribution of commodities required by the increased numbers and the improved condition of the resident population.

"The progress of agriculture in the land-bound parishes has been similar to what has been detailed in connection with Dirleton. Throughout the whole of the county the improvement of cottages, farm buildings, and fences, can be traced. Furrow draining has been extensively practised, the application of extraneous fertilizers and the use of fattening auxiliaries generally carried out. The application of lime to the soil has long been decreasing. With the exception of a few spots being reclaimed on the slopes of the Lammermuir hills, lime is now seldom used in agriculture.

"Within these last sixteen years little difference is observable in the breeds of sheep fatted within the county, with the exception of the introduction of a few South-downs; but a striking change has taken place with regard to cattle. For the fine and mature-aged animals from the northern counties of Scotland, which formerly graced the feeding courts during winter, have been substituted young and inferior descriptions of short-horns from Ireland and the north of England. This change has perhaps been owing to more of the northern cattle being now fatted where they are bred, and sent direct for the English shambles; but there is no reason for supposing that the farmers of East Lothian have sustained a loss by this change of breeds, as the young short-horn is considered to grow more in size while under the fatting process. In the modes of fattening animals changes have recently crept in. With cattle there has been introduced box feeding and an extended use of auxiliary foods. Sheep are fatted in July, August, and September, by folding off winter and spring tares approaching ripeness, with addition of oil-cake; and also from the middle of August onwards by means of early sown turnips. The cultivation of winter tares upon a considerable scale has hitherto been confined to the neighbourhood of Ormiston, where they were successfully grown by Mr. Wight 130 years ago.

"The improvement in implements and machinery has hitherto been slow; but a spirit of inquiry has lately been directed towards this department of agriculture. The thrashing machine, which was first invented in this country in 1786, continues to be used with some of its defects uncorrected. Within fourteen years, as a substitute for the scutching drum, the American peg drum has been tried and laid aside; and very recently the English bolting drum has been introduced. The bolting drum and concave, from acting by a union of beating and rubbing, preserves the straw nearly unbroken, facilitates the shaking and winnowing processes, extracts the corns from the ears whatever may be the position of the sheaf on entering the machine, and is easily propelled. From combining so many good properties the bolting drum and concave is likely to supersede Meikle's scutching drum.

"The first properly authenticated attempt to construct a thrashing machine was made in this country in 1732, by Mr. Michael Menzies; and the machine now in use was introduced by an inhabitant (Mr. Andrew Meikle) in 1786. No individual has laid claim to the invention of the rubbing drum and concave now so generally found in the southern parts of England, and there is every reason to believe that they originated with Mr. (afterwards Sir Francis) Kinloch of Gilmerton in this county. Evidence of this fact may be obtained in the *Survey of East Lothian*, by Mr. Buchan Hepburn, in 1794, and in a letter from George Rennie, Esq., of Phantassie, published in the *Farmer's Magazine* for 1811.

"No change deserving of notice has lately taken place with regard to ploughs and harrows. Scoullar's and Tennant's grubbers, both recent inventions, are much esteemed. In some instances they have supplanted Finlayson's harrow, which has been the favourite grubber in the county since 1826.

"Several improvements in corn drills have lately been effected by Hunter of Samuelston, and Sheriff of Westbarns, in this county; but the drilling of corn crops is far from being general in East Lothian. The practice has not increased of late years, a belief existing amongst farmers that drilling affords no increase of produce unless the ground is hoed when infested with annual weeds. Garret's and Sheriff's horse-hoes for drilled corn crops are used by a few farmers.

"After reaping machines having engaged the attention of some of the inhabitants of this county for nearly half a century, the harvest of 1852 brought into the field six or seven of Hussey's American reapers manufactured by Crosskill; all of which were laid aside after the first trial, with exception of one, the owner of which successfully persevered throughout the harvest. Bell's reaping machine was also exhibited at work within the county, and met with general approbation, after having been neglected for nearly a quarter of a century. The cutting of crops by machinery having been publicly demonstrated, there is reason to believe that reaping machines will be much used in time to come. Hitherto the extensive harvests of East Lothian have been chiefly cut down by people from other districts, enticed by the hope of high wages, and who return to their homes when the harvest is over. The recent increase of commercial and manufacturing employment, resulting from freedom of trade and consequent improved state of the lower classes, joined to an extensive and extending emigration of labourers, also the result of free trade, has so diminished the number of itinerating harvesters, that, in future, East Lothian farmers must either employ reaping machines or allure assisting hands by extravagant wages.

"Within these last sixteen years no striking advance has perhaps been made in improving the implements of the farm; but considerable changes are taking place in the uses to which they are applied. Of late years the plough and the roller are seldomer, and the grubbers are oftener employed in preparing soils for green crops, and in extracting root-weeds from them, whether the cleaning process is performed in spring or in autumn. It frequently happens that clay soils, which were formerly ploughed four or five times, and received perhaps as many harrowings and rollings to fit them for a turnip-crop, are now prepared by one ploughing: natural agencies being more effectual than the implements of man in pulverizing such soils.

"Hunter's, Hopetoun, and Fenton wheats all originated in East Lothian; and at the present time are the standard wheats of the county. Many new varieties of the different grains are introduced from time to time, and generally find a short-lived reputation; but although no very marked improvement of agricultural plants has lately taken place, there are no signs of degeneracy in the oldest kinds of grain. At the shows of seed-corn under the auspices of the East Lothian Agricultural Society, in the case of the mentioned wheats the prizes are occasionally carried off by parcels grown upon the farms where the variety was first propagated, and where it has been since cultivated without a change of seed from the time of discovery; proving beyond question that, when soil and climate are congenial to the wheat plant, change of seed is unnecessary. Vast and increasing quantities of seed-corn are annually sent from East Lothian to other districts. With turnips, Skirving's purple-top yellow has supplanted, in many instances, the white globe and the Swede, having been found to answer well both for early and late consumption.

"In the rotations of cropping, or in the relative extent which one description of crop bears to another, the chief change has taken place with the turnip and the potato; the one having supplanted the bean, and the other naked fallow. The increased growth of these plants is chiefly owing to drainage, and the application of extraneous manures—the one having supplied nourishment, and the other a fitting condition of soil. Without a union of these improvements, the cultivation of such crops could not have been successfully extended.

"The potato disease, which has been so prevalent of late years throughout Britain, and more especially on its western shores, has been comparatively little felt in East Lothian, and hence the extended growth of this root. Whatever may be the cause of the potato being less affected by disease in East Lothian than in the surrounding districts, the fact is unquestionable. So fine has been the quality of this root, that large quantities of potatoes have been annually sent to the markets of England, Ireland, and Wales.

"Among the recent changes affecting agriculture, railways ought not to be forgotten. The North British Railway and its branches intersect East Lothian, and afford a cheap and an expeditious conveyance for manures and farm produce, whether in a raw or manufactured state, and more especially for the potato, which is one of the most perishable and cumbrous commodities of the farm.

"However great the advances of East Lothian agriculture may have been of late years, its future progress is likely to be still more rapid. Without placing undue reliance on the discoveries which the intelligence and enterprise of the age are likely to effect, there is much to be expected from what is now at command. Unrestricted competition, which has been found so beneficial with other classes, will urge agriculturists to adopt, and energetically to employ, all agencies within their reach. Naked summer fallow, which at one time was considered so beneficial, that a monument was proposed to be erected to John Walker, who first practised it in East Lothian, must be entirely laid aside. The occupiers of clay soil, by substituting the grubber for the plough, and early for late green crops, will vie with the possessors of light land in the fattening of animals, without diminishing the corn crops which such soils are so pre-eminently calculated to yield. By an extended use of portable manures, combined with early sowing of early varieties, much of the uplands, now yielding scanty returns, will equal soils near the level of the sea in the production of butcher meat and grain, with an increase of sustenance for the breeding flocks, which constitute the staple commodity of such districts. In the genial climate of East Lothian, annual applications of fertilizers to the whole arable surface of the farm could not fail of proving advantageous. And with the adoption of the changes enumerated, the disposable produce of the county would be vastly increased in a few years.

"It will be found that the state of the population connected with farming is often affected by the security of tenure granted to, and the amount of rent paid by, the occupiers of the soil. Leases have long been general in East Lothian, and in some cases the rents of farms have always been quantities of corn either delivered in bulk or payable in money at fiars prices. The money-rents contracted previous to 1830 were soon afterwards generally changed into quantities of corn payable at fiars prices, and nearly all the corn-growing farms of the district are held at such rents. The succession of deficient crops formerly noticed, and consequent distress amongst farmers, extended over the county generally, and arose from the severe drought of 1826, followed by the ravages of the wheat fly for several consecutive years, when the yield of wheat on some of the best farms did not reach 16 bushels per statute acre; and in 1828 the wheat crop on the farm of Wintonhill was offered to and refused by the incoming tenant at 12⅞ bushels, exclusive of the expense of harvesting and marketing the crop. About that time many farmers were impoverished, and without security of tenure, from being in arrears of rent. With a view of meeting their pressing liabilities, retrenchment was carried into every department of the farm. The productive powers of the soil were drawn upon, fewer people were employed, the wages of labour fell, and depression over-shadowed the industrial classes connected with agriculture. The change of money-rents into quantities of corn payable at fiars prices, coupled with the return of more productive seasons, altered the prospects and policy of farmers. Knowing that, under the altered terms of their contracts, security of tenure was restored, and that all the proceeds of augmented crops would not be absorbed in paying rent; and having experienced the evils of parsimonious management, they set about increasing the productiveness of their farm by every available means. To accomplish this object, soils were deepened, drained, and enriched, by employing more capital and labour; better crops were obtained, and the working-classes became enabled to purchase with the wages of labour a greater share of farm-produce.

"From what has been experienced in East Lothian, it would appear that when landowners for a length of time exacted too much rent, farmers employed little capital and labour, inferior crops were reaped, and the state of cultivation retrograded. On the other hand, when a moderate rent was paid, much capital and labour were employed, augmented crops were obtained, and agriculture was progressive.

"In the metayer system which prevails in some countries, the miserable crops are equally divided between the owner and occupier of the soil; and other parties are but little interested in the division. With an improved state of agriculture, such as now exists in East Lothian, matters became very different; and it is the province of the farmer to distribute the produce, or rather its money value, amongst the parties entitled to it. Every individual who aids the productive powers of the soil by his labour, or otherwise, becomes entitled first to be paid; and the landowner ought to receive as rent only what remains after disbursing the legitimate expenses of production. Much of the augmented produce of the present time goes to the non-agricultural population—such as ingenious mechanics and manure merchants. The results of high farming form a large fund for rewarding many classes of the community, and with a good understanding existing between the owners and occupiers of the soil, that fund will progressively increase.

"Viewing the farmer simply as a distributor of the fruits of the earth, it may appear that he has no pecuniary interest in the quantity gathered or the division of it beyond what falls to his own share. He will, however, find as a general rule, that without large crops his portion will be small, and that the larger the produce distributed amongst the number of individuals aiding in producing the crop, the greater will be the happiness diffused amongst the population."

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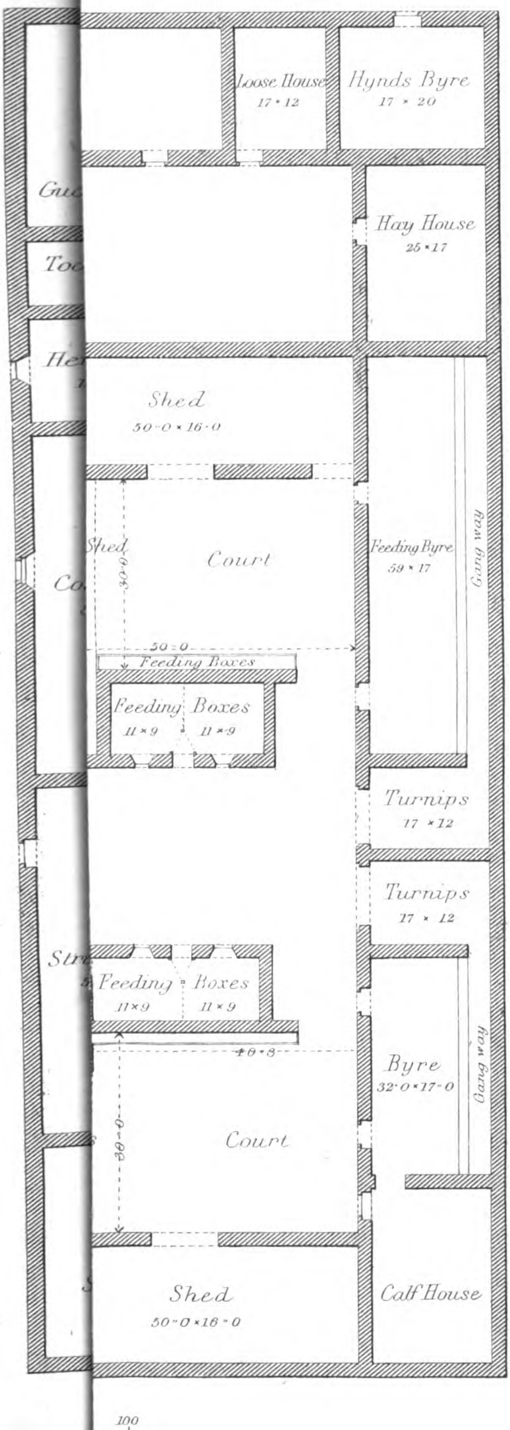
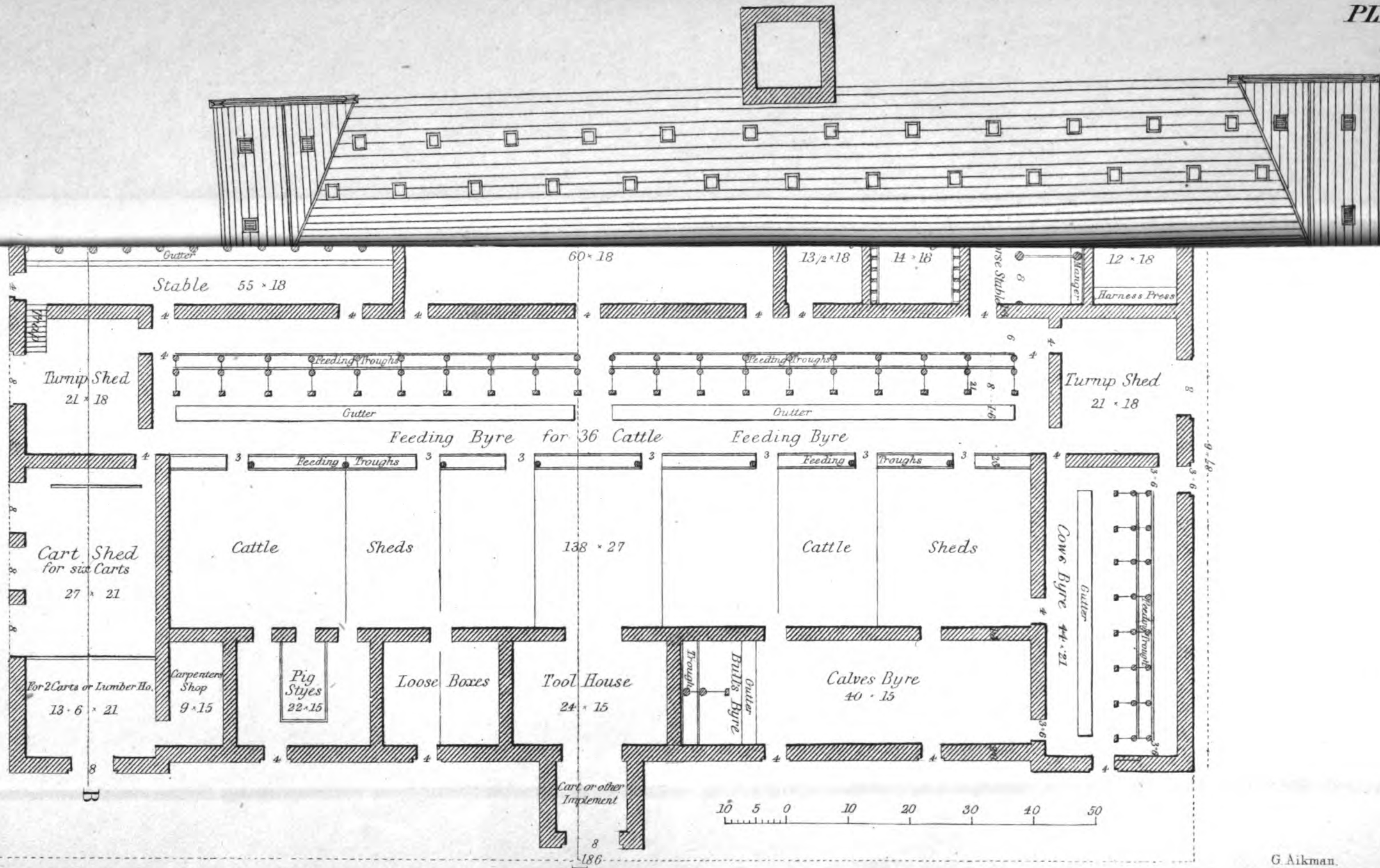
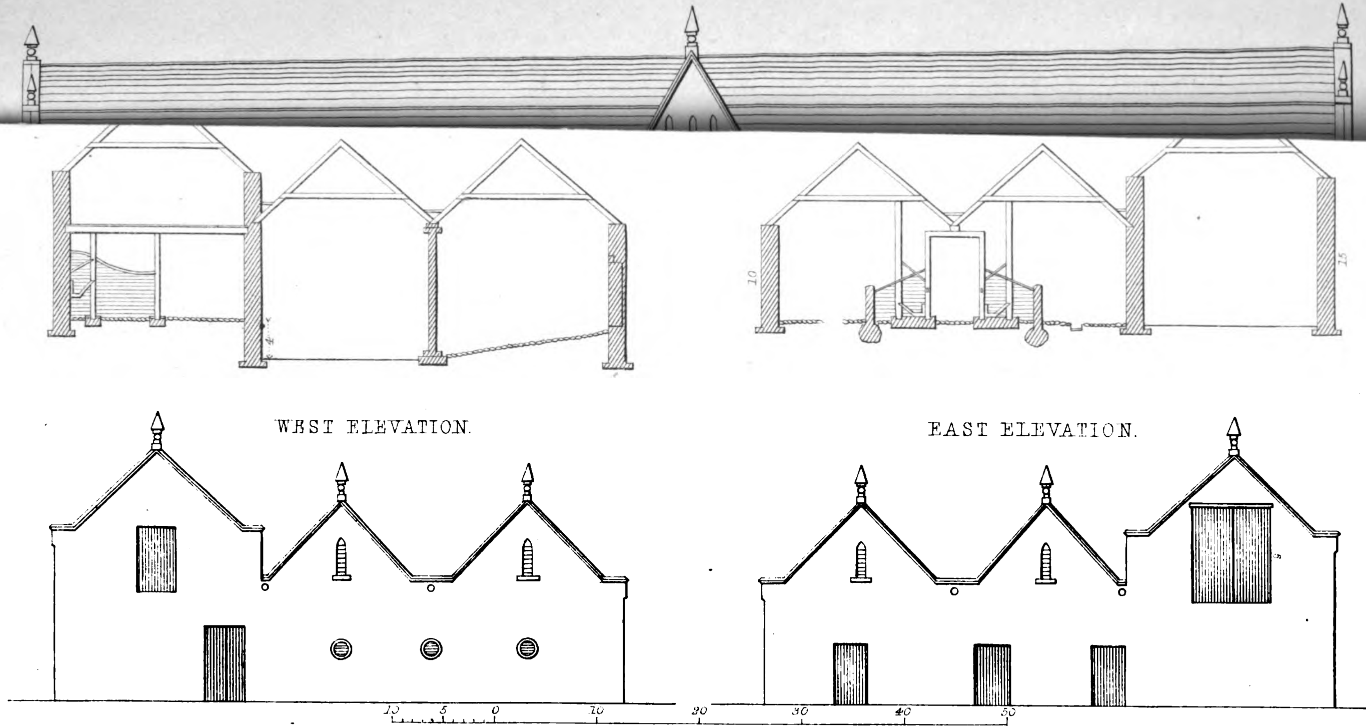
PLATE I



G Aikman.

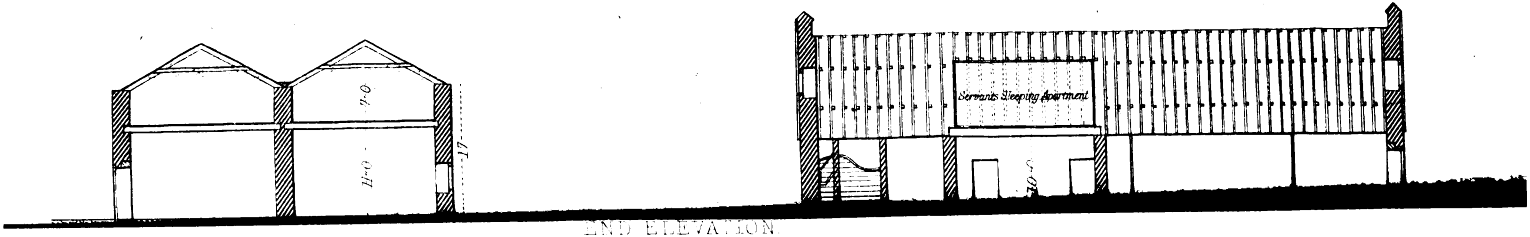


PLAN OF COVERED HOMESTEAD FOR A FARM OF 400 ACRES BY M^R. J. COWIE.

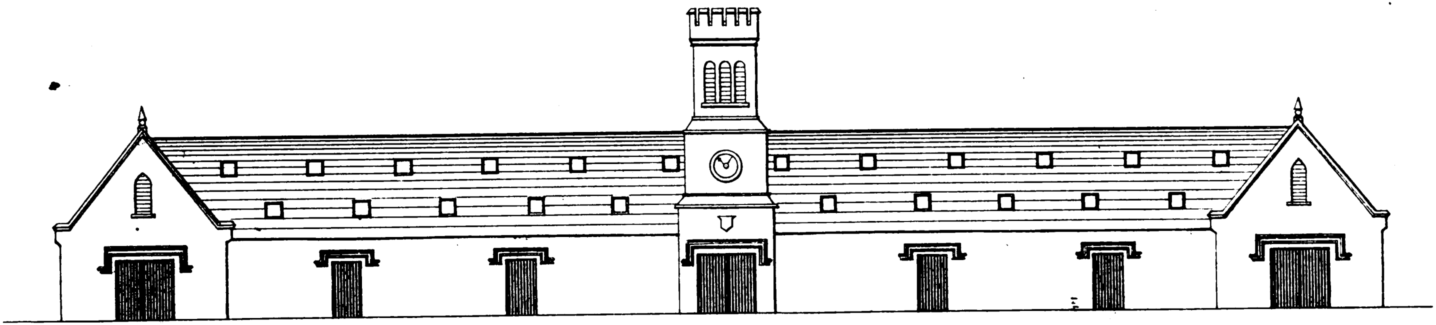


PLAN OF COVERED HOMESTEAD FOR A SMALL FARM, BY Mr. J. COWIE.

G. Aikman



END ELEVATION



FRONT ELEVATION

SECTIONS AND ELEVATION PLAN II, BY Mr. J. COWIE.

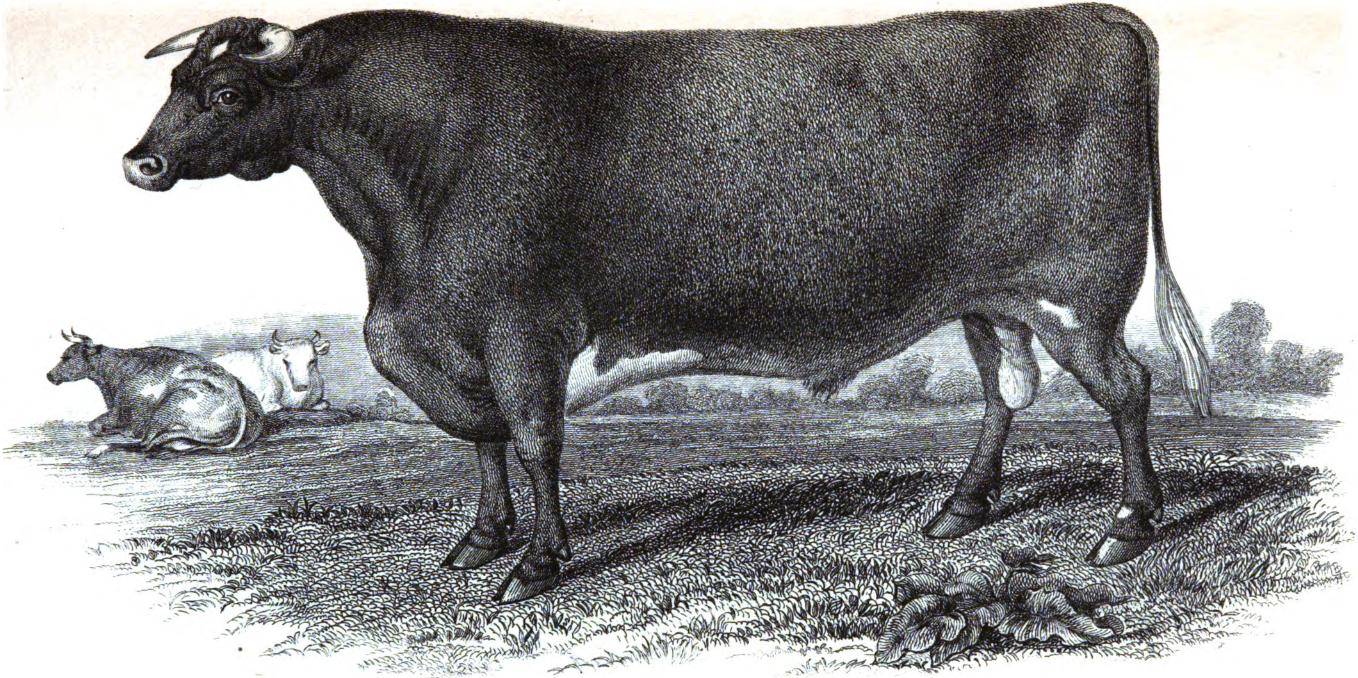
G Aikman

Pinx^t

Clydesdale Horse.

Eng^d by G. Aikman

Highland Pony.



SHORT-HORNED BULL

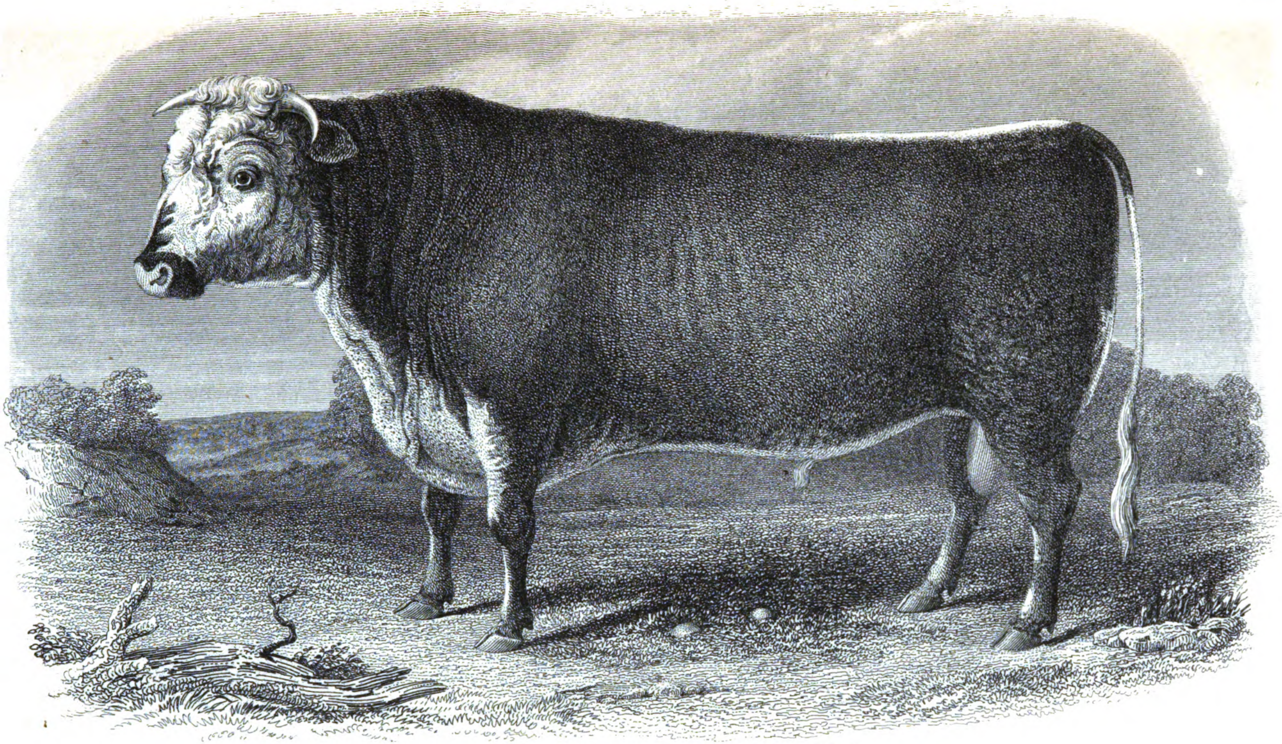
PHŒNIX.

Bred by and the property of Mr Crisp. Hawkhill. Northumberland.
Winner in 1852 of the First Prizes given by the Agricultural Societies
of England. Scotland & Ireland.

SHORT-HORNED COW

CHARITY.

Bred by and the Property of Mr. Booth. Warlaby. Yorkshire.



BULL, HEREFORD BREED

Bred by the Right Hon^ble the Earl of Talbot.

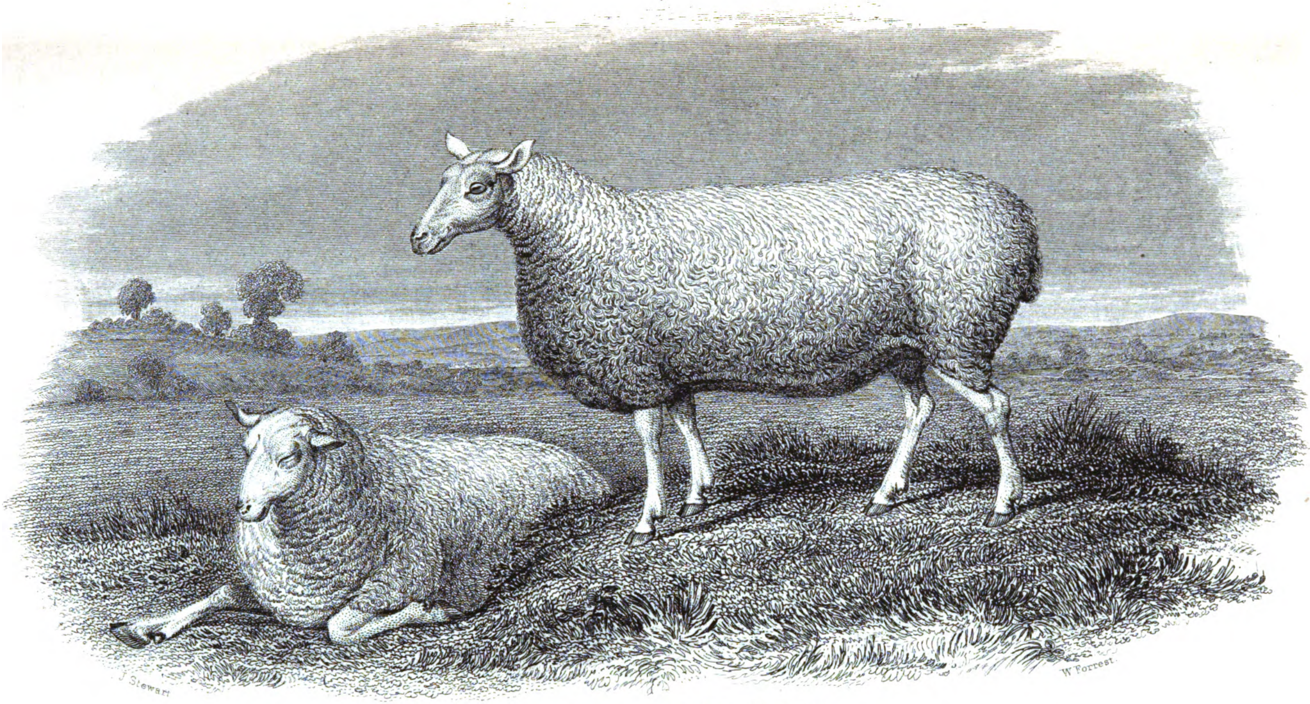
Copied by permission from Professor Low's description of breeds of Domesticated Animals

Galloway Bull.

Ayrshire Cow.

LEICESTER RAM

Bred by, and the Property of Mr Dickinson. Magdalene Hall. Roxburghshire.



LEICESTER EWE

Bred by, and the Property of Mr. George Thomson, Haymount, Roxburghshire.

THE ROMNEY MARSH BREED

Ewe in her second fleece.

Bred by M^r. Bishop of Losenham House, Kent

EWE & LAMB, SOUTH DOWN BREED

Bred by Thomas Ellman Esq^r. Beddingham

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CHEVIOT EWE

Bred by, and the Property of Mr. Thomas Elliott, Hyndhope, Roxburghshire.

THE BLACK-FACED HEATH BREED

One Year Old.

Bred by Mr. Thomas Robertson. Broomlea. County of Peebles.

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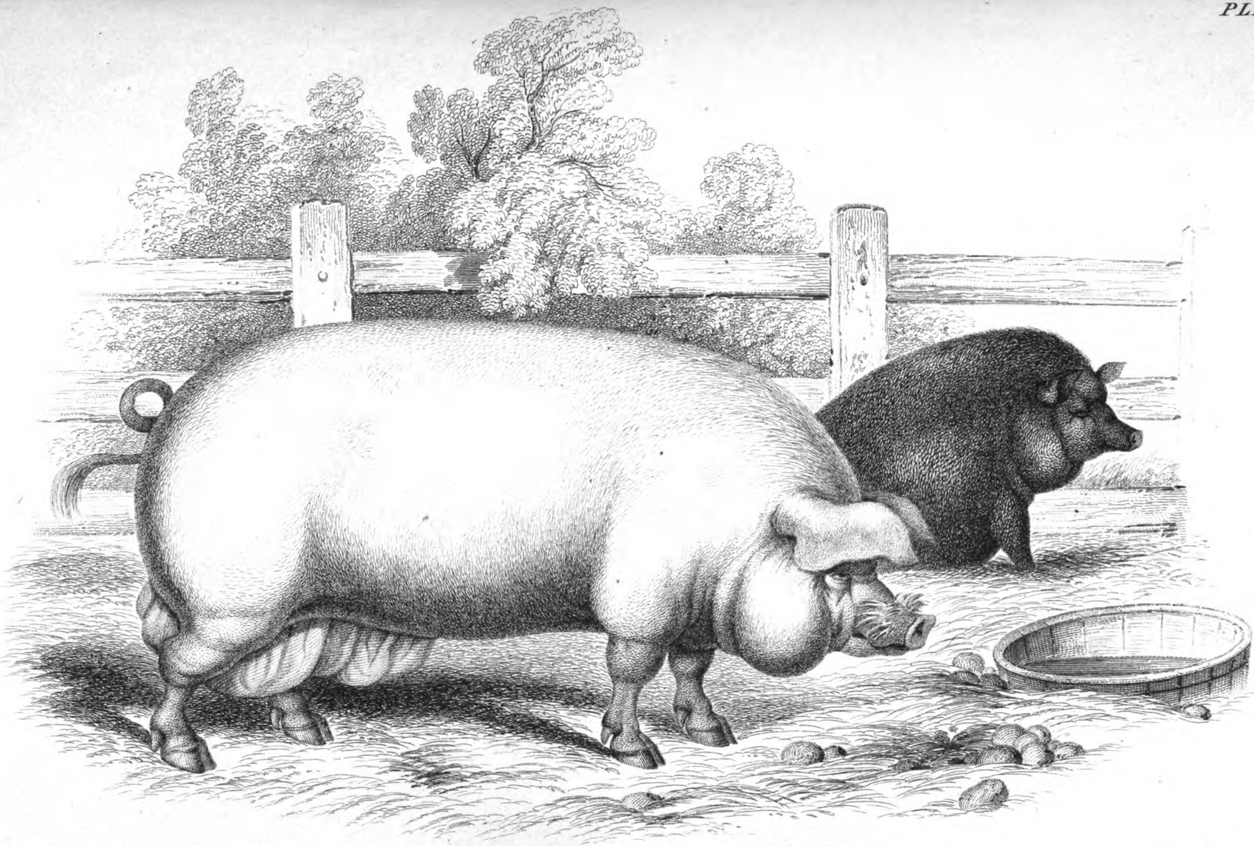
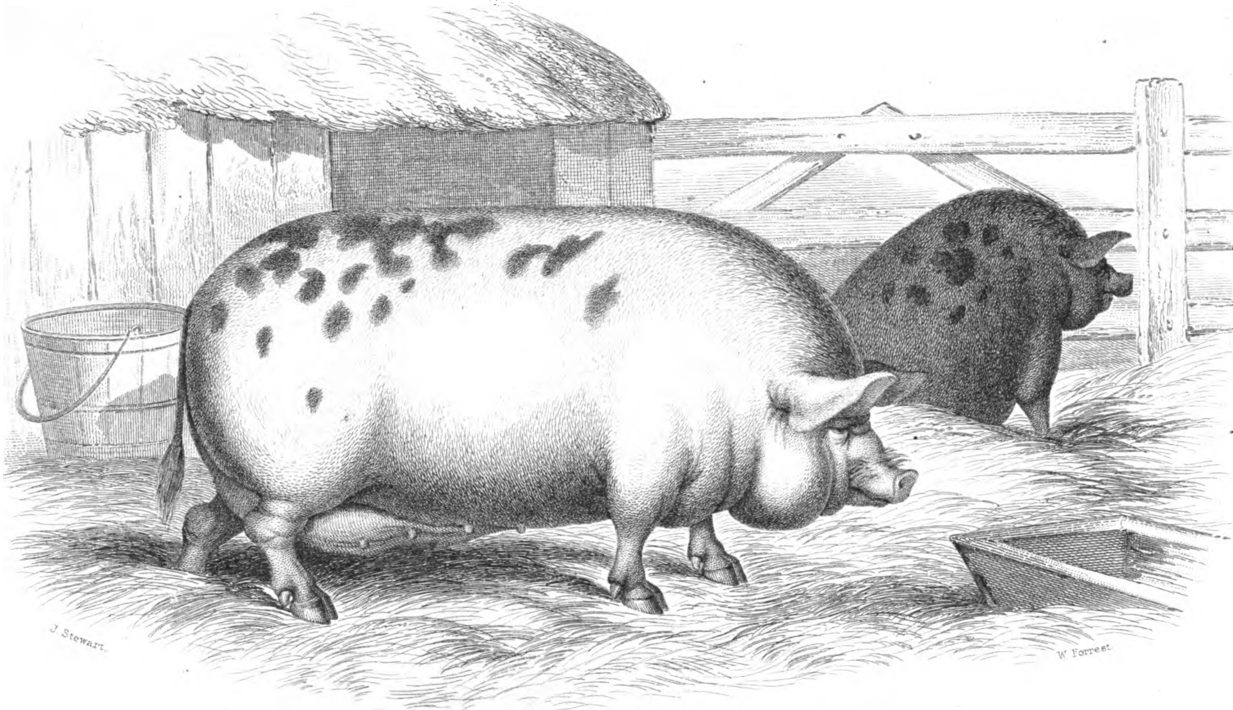


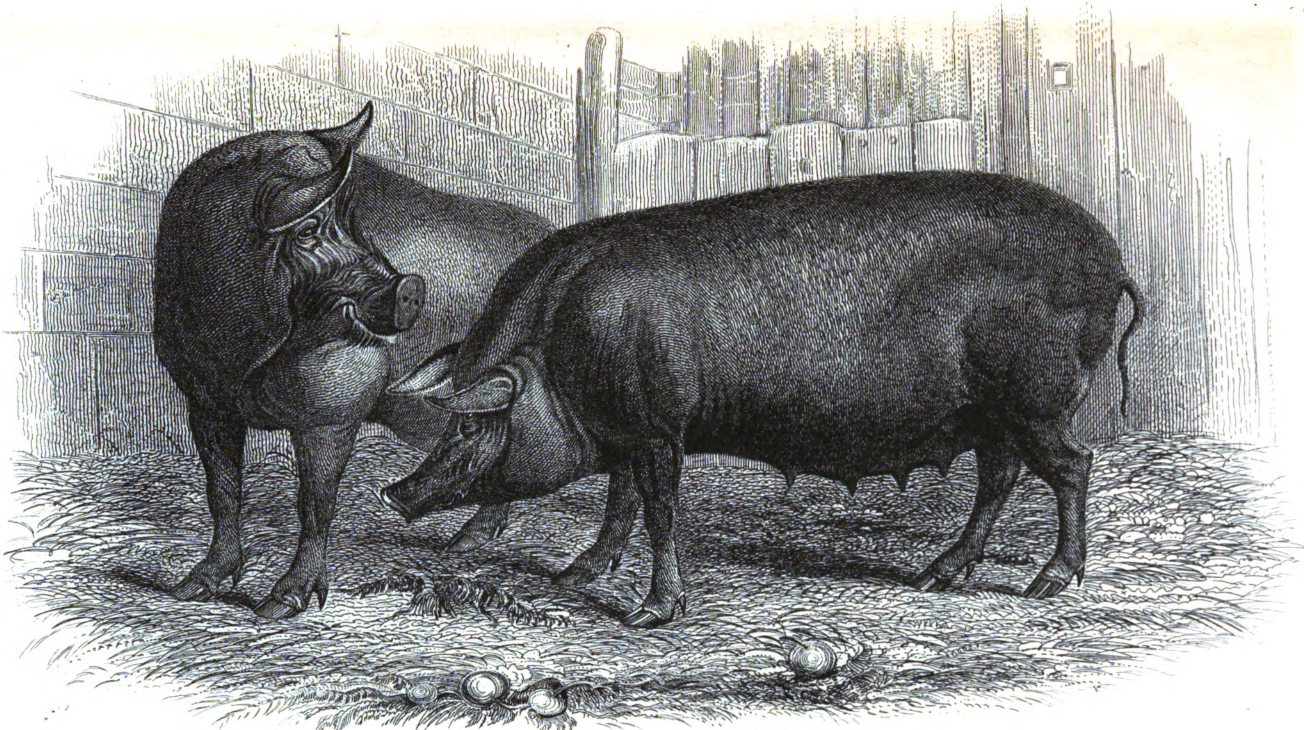
BOAR OF THE LARGE ENGLISH BREED

Bred by, and the Property of Mr. Eddison, Yorkshire.



SOW OF THE LARGE ENGLISH BREED

Bred by, and the Property of Mr. Eddison, Yorkshire.



NEAPOLITAN BREED

Boar and Sow.

The Property of the Right Hon. Earl Spencer, imported from Naples by the Hon. Captain Spencer.

Copied by permission from Professor Low's description of breeds of Domesticated Animals.

"Among the topics discussed in this really elaborate though elementary volume, are the organic, proximate, and inorganic constituents of plants—the changes which take place in the food of plants during their growth—the chemical and physical character of the soil, and its improvement by mechanical processes—the general principles of manuring—the rotation of crops, and the feeding of farm-stock. There are also chapters on the composition and properties of farm-yard liquid, vegetable, animal, and mineral manures, and a final one, under this head, on the valuation of manures. All the departments of the work are illustrated by tables of numerical details, the results of analyses and experiments, a considerable number of which were made in Professor Anderson's own laboratory, while those adopted from other chemists have been in many cases confirmed by his own investigations. It is, consequently, of great value as an agricultural treatise, and will no doubt add much to the impetus recently given to the science of Agricultural Chemistry. The author's advice on draining, subsoil-ploughing, and manures—taken in connection with his able disquisitions on the properties and classification of soils, and the constituents of plants—will lead, if followed, to the improvement of agriculture, as the facts adduced may all be implicitly relied on, and the conclusions based upon them may be safely followed by any farmer who wishes to increase the productiveness of his land. . . We, in conclusion, cordially commend this work to our agricultural readers, as they will find in it a vast fund of really useful information relating to the first principles of their profession."—GLASGOW HERALD.
