THE

BOOK OF THE LANDED ESTATE

CONTAINING DIRECTIONS FOR THE

MANAGEMENT AND DEVELOPMENT

OF THE RESOURCES OF

LANDED PROPERTY

BY

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WILLIAM BLACKWOOD AND SONS
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MDCCCLXIX

TO

MAJOR STAPYLTON,

OF

MYTON HALL AND WASS, YORKSHIRE:

SIR,

IT IS WITH SINCERE GRATIFICATION THAT I AVAIL MYSELF OF YOUR KIND PERMISSION TO DEDICATE THIS WORK TO YOU.

IT HAS BEEN WRITTEN WITH THE VIEW OF PROMOTING A BETTER SYSTEM IN THE MANAGEMENT OF LANDED PROPERTY THAN THAT WHICH PREVAILS IN MANY PARTS OF THE COUNTRY; AND I FEEL THAT IT COULD NOT BE MORE SUITABLY INSCRIBED THAN TO ONE WHO HAS EXEMPLIFIED ON HIS OWN ESTATES THOSE PRINCIPLES OF EQUITABLE DEALING AND PRACTICAL IMPROVEMENT WHICH I HAVE ENDEAVOURED TO INCULCATE.

I HAVE THE HONOUR TO BE,

SIR,

YOUR OBEDIENT SERVANT,

ROBERT E. BROWN.

ESTATE OFFICE, WASS, YORK,
January 1869.

PREFACE.

While Works embracing details of the Science and Practice of Agriculture have been issued in considerable numbers, those which relate to what may be termed the Science of Landownership, or the general Management of Landed Property, are comparatively few. Yet this is a matter in which many persons have a direct interest, rendering it desirable that full and clear information should exist on all points connected with it. Thus we have, in the first place, the Proprietors of Land, Tenant-Farmers, and those who represent the proprietors, and stand between them and their tenants, or Land Agents; but beyond those parties there are others occupying subordinate positions, such as Farm-Bailiffs, Foresters, and even Country Tradesmen, all more or less directly engaged in the business of Estate Management.

In preparing the 'Book of the Landed Estate,' I have endeavoured, therefore, to address myself to each section; and, while fully acknowledging the great merits of several of my predecessors in the same field of labour, I have reason to believe that a Work perhaps more suited to the advanced ideas and requirements of the present day than most of those which have hitherto appeared, is not uncalled for. We live in an age of progress, and Practical Agriculture is striving to advance along with it. In some respects, however, its advancement is hampered by customs and ideas which have come down from other times; and it has been my endeavour to remove these as far as possible. Having been guided by personal experience of a somewhat extensive nature in preparing this Work, I offer it, therefore, to the Public, in the hope that it will be found useful in promoting the important object for which it is designed—namely, the Improvement of Landed Property, and, as a necessary consequence, the general welfare of the community. "The profit of the earth is for all; the king himself is served by the field."

WASS, OSWALDKIRK, YORKSHIRE, *Jan.* 1869.

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THE BOOK

OF

THE LANDED ESTATE.

CHAPTER I.

ESTATE MANAGEMENT.

SECTION 1.—*Landed Property commercially considered.*

LANDED PROPERTY, like most other possessions, is bought and sold at various rates, according to its money-producing qualities. In the immediate neighbourhood of cities and large towns the price given for land is sometimes very great. In such cases, however, it is neither the natural nor artificial or cultivated qualities of the land that are taken into consideration in estimating its value, but the adaptation of and demand for it as a site for building and other industrial purposes. Hence, in considering the subject from an agricultural point of view, such conditions, as affecting the value of land, do not properly come within the range of a work of this kind. Speaking in a strictly agricultural sense, then, the market price of any piece of land is estimated in accordance with its capabilities to grow crops of the kinds of plants generally raised in the rural economy of the country, or to maintain stock, as in the case of mountain-grazings and other pastures of a strictly permanent nature. Locality as to markets, &c., has also an influence on the commercial value of land considered as an agricultural subject; although, no doubt, this has been modified considerably by the extension of railways. Land may be naturally very productive, but if the expense of carrying the produce to market is great, the effect of its natural productiveness on the value of the land is much less than it would be in the case of land of the same kind more favourably situated. Of this the Western States of America afford us examples; for in that part of the world there are wide districts where the cost of carrying a bushel of corn to market exceeds the price which would be obtained for the grain from the merchant.

There are other causes which have a decided effect on the value of landed property in this country; and although these are not, strictly speaking, of an agricultural nature, still it is needful that some notice is taken of them.

The possession of landed property confers a certain position on the proprietor which does not belong to property of other kinds, although it may be that the latter is of even greater intrinsic value. But our bounds are limited; and as the extent of landed property brought into the market is comparatively small, those who, having made money in other pursuits, are desirous to become purchasers of land, pay more for it than they would do if it lacked this condition. Then, we have to take into account that land is a secure investment for capital, although it may not, on the average, yield as large a percentage for the money invested as other forms of commercial enterprise. This, too, has a considerable effect on its value. It sometimes happens that an estate is so mixed up with another, that when offered for sale, the owner of the adjoining property, who has perhaps been accustomed to look upon his neighbour's land as an eyesore, will give more for it than it is worth to any other person. This last-named condition is, of course, purely adventitious, and the additional value which it confers may be regarded in some degree as fictitious; but the *prestige* of landownership, combined with the security of the investment, are tangible considerations, and as such exercise an influence on the value of landed property.

Landed property, like most other kinds of property, loses in value when it is not skilfully attended to, and "practice with science" brought to bear upon it for its improvement. A house allowed to remain in the state that houses generally were fifty years ago, is of less money value compared with that of one of equal size, but which has been fitted up with all the modern improvements for comfort and convenience; and a manufacturing machine, which has not had modern improvements applied to it, must be worthless compared with one which has these, just because the improved house is more suitable for the wants of the time than the other, and therefore lets at a higher rent, and the improved machine is capable of producing a much higher profit to its proprietor than the other. As in the case of a house or a machine, then, where land is neglected and allowed to lie unimproved in the modern sense of the term, its productive qualities must be small, and consequently its market value depreciated.

To show to what extent both the present and prospective market value of land is affected by the judicious application of modern improvements, I shall give some particulars of one case out of many that have come under my own notice in dealing with estates.

The subject to which I refer is a farm of three hundred and forty acres—two hundred and eighty of which were arable before the improvements were commenced on it, and the remaining sixty old meadow pasture. The rent was £425 in all, or at the rate of £1, 5s. per acre. This farm is situated within about six miles of a thriving town, and the land consists of a light loam, a considerable portion of which, previous to the improvements, was wet, although it had been drained—but, as the result showed, only imperfectly drained—seven years before. The lease of the farm having expired, the proprietor very properly resolved to take it into his own hand for improvement, and accordingly the farm-house and other buildings were all fitted up on the most improved principles; the fences thoroughly repaired, and new ones substituted and added where these were found necessary. All the wet parts of the farm were thoroughly drained, and about one hundred acres of it were trenched, in order to deepen parts of the land, and to remove stones from it. In short, everything was done to the farm which modern experience could suggest and money accomplish for its improvement at the time, keeping strictly in view that the money expended should be so laid out as to return a good interest to the proprietor in the shape of yearly rent afterwards. The outlay in all was £2960, or at the rate of nearly £9 on each acre of the land embraced in the farm. After having the farm in his own hands for a period of three years, and having got it into the best possible condition for a tenant, the proprietor let it on a nineteen years' lease for the sum of £900 yearly rent, or at the rate of nearly £2, 13s. per acre per annum. From this it appears that the proprietor, by laying out £2960 on the improvement of the farm, secured an advance of yearly rent equal to £475, thus giving him fully fifteen per cent per annum as interest on the sum he expended on the improvements.

But besides the advantage stated in regard to the high interest the proprietor had obtained for the money he laid out in this manner, he had secured another, perhaps even more important—namely, that of having fully doubled the value of the farm in a commercial point of view; for, taking thirty-two years' rent as its value, we have £13,590 as the probable sum the proprietor would have got for the subject had he put it into the market in its unimproved condition; whereas, taking the rent at which the farm was let after the improvements had been executed, and multiplying it by 32, on the same principle as in the other case, we have £28,800 as its improved market value; so that, by judiciously laying out about £3000 on the improvement of a farm, the proprietor added fully £15,000 to its commercial value.

This, then, is a matter of the first importance to all landed proprietors; for by judiciously laying out money on the improvement of their property, they not only reap an immediate advantage in an increased yearly rental, but also materially enhance the market value of their estates.

The following is another instance of the improved value of land from a judicious outlay of money upon it, but of a different description from the case already given:—A small farm on an estate under my management was, in 1862, let for the sum of £32; it extends to thirty-three acres of arable land, five acres of meadow, and twenty-two acres of rough pasture. The fences upon it were in a wretched state, and the buildings were very bad, and not sufficient for the requirements of the place. The land was also very poor and in a dirty condition. The tenant left the farm a bankrupt. I took it into our own management for two years, had the land thoroughly cleaned and put into good condition, the buildings remodelled, and a few additions made. As stone was plentiful on the farm, we replaced the old fences with strong and substantial stone walls or dykes. The total outlay on these improvements was £344; and the farm was then let to a good tenant at the yearly rent of £65, being an increased rental of £33 per annum, or double the old rent; which was at the rate of nearly 9½ per cent upon the outlay, and at the same time doubling the commercial value of the farm.

A great deal more might be said illustrative of the importance of improvement as the means of enhancing the value of land, but the space which I have allotted myself does not admit of it. Suffice it to say, that whatever may be the present value of any piece of land, it is capable of being made very much more valuable by the judicious outlay of money in improving it, so as to increase its productive qualities, and hence its yearly rent as well as its prospective price in the market; unless, indeed, it is already cultivated and improved to the utmost limits which modern "practice with science" will admit.

SECTION 2.—*Estate Management generally considered.*

The management of landed property in such a way as to insure the highest possible money returns from it, seems to be generally less understood than any other business. In this country, land is seldom cultivated by the proprietor of it, but chiefly by tenants, who hold it on lease for a certain period of years, and in a large proportion of cases from year to year, under certain regulations and restrictions, &c. &c. Those tenants are, generally speaking, men of small capital, and hence comparatively few of them are able to improve their subjects to any considerable extent; for which reason these are for the most part cultivated in such a way as the holders can best effect, in order to save expense and make the most they can out of their farms during the period of their occupation.

The generally wet state of the land is the first observable feature in its condition, and this prevails over a very large proportion of most parts of the country; and it is certainly a matter of surprise that so many tenants lay out their capital in the cultivation of land of this character, seeing that at best they must reap but scanty crops from it, and at times run the risk of losing them altogether. In this, however, the proprietors are more to blame than the tenants; still, the fact of the latter agreeing to cultivate land which is in a wet and undrained state is a proof that they are not sufficiently aware of the disadvantages they labour under in this respect.

In cultivating the land, the upper surface only is stirred by the plough, and that generally to the depth of about six or seven inches—seldom deeper, and often shallower. From this it follows that the roots of plants cultivated on it are prevented from getting down sufficiently to insure a full and healthy development in all their parts; and thus poor and unthrifty crops are reaped, instead of rich and highly profitable ones, as is invariably the result where the same kinds of plants are grown in a much deeper soil.

But, besides, by continual cropping for many years on this thin stratum of surface soil, it becomes foul from the seeds of all kinds of weeds and eggs of insects lodging in it. In fact, there can be no doubt that many of the diseases which attack both plants and animals reared on such land are attributable to this accumulated foulness in its upper stratum; and it is equally clear that this state of things might be remedied by a different mode of procedure in regard to the cultivation and general management of the land.

Over a large extent of the country the farm-fences are found in a condition quite the opposite of profitable for the tenants. How frequently do we find the hedgerows in a wild, straggling, and uncared-for condition, presenting large gaps, frequently overgrown with brambles, and occupying much land which might be made available for culture, and therefore valuable under a different state of things! In many parts of England we see the hedges remaining uncut for a long period of years, so that they spread out and occupy a large proportion of useful land, which could be made to grow crops. Where such is the case, they are not only a preserve for hares and rabbits, but they are a hotbed for rearing weeds, which grow up and spread their seeds all over the adjoining land. We have, within the last few years, removed a great extent of old hedges on this estate, and we soon found that it did not take a great length of such fences to cover an acre of good land. The remaining hedges we have had neatly trimmed and put into form. (See "Hedges.") And, besides, we very generally see old stone dykes or walls in as bad a condition, broken down, and comparatively worthless as fences. These, as well as the hedge-banks, are in many places found the resorts of rabbits and rats, which destroy the crops in the adjoining fields, and of course render them of little value.

With regard to farm-buildings, I shall merely remark that the greater part of them are insufficient in extent of accommodation needful for all purposes, and but ill adapted to secure the health of the animals kept on the land.

It is clear, therefore, that if the proprietor of land which is unimproved or deteriorated by bad management choose to let it lie in the condition in which it came into his possession, without expending money in improvements, he must be content with small profits; but if he, on the other hand, apply money, skilfully and prudently, in improvements, he will certainly render the property much more remunerative, while it will be a sure investment for his capital, and one he can more certainly depend on leaving unimpaired in value to his heirs than he could do in the case of a manufactory, the produce of which is generally of a fluctuating character, and liable to become less valuable any day.

CHAPTER II.

THE TRAINING NECESSARY FOR LANDED PROPRIETORS.

Proprietors of estates, being professedly cultivators of the soil, or deriving their incomes from it, should, taking a common-sense view of the matter, be able, therefore, to manage their properties on the principle of securing the greatest possible profits from them as interest on their capital, and at the same time of producing the greatest possible amount of food for the public advantage. Indeed, in these respects, the welfare of both the proprietors of land and the public at large go hand in hand; for when there are large returns, both have their advantages from it; and for this reason the proprietors who do most for the improvement of their estates, are those who reap the greatest advantages from them, and are deserving of the highest esteem from the public. It is, therefore, in all respects the interest of every landed proprietor to cultivate his estate to the highest degree possible, and in order to do this he must be well acquainted with the particular conditions of the land, as well as able to judge correctly as to the operations which are necessary to be performed on it in order to increase its fertility, and consequently the returns from it.

From what has been previously stated, it is to be inferred that the landed property of this country is not generally well managed; that the greater proportion of it is undrained and wet; that nearly all of it is cultivated on too shallow a principle, whereby the plants grown have not depth of soil to insure full and healthy development; that from continual cropping on the shallow surface-soil it becomes foul, and unfit for the rearing of healthy plants and animals; that a large proportion of the fences occupy the land unprofitably, forming nurseries for vermin, which destroy the crops; that the greater part of the farm-buildings are insufficient in extent and ill adapted to the health of the animals kept in them; and that from those causes the land generally produces unthrifty crops, and hence a small money return to the proprietor on the capital invested in the subject.

These are facts in regard to the condition of landed property which everywhere speak for themselves, and cannot be denied. They are plain to every one who looks about him with his eyes open. In this country, where wealth and men are abundant, and where agricultural skill cannot be said to be wanting, it is doubtless remarkable that the unsatisfactory state of things referred to in regard to landed property should prevail, at least to such an extent as we find it. And here the question naturally arises, Who is to blame for it? My answer is, The blame rests with the proprietors themselves.

But few of them have hitherto been trained directly to the proper management of their own peculiar branch of business, which may be called the science of landownership; namely, that of dealing with, on the most improved principles, the land which they possess. Hence they have not, generally speaking, understood the real state of things which surround them on their properties, but have left their agents and tenants to judge for them in these matters, and to act in most cases as they thought best. But neither agents nor tenants can do much for the permanent improvement of the land without an advance of means from the proprietor; so the former have, of course, been comparatively helpless when left to themselves. From this cause little has been done compared with what would have been the case had the proprietors themselves been thoroughly educated so as to understand the real condition of their estates, and the great advantages they would certainly gain by the judicious outlay of money in permanently improving the condition of the land.

In any branch of business a particular course of education is required to fit a man for properly and profitably conducting it; and it is very well understood among business men, that where the head of an establishment has not himself been trained and educated specially for it, that establishment is more likely to turn out a failure than a success. Every merchant and manufacturer attends at the helm of his own peculiar business, and sees that the most minute operations in connection with it are rightly performed, all of which he thoroughly understands, and hence the general success of such men in their undertakings.

If these remarks hold true in regard to management in the establishments of merchants, manufacturers, and traders generally, they must be equally applicable to the management of landed property; for without doubt, the more one knows in regard to his own peculiar branch of business, the more likely is he to be successful in it, and to make it remunerative. It is nevertheless true that, in regard to the management of landed property, these facts do not seem to have been sufficiently recognised nor acted upon; for, as I have already hinted, I know of but few landed proprietors who may be said to have been properly trained and educated with the special view of their understanding, practically, the cultivation of their estates, and of discharging the various duties of managing them in all the various departments embraced on an estate of considerable extent; therefore it cannot be expected that improvements on landed property will make rapid progress till its owners see the great loss they sustain by allowing it to be in the unprofitable condition which has been already described. The extent of the loss they are sustaining annually is incalculable. There are vast mines of wealth lying dormant in the land all over the country, to utilise which requires only the application of skill, industry, and capital on the part of its proprietors and cultivators. But until proprietors receive a sound, practical, and theoretical education, to enable them to understand how to go about their peculiar business, and to appreciate the merits of the case, these mines of wealth must continue to lie dormant. As soon, however, as they obtain this kind of education, they will see the way to deal with their land so as to gain the end held out to them in regard to it; and consequently, in order that they may make up for time lost in the past, they will take the reins of management in a great measure, if not entirely, into their own hands—laying out capital on improvements which will not only pay them a high percentage, but add vastly to the permanent value of their estates.

Keeping out of view altogether the education which it is understood every landed proprietor receives as a gentleman, it is absolutely necessary, in order that he may creditably discharge the duties devolving upon him as a proprietor of the soil, that he should be trained and educated, practically and theoretically, in the arts and sciences which have a bearing on the cultivation of his property, and which are calculated to promote his success in dealing with it. It is, I think, scarcely possible for a man to become thoroughly acquainted with all the necessary branches of estate management unless he attend to the subject from his youth; and therefore every one who has the fortune to be a landed proprietor, or who may have the prospect of becoming one in due time, should begin early in life to prepare himself for the discharge of the after-duties of his position; as, if this is not attended to, he is not so likely to become such a very successful improver, nor to have so much pleasure in the management of his property, as one who has made this his principal object and study when young. In order, then, that the young man who has the prospect of becoming a landed proprietor may have the advantage of an early training to the proper after-management of the estate, the proprietor for the time should have a home farm, on which the young man may receive useful instruction, and become familiarised with the various processes of agriculture, as well as have recreation and pleasure during any leisure time he may be able to command.

On a farm of this kind, practical agriculture, or the way in which crops in general are grown and live stock reared, should form the first step in the ladder by which the heir to an estate is to ascend to its management. After having spent the leisure time of a few years in youth in acquiring a knowledge of practical agriculture, he will, without doubt, have his mind well established in the first principles of the art, and will then be ready to enter upon a higher field of study in reference to it. This field should be an Agricultural College, and there he should study the various departments of science which have a bearing on agriculture and successful estate-management.

Having finished his course of education at the Agricultural College, and there acquired a fair knowledge of the sciences referred to, as well as seen how they are made applicable to the everyday business of a landed proprietor's estate, he should return home in order still further to prosecute the more practical part of his studies. Here he should enter upon and carry out a course of experiments on the home farm, entirely on his own account, in order to confirm his own views in regard to particular points he may have taken up, whether as to cropping or the rearing of stock, as well as to secure experience from them. And in respect to all the operations on the home farm, he should make it his study to investigate them, as to whether they are being conducted on the principles he was taught at college; and if not, he should satisfy himself, by both theoretical and practical means, what modes of operation and cultivation are the best, as may be proved from the results of experiments.

While putting his school education into practice in this way on the home farm, he should also visit from time to time every farm on the estate, and make himself thoroughly acquainted with all the tenants, and with their respective modes of dealing with their subjects. He should also visit other parts of the country from time to time, more especially such as are distinguished for the excellence of their agriculture, and the advanced or enlightened manner in which the general management of landed property is conducted.

This will do much to open up his mind, as it will bring the theoretical part of his education into fair contact with practice in various ways; and hence his mind will be called into action on them, by comparing his own views with those of practical rent-paying tenants, as exemplified in the practice they respectively adopt; and in this way he will soon be able to judge for himself, from the results brought out in regard to the respective cases, as to what mode is right and what is wrong.

In his visits to the farms on the estate he should be accompanied by the agent or factor, who, it is understood, should be as much informed as himself in all matters bearing on estate management, and superior to him only in having a greater amount of practical knowledge and experience.

Accompanied by the agent, he will have the advantage of his explanations in regard to any points in management he may not understand; and with reference to all of these he should take notes, and work out experiments on them afterwards, unless he may see the problems satisfactorily solved otherwise.

By a steady course of practical training in this way, and by spending a day now and then in the office of the agent among the estate accounts and other documents in connection with the management of the property, the heir would eventually become perfectly acquainted with every farmer and farm on the property, and with the system of agriculture and general management pursued on the estate; and he would also have learned which of the tenants were intelligent and improving, and which of them were not;—in short, he would now have made himself master of his business, and would not be subject to be imposed upon in matters in connection with it by any one, and hence he would at any time be prepared to deal with the property satisfactorily on his own account. It is, perhaps, unnecessary to add, that were all our landed proprietors trained in this way, the result could not fail to be that we would have the satisfaction of seeing them vastly more prosperous, and their estates much more productive than they are at present.

What has been said with regard to the importance of a practical early training in rural affairs, in the case of all young men who have the prospect of becoming landed proprietors at some after period in life, is not affected by the fact that several gentlemen who have been famous for the manner in which they conducted the business affairs of their estates, and for their knowledge of practical agriculture, spent the early part of their lives in other pursuits. Of this we have a notable instance in the Marquis of Tweeddale, who, after a brilliant career in the army, became a most energetic improver of landed property, and of practical agriculture, when he exchanged the sword for the ploughshare. Such cases cannot, however, be regarded as constituting a general rule; and, therefore, training is as necessary in the case of an expectant landowner as it is in any other profession or business.

CHAPTER III.

LAND-AGENCY.

SECTION 1.—*Agents, or Factors, as Estate Managers.*

AGENTS—or Factors, as they are called in Scotland—are men employed by landowners to look after the affairs of their estates, and transact any general business arising out of or in connection with them, and generally speaking they are resident on the estates. An agent for a landed proprietor occupies a responsible position in the neighbourhood where he has his charge, inasmuch as he has to exercise a large share of the power of his employer, and is his representative in most respects when absent, not only in respect to the tenants of the estate he has in charge, but also in other matters connected with the district.

This class of estate managers includes men of four different qualifications,—1*st*, Those who are mere theorists in the profession, and have not had a thorough training for it; 2*d*, Those who have had practical training on the farm only, and are without sufficient general education; 3*d* Members of the legal profession; and, 4*th*, Those who have had both a practical and theoretical education specially designed to fit them for the business of land-agent.

With regard to the class of men first referred to, they are, in my opinion, least of all to be trusted with the management of an estate; for they are apt to be led away into extremes in any hobby they may take up, not knowing whether it is suitable for the case in hand; and the result, therefore, is more likely to turn out a failure than a success. I have seen much loss arise to an estate from the bad management of an agent of this kind, who had come out full of the theory of the profession, but without any considerable acquaintance with the practical details of land agency, or, indeed, of country business in any form. In fact, men of this stamp, as I have said, should never be trusted with the management of an estate, because they have not enough of practical experience to counteract the tendency of their minds to purely theoretical schemes.

As to those who have had practical training in purely agricultural details only, they are, undoubtedly, much safer as land-agents than the mere theorists; still, they cannot be said to be fully qualified to carry out the management of an estate in the highly enlightened way which is found necessary to secure the permanent success expected in the present age of improvement. The mere practical man is best qualified for carrying out improvements on land under the directions of one of higher attainments, but he is disqualified, from his want of theoretical and general knowledge, from examining into the cause and effect of things generally in the management of an estate, and from dealing with the higher branches of business devolving on one who undertakes the onerous duties of a land-agent. In the ordinary business of cultivating the lands of an estate I have seldom seen a merely practical man go far wrong, but, generally speaking, I have found him inclined to be narrow in his ideas, and therefore deficient in taking broad and intelligent views in regard to conducting the general affairs of a large estate to a definite and satisfactory conclusion.

Members of the legal profession are frequently put in charge of estates, but, so far as I have had an opportunity of seeing their management of landed property, I must say that it is, in general, of a very defective kind. This, no doubt, arises from their want of training to the outdoor departments of the business, their province being among the accounts and law matters connected with it, while the improvement of the property is either entirely neglected or but partially carried out. I have, generally speaking, little hope of the improvement of an estate when I see it managed by one who is merely a member of the legal profession and nothing else, for in most cases he is more disposed to draw money from it than to lay out any on it. I do not mean to infer that this is always the case in regard to estates managed by law-agents, for I have seen some properties highly improved under the management of such men; but, as a rule, agents of this class are unfit, from their habits and education, to act as successful improvers and managers of landed property. They view most things through the medium of the law, and hence, in many cases, arise disputes with tenants and others, and in this way the machinery becomes clogged, and does not work well.

With regard to the men who have had both a practical and theoretical education to fit them for the business of estate agents, there can be only one opinion, and that is, that they are the kind of men who are most likely to succeed and give all parties satisfaction. A man who has undergone a thorough practical training in agricultural pursuits, on a first-class farm and under a highly intelligent farmer, if he is at all of good natural abilities, and has a desire to succeed in the pursuit, must be well prepared to carry out farm improvements on a large scale, such as a landed estate involves; and from his having obtained, besides, a theoretical education bearing on the same subject, he must be well qualified, in other respects, to deal with the management of landed property.

Men who have been brought up in the country from boyhood always make better agents than those who have been reared in towns. Indeed, it seems but natural to suppose that such should be the case. Young men brought up in towns are generally ignorant of country matters, and seldom take to them from choice in after life, and therefore do not generally make good land-agents. On the other hand, young men who are brought up in the country have the most of their associations connected with it, and their earliest impressions derived from it, so they are most at home among such scenes in after life, and consequently are the persons who are most likely to make the very best of land-agents. This is a point but seldom taken into consideration by proprietors in choosing agents to act for them on their estates, but it is not the less necessary that they should do so; for the impressions received in youth form, in most cases, the basis of character in the man; and this holds true in the case of land-agents as much as in most other professions. Nearly all of the most successful improvers or estate agents are men who have been trained from early life in the country, where farming was daily going on before them; where they saw, and could not avoid seeing, certain operations in this respect attended with certain results, and where they heard the farmers and their friends talk and reason about crops and cattle, and the best mode of dealing with certain kinds of land, &c. &c. An agent, to be a successful manager of an estate, must, therefore, not only have a thorough practical training and theoretical education to fit him for the position, but also have had early associations in connection with the country to give him a strong natural bias for the work; and proprietors should take this into consideration in choosing an agent, as it sometimes happens that, from not bearing this in view, men of town-bred associations and habits are appointed, who are apt to grow tired of country life, and so become careless in conducting their business, which, generally speaking, requires not only energy, but a certain amount of professional enthusiasm, to secure its satisfactory management.

SECTION 2.—*Training and Qualifications necessary in an Estate Agent or Factor.*

Although the leading points of training and qualifications necessary for an estate agent are to be inferred from the remarks made in the foregoing section, still I think it requisite to devote a separate section to the subject, in order to bring out a few particulars which require to be attended to in regard to it.

The duties of an estate agent being of a very varied character, embracing all the branches of rural economy, his training and qualifications should be in accordance with them. He must not only be acquainted with farming and forestry, but, to a certain extent, with mining and quarrying, and should therefore be prepared to deal with all these branches of industry with judgment and skill, keeping in view at all times both the present and prospective interests of the proprietor and value of the estate.

The young man who has in view to become a land-agent should, in the first place, secure a thoroughly good general education, embracing a fair knowledge of classics and mathematics. Ability to read French and German correctly will enable him to avail himself of the valuable works which are issued in these languages bearing on rural economy. This general education being finished, so far at least as school-training is concerned, he should engage himself to some high-class farmer for one year—not as a looker-on, but as a workman, and on the distinct understanding that he is to have a hand in all the different branches of work to be performed during the year, and have liberty to attend markets, sales, &c. &c., with the farmer himself. One year spent on a good farm in this way, and under the superintendence of an intelligent agriculturist, willing to instruct him at all times on subjects in connection with the farm, will do more to make a young man a practical farmer than three years spent as an idle onlooker, sporting about on horseback, as too many young men do, who go out to learn farming with the view of becoming farmers or land-agents. Having spent one year on a farm in this way, the intended land-agent should remove to another in a different part of the country, where the land is of a different description, and the system of agriculture is somewhat different in consequence. There also he should remain one year, taking his part with his own hands in all branches of work, and on the understanding that he is to receive every advantage from the farmer in respect of information on the farm, as well as from attendance at markets, sales, &c. &c., as in the other case. After spending two years in this way he will have become tolerably well acquainted with practical agriculture, and should then enter an Agricultural College, where he should apply himself to acquire such a knowledge of the sciences bearing on agriculture as we find embraced in the course of study at such an institution as the Royal College of Cirencester, or as comprised under the new regulations adopted by the authorities of the Edinburgh University. As the next step in his training, he should endeavour to get employed in the office of a good land-surveyor for at least one year, where he will have an opportunity of practising measuring and valuing of land, surveying, mapping, &c. &c. He should afterwards engage himself as assistant in the office of some land-agent as factor, and on an estate where extensive improvements are being carried out. There he will learn much, as at this stage of his training and education he should be well able to reason on all matters in connection with estate business, and to form correct conclusions from what he may see going on around him, so that, by the end of a year or so, he should be fit to undertake the responsibility of a land-agency. In order that he may be in all respects thoroughly prepared for this, he should, while acting in the capacity of assistant to an agent, endeavour to gain a complete knowledge of book-keeping in all its details, as applicable to estate purposes, and also to acquire some acquaintance with law so far as it may have a bearing on landed property. It is not possible, neither is it desirable, that he should be a lawyer, but without some acquaintance with law an agent is apt to commit mistakes in many points of his business, while a moderate knowledge of it would enable him to steer clear of serious blunders. Another branch which he should endeavour to gain some knowledge of while in the office of an estate agent, is that of the management of plantations. This he can easily obtain by paying attention to the operations going on in the department of woods on the estate, and by inquiries in regard to these at the forester and agent respectively, as occasion or opportunity may occur, together with the study of works of acknowledged repute bearing on the subject. In regard to the management of woods, it is not understood, of course, that an agent should have complete practical knowledge of it in all its details, as this must in general cases be left to the judgment of the forester himself; still, it is absolutely necessary that an agent should have a fair knowledge as to how the department should in general be dealt with, in order that he may be able to form a sound opinion and correct judgment on the proceedings of the forester, and consult with the proprietor in an intelligent and experienced manner in regard to any matters that may arise in connection with this department. I have, however, known men who had been well trained, and educated in all the branches of knowledge referred to, but who, nevertheless, were not well qualified to conduct all the business devolving on an estate agent in a satisfactory manner; and I shall, therefore, just refer to a few qualifications which are absolutely necessary to enable a man to turn his previous training to good account in conducting his business. He should be of a cool and calculating turn of mind; never acting without calm consideration as to the probable results of all he proposes or undertakes in relation to the business of his employer. He will find, on most estates, farmers who are as well able to judge of agricultural matters as he is, perhaps more so; and if he give them a hasty and inconsiderate opinion in reference to any matter, it cannot fail to damage his reputation, not only in the eyes of the tenants generally, but also in the estimation of the proprietor. He should never be one-sided in his dealings between landlord and tenant, but act in the fairest and most candid way possible between them. In order to insure his dealing fairly between the respective parties, he must have a clear judgment in regard to everything he engages in; as if he has not this qualification, he is apt to lean to one side or to the other, as it were by chance, and without being able to give a reason for it in his own mind. Clearness of judgment and decision of character form high qualifications in a land-agent, as without them nothing can go on well under him. He should have a considerable amount of patience and frankness, combined with acuteness, in order to enable him to deal with the different characters of men, such as are to be found among farmers and tradespeople generally in the country. In dealing with farmers, especially, he is likely to find many of them of antiquated habits and ideas; and unless he can reason them out of such in a patient, cool, and happy manner, he will not be able to command their respect, or induce them to listen to his advice.

It will thus be seen that the duties of a land-agent, and the qualifications requisite in order to enable him to conduct his business in an efficient manner, are of a different, and, in fact, a much higher nature than we should be led to expect from the qualifications of not a few individuals who have been appointed to the office. Poor relations have in manifold instances been provided for by an appointment of this kind; and we have known even ex-butlers and confidential valets figuring as stewards or agents on certain estates: it has been considered, in short, an office for which "all sorts and conditions of men" were suitable, and hence the backward state of agriculture in many parts of the country. The agent, when thoroughly qualified, ought to be, and really is, the great promoter of agricultural improvement on the estate under his charge. Nor is the influence of a man of that description confined to those in whom he is more immediately interested, for it is felt outside that circle, directing and modifying the actions of others, and effecting an amount of good which it is impossible to estimate.

CHAPTER IV.

TENANT-FARMERS.

SECTION 1.—*Farmers as a Class.*

As is the case in every occupation in which a large number of persons are engaged, we find amongst farmers great diversity of character, means, and attainments. The farming class includes men of every imaginable description and reputation, from the most honourable and upright down to those who would not hesitate to take every kind of advantage of their neighbours, when they could find a safe opportunity of doing so. In it we find also men possessed of very considerable wealth—more than equal, in this respect, to meet any demands likely to be made on them in their circumstances; while we find also men of more moderate means, able only to carry on their business profitably, and also men who are so much straitened in their circumstances as to be in a state of comparative poverty. In it we find also men possessed of strong natural talents, and of high attainments, fully qualified to carry on their business on enlightened principles; while, of course, a large proportion are men of moderate capacity and attainments, sufficient to enable them to conduct their business in the usual routine way; and not an inconsiderable proportion are so ill-informed and unskilful as not to be able to conduct their concerns in such a way as to insure either profit or comfort to themselves, or those with whom they have to deal.

This great variety of character is only what is to be expected in a class of men made up of all grades of society; for here we find retired merchants and tradesmen, with professional men of every description, besides those who have been brought up as cultivators of the soil; and hence we find all kinds of management on the different subjects held, according to the views entertained by the respective parties, which are, of course, biased according to the peculiar training each has had in his earlier pursuits and habits in life.

Taking farmers as a class, there are few, in comparison to their numbers, who have made rapid strides in the improvement of their farms, and who occupy, consequently, a high standing in their line of life. This is no doubt owing partly to the want of proper training and education, whereby their minds can be made to comprehend the advantages arising from superior modes of culture; partly to the want of sufficient capital to enable them to carry out farming on better principles; and, perhaps, partly to the fact that, generally speaking, the beef, mutton, and grain belonging to the man who rears them in the ordinary way, meet with as ready a demand in the market as these commodities do when reared and sold by the improver, the difference in the profits lying more in the quantity than in the quality,—of course all other points being equal.

Generally speaking, however, farmers, as a class, are acute in respect to their own interests, and in so far as their intelligence and means enable them they make the most they can of their subjects. For the most part I have found them inclined to enter into such arrangements as were suggested by the proprietors for the improvement of their subjects, when the schemes were likely to turn out advantageous to the interests of the farmers in the first place, and to the proprietors as well in due course. In short, having had a considerable experience among farmers in the way of carrying out improvements in many parts of the country, I have seldom found the younger and more intelligent part of them insensible to the advantages of superior modes of culture, nor unwilling to introduce these on their farms where the proprietors have been at all liberal in dealing with them. Generally speaking, and with some exceptions, even where farmers are inferior in intelligence and possessed of but small capital, if they are liberally dealt with, and under the direction of liberal landlords and judicious agents, they may be made to carry out and follow such a system of cultivation on their respective farms as will be found highly conducive to the interests and prosperity of both landlord and tenant.

Section 2.—*The Prosperity of an Estate affected by the Qualifications of the Tenantry.*

In farming, as in all other pursuits, the condition of the subjects operated on is a pretty correct index to the intelligence of the parties engaged in their management. In taking a journey through different parts of the kingdom, a great variety in the state of the respective farms and estates is observable, and that variety is frequently so striking as to attract even the attention of people who know little about the country or agricultural affairs. What, I would ask, is the cause of this state of things? Is it not that the superiority and inferiority in the conditions of the respective districts contrasted, are caused in a great measure by the possession or want of intelligence in the holders?

I shall give an example or two, drawn from the actual state of matters in certain districts with which I am familiar, in order to illustrate this point more clearly.

In one district are to be found large and well-defined fields, enclosed partly by strong and well-constructed wire-fences, and partly by healthy and neatly-kept hedgerows. In the fields there is not the slightest indication of superfluous water, even after heavy rains, showing that the drainage of the land must be perfect; and, besides, every field is cultivated close to the respective fences, so that not a foot of the soil is wasted where it can be made available for cultivation; and this satisfactory state of things extends over a district embracing several thousands of acres. The next district is one consisting of the same description of land as the one just referred to, and consequently its natural capabilities must be similar. The fences on it, however, are of the worst description possible, consisting of wild-looking and overgrown hedges, here and there useless from large gaps, and in all parts occupying a considerable breadth of land on each side. In this district it does not appear that any drainage has been performed, as the fields have a cold and bleak aspect from the rushes and water-loving plants growing on them, and from the poor, thin, and sickly character of the crops. This state of things prevails on a large extent of country. From these examples of contrast in regard to the condition of landed property, it cannot be doubted that the occupier of the land, in the first case described, must be a man of very superior intelligence as compared with the occupier of the land in the latter. There is no other way of accounting for the difference in the condition of the subjects. I know that many will say that the difference in such cases lies more in the command of money in the occupiers than in the possession of superior intelligence. I admit that money is absolutely necessary for the improvement of the condition of land; but, at the same time, without intelligence to direct its expenditure, even money would fail to effect such a marked improvement as that which we witness in different parts of the country. Farming requires the possession of considerable capital, and when capital and intelligence are combined we may hope for the best results.

I have already stated that, generally speaking, and with some exceptions, even where farmers are inferior in intelligence, and possessed of but small capital, if they are liberally dealt with, and under the direction of liberal landlords and judicious agents, they may be made to carry out and follow such a system of culture on their farms as will be found highly conducive to the interests and prosperity of both landlord and tenant. This is meant to be applicable to cases where inferior tenants cannot be removed, to give place to others of a superior class, and where proprietors are desirous, in the mean time, to improve their estates even under the disadvantages arising from having to deal with a class of inferior tenants. But, notwithstanding that estates may be vastly improved under the guidance of liberal landlords and qualified agents, even with the disadvantage of tenants of an inferior class, it is clear that the same improvements can be more cheaply, and in all respects more satisfactorily, carried out with the co-operation of really intelligent tenants, who understand their business, and take a deep interest in it, than with that of inferior men who do not properly understand nor thoroughly appreciate the improvements which it is necessary to effect, and who, therefore, cannot be expected to enter into them with that zeal which is essential to success.

In making these remarks, I speak entirely from my own experience in dealing with tenant-farmers in the way of carrying out improvements in various parts of the country. In no case have I found any difficulty in carrying out improvements, however extensive, on the farms of intelligent and thoroughly qualified men, as they in all cases had a complete understanding of the works before they were entered upon, and were, for their own sakes, as anxious as the proprietor himself that they should be conducted to a satisfactory result; but, on the other hand, where I have had to deal with tenants of antiquated views, and without the necessary intelligence to understand what we proposed doing, I have experienced very considerable difficulty in getting the respective works carried on satisfactorily, and have never had them so cheaply performed on the farms of this class as on those of the other. For this as well as other reasons, I believe it may be laid down as a maxim in rural affairs, that much of the prosperity of a landed property depends on the intelligence of the class of tenant-farmers which exists upon it.

Perhaps there is no branch of work so dependent for its proper performance on the intelligence of the farmer as that of drainage, for however able a man the agent of a property may be, and however desirous he may be for the interests of his employer, he cannot carry on the works of drainage well and satisfactorily to any considerable extent, unless at much extra expense for superintendents, without the co-operation of the farmers on whose land the operations are being carried out. If the farmers are men of proper training and education they will understand the nature of the work as well as the agent, and from their having the deepest interest in its success they will be certain to look sharply after the proper execution of the work; so that the agent will have confidence in its being well done, and be saved much expense and anxiety besides. On the other hand, where farmers have not had experience in drainage-works, and have not the intelligence to understand how they ought to be carried out, the agent has either to attend closely on them himself, or appoint some one as a superintendent to look after them, causing extra trouble to the agent and expense to the proprietor. But in the latter case the work is seldom so well performed as in the former; for I have seldom found drainage-work so satisfactorily gone about when under the care of a hired superintendent, unless he is a very conscientious man, as when they are under the immediate superintendence of an intelligent and enterprising tenant-farmer. A man of that kind will not allow any deficiency to pass, but will have it put right, while the hired superintendent, having no direct interest in the after results, may be less attentive, and in this way faults and defects are overlooked, and, as it were, buried in the ground.

It is not, however, in works of drainage alone that the advantages arising from intelligent farmers affect the prosperity of an estate, but in works of all kinds that may be carried out for its improvement. In short, the prosperity of an estate is very much influenced in all respects by having a superior class of tenants on it; for besides their being able to carry out improvements more satisfactorily than inferior tenants, they are also better able to maintain the effective condition of the respective works after they have been performed, and therefore to increase the value of their subjects. For instance, it has frequently happened that drainage-works, conducted and completed in the best manner, have been rendered nearly useless owing to the state of the outfalls being neglected by ignorant or careless people; whereas an intelligent man, fully alive to the importance of maintaining the drainage of his farm in the best possible order, would never neglect so material a point.

SECTION 3.—*Training and Education necessary for a Farmer.*

It is only those who have had a wide and intimate acquaintance among farmers that can understand the extent of their acquirements and fitness for the business they pursue. There is no profession in which a knowledge of the laws of nature is so much needed in those who follow it as in farming; and still, there are comparatively few of them who have studied these laws in the light of science. In most trades, arts, and manufactories, those engaged in them are well acquainted with the nature and component parts of the substances they use; while farmers, for the greater part, know very little as to the real nature of the soils they cultivate, or of the plants they grow, nor as to the changes these undergo when subjected to altered conditions, whether in regard to weather or the effects of mechanical operations. Most people engaged in business keep regular accounts of income and expenditure connected with their transactions, so that at the end of the year they are able to understand exactly how matters stand; but there are comparatively few farmers who attend to this essential point, or who can at any stage of their business give a correct statement as to the profit or loss on it. If this is truly the state of things in regard to a very large proportion of the farmers of our country—and I believe no one will deny that it is so—then it is certainly high time that a higher degree of intelligence and more correct business habits prevailed amongst them. Suitable education and training for the profession can alone effect improvement in those respects in the cultivators of land in this country. Without suitable education and training in the case of our farmers, as a class, it is impossible that the agriculture of Britain can make the great and rapid progress which its importance demands in the interests of a rapidly-increasing population, who may be said to have a right to expect cheap food, and a plentiful supply of it, from those who have the land in their hands, and who profess to cultivate it to the best advantage of all concerned. If a certain degree of education and training is requisite in the case of the land-agent, to fit him for the proper discharge of his part in the business of estate management, the same is equally necessary to prepare farmers for the proper and profitable discharge of their duties. The question, therefore, is, What kind of education is best fitted to insure the farmer being able to carry out a system of high cultivation profitably for himself and for all concerned?

In the case of a farmer, as well as in that of a land-agent, the first preparative step is a good general education, embracing all the usual branches of English instruction, including book-keeping and some knowledge of mathematics, which can always be obtained in this country at a moderate cost in most towns. The young man who intends to make farming his business should next place himself under the instructions of some really good and intelligent practical farmer—unless he is the son of a farmer of good abilities—on whose farm he is likely to see all the details of the business systematically carried out on the most approved principles. On such a farm he should remain at least one full year, working with his own hands in every branch of operations, so that he may be able to know not only how each branch ought to be gone about, but also how to perform it properly himself. I hold that this working with their own hands is a great advantage to young men who are to follow farming in after-life, as it gives them an acquaintance with the different works which they cannot obtain otherwise. It is not absolutely necessary that he should work in all respects as a common labourer, if his means and circumstances in life can afford him to go about it otherwise; what I mean is, that he should take an active part in all the operations in a systematic and effective way, so as to insure his becoming perfectly acquainted with them all, which is necessary to secure his practical education being complete. On entering a farm for instruction, the young man should of course arrange to pay the farmer a certain fee for it, and on this understanding he should have every attention paid him by the farmer, in so far as the latter is able to give him information, both practically and theoretically. This information should consist chiefly in dealing with the cultivation of the land, the rotations of cropping, the rearing of live stock, and the selling of both stock and crop; and, besides, the farmer should give him full instructions in regard to the valuation of land, crops, and stock, not only in connection with his own farm, but in regard to those on the farms of others in the neighbourhood. The pupil should draw out for himself a complete plan of the farm, and of the farm-buildings in connection with it, noting the character of land in each field, and the kind of crops on it, and also that proposed for rotation next year. In short, the pupil should, if he mean to profit by his residence on the farm, lay his whole mind to learn all about it, and about every plant and beast reared upon it, and to absorb, as it were, into his own mind all the knowledge of the farmer under whose instruction he is being trained; as, unless he do this, he will not profit by his residence with him as he ought to do, and as is absolutely necessary for his after success in the profession he has taken up.

Having remained one year on a farm in this way, he should remove to another in a different part of the country, where farming is carried out on approved principles and under a highly-qualified man. There he should remain one year also, working with his own hands, and gathering all the information he possibly can on every branch of the business conducted on the farm. This change of scene he should seek, although he may have enjoyed the privilege of living on his father's farm, as by so doing he obtains a wider acquaintance with the practical details of his intended profession than he could get by remaining at home—

"Home-keeping youths have ever homely wits."

Afterwards he should go for a like period to a farm in another part of the country; and having done this, he ought, if he have been at all persevering and observant, after three years' experience on three farms in three different parts of the country, be well acquainted with practical farming, and prepared to enter on a course of higher studies to fit him for pursuing farming on his own account.

His next school should be an Agricultural College. He will there have the double advantage of learning practical agriculture, as well as the sciences bearing on it, and their application to its everyday operations; so that, having studied his profession in this manner for such a length of time as may be found necessary to make himself thoroughly acquainted with the branches taught, and their application to the business of the farm, he will have completed his education, and have become fit to enter on the charge and management of a farm on his own account.

But besides being possessed of the education and training referred to, farmers require to have acute observing faculties, as, if they have not this very necessary qualification, they will not excel in conducting their works profitably, nor in the rearing of their stock and crops generally. Much of the success of our best farmers depends on their powers of close observation in regard to the state of their crops as affected by certain conditions of soil and weather, and in regard to the health of their animals in certain states of the weather, on certain kinds of food, and under certain kinds of treatment, &c. &c.; so that, independent of education, the habit of close observation is absolutely necessary in order to secure a high degree of success in farming. And, moreover, the farmer must be of a persevering turn, not apt to take up with a scheme at first sight, and upon trial to become tired of it and give it up. In all his undertakings he should weigh them well before he enter into them at all; and after having done this, he should take them up for practical operation, or not, as he may see fit and proper. These are qualifications indispensable to success in farming, for without them, even with the best of education, much valuable time and money may be lost; but with the education and training stated, and with good powers of observation and perseverance, men are likely to take the highest standing as agriculturists.

It may, perhaps, be supposed by some that the course of education and training which has been described as necessary to enable the young farmer to enter upon his profession with reasonable hopes of success, is too elaborate to be required by one intended to become, what some designate, "a mere farmer." The account given by Mr Stephens of the special training he underwent in order to fit him for the duties of the profession he had selected, and its results, will show that the course which has been sketched in the preceding remarks is quite in accordance with the views of that eminent authority on agricultural matters:—

It may be proper for me to state, in a few words, the opportunities I have had of acquiring such an extent of knowledge in the various departments of practical agriculture, and the other subjects enumerated above, as to warrant me in assuming the part of monitor to the agricultural student. The following short narrative, I trust, may be sufficient to satisfy the reasonable inquirer:—

After receiving what is commonly called a liberal education at the Parochial and Grammar Schools of Dundee, at the Academy there, under Mr Duncan, the Rector, now Professor of Mathematics in St Salvador's College, St Andrews, and at the College of Edinburgh, I boarded myself with Mr George Brown, of Whitsome Hill, a farm in Berwickshire of about 600 acres, with the view of learning agriculture. Mr Brown was universally esteemed one of the best farmers of that well-farmed county; and so high an opinion did the late Mr Robertson of Ladykirk, the most celebrated breeder of shorthorns in Scotland of his day, entertain of his farming, both in stock and crop, that he gave him permission to send his cows to the bulls at Ladykirk—a singular favour, which he extended, I believe, to no one else, with the exception of his old tenant and intimate friend, Mr Heriot of Fellowhills. I remained three years at Whitsome Hill, during the first two of which I laboured with my own hands at every species of work which the ploughman, the field-worker, and the shepherd must perform in the field, or the steward and the cattleman at the steading: and even in the dairy and poultry-house part of my time was spent. All this labour I undertook, not of necessity, but voluntarily and with cheerfulness, in the determination of acquiring a thoroughly practical knowledge of my profession. In my third year, when there happened to be no steward, Mr Brown permitted me to manage the farm under his own immediate superintendence.

I then travelled for nearly a twelvemonth, soon after peace was restored, through most of the countries of Europe, and in many places I happened to be the first Briton who had visited them since the outbreak of the Revolutionary War. This excursion gave me considerable insight into the methods of Continental farming.

Shortly after my return home, I took possession of a small farm on Balmadies in Forfarshire, consisting of 300 acres. It was in such a state of dilapidation as to present an excellent subject for improvement. It had no farmhouse—only the remains of a steading; the fields were nine-and-twenty in number, very irregular in shape, and fenced with broken-down stone dykes and clumsy layers of boulders and turf; a rivulet every year inundated parts of the best land; the farm-roads were in a wretched condition; and above forty acres of waste land were covered with whins and broom. The heaviest description of soil was hazel loam, some of it deep, some shallow, and all resting on retentive clay; and the lightest kind was gravelly, resting on gravel. The farm contained a remarkable feature, not uncommon, however, in that part of the country—an isolated peat-bog, very deep, containing thick beds of shell-marl, and enclosing a small lake, around whose margin grew aquatic plants in the utmost luxuriance. In a few years the farm possessed a mansion-house, offices, and steading; the surface was laid off in twelve fields of equal size and rectangular shape, to suit the six-course shift with three years' grass; some of those fields were fenced with thorn hedges, and some with stone dykes; the impetuous rivulet, the Vinny, was embanked out; the land upon the retentive bottom was drained in the old mode with stones, but a few acres were tried with furrow-drains filled with small stones, several years before the Deanston plan was made public by the late lamented James Smith; after the draining, the soil was trench-ploughed with four horses; the farm-roads were extended and made serviceable, and all the waste land was brought into cultivation. I made the plans of the buildings myself, and also set off the form of the fields, and the lines of the fences and roads—not because I imagined that a professional man could not have done them better, but that my mind and hands might be familiarised with every variety of labour appertaining to rural affairs. The results each year were twenty-five acres of good turnips, instead of ten or twelve of bad, and fifty stacks of corn in the stackyard, instead of seventeen. The rent offered for the farm before I took possession of it was £150, and after I relinquished farming it was let for nearly £400. The fee-simple arising from this increase of rent represents a sum larger than what was expended in producing those results. I believe I was the first person to introduce into Forfarshire the feeding of cattle in small numbers in hammels, instead of large numbers in large courts; to show the advantage of building troughs around the walls of the courts to hold topped turnips, instead of spreading untopped ones upon the dung; to confine sheep upon turnips in winter with nets instead of hurdles—a plan which the late Mr Andrew Dalgairns of Ingliston readily adopted, at my suggestion, even with black-faced sheep; and to grow the Swedish turnip in a larger proportion than the other sorts.

It must be remarked, however, that Mr Stephens had not the opportunity which now exists of studying in his professional training the sciences bearing more immediately on agriculture. There was no Royal College at Cirencester at that time, nor was the agricultural course in the Edinburgh University of the same complete nature that it has recently become through the joint efforts of the Government, the Highland and Agricultural Society, and the Senatus Academicus.

But although it is not only desirable but essential that the education and practical training of the young agriculturist, who hopes to take a high place in his profession, shall be of as liberal a nature as possible, there still remains a large class of farmers to whom such training, educational and practical, is in a great measure unattainable from their position. They may desire to give their sons as good an education as they can afford, but their means are too limited to allow them to do so on the scale which has been pointed out in these remarks. Education having special reference to agriculture, as suited to the middle and humbler classes of farmers, is still a desideratum in Great Britain. Ireland has enjoyed greater advantages in this respect; and although the system pursued in that country may not in times past have been so productive of benefit as it was expected it would be, still, recent alterations have improved its tone, and the Albert Institution, near Dublin, as well as some of the larger school-farms in different parts of the country, are now of a really useful character.

It is much to be desired that technical education, having reference to agricultural pursuits, should be introduced, as far as possible, into all parish and country schools, as this would be of material advantage to the boys in after-life, even if destined to be merely farm-labourers all their lives. In the case of farmers' sons, who might be expected to follow their fathers' occupation, such training would be of the greatest consequence; and if such lads, instead of remaining constantly at home, where they merely imbibed their father's ideas, would engage themselves to work on well-conducted farms in other districts for a few years, they would return with an enlarged amount of experience, which would prove of the greatest possible service to them in after-life. I know several instances where the sons of humble farmers have followed the course I have pointed out, and the result is, that after passing through various grades as confidential managers, they now occupy very responsible and well-remunerated appointments. Others have either succeeded their fathers as tenants in the farms they occupied, or taken farms on their own account, and in both cases have done well, assisted by the experience gained in other parts of the country.

Under all circumstances, therefore, special educational and practical training are essential to the success of those who intend to live by the cultivation of the soil. Agriculture has become a very different pursuit from what it was forty or fifty years ago, and we must seek to elevate the educational status of all classes of farmers, in order to enable them to meet in some degree the pressure which is now brought to bear on the resources of British agriculture.

SECTION 4.—*To whom Farms should be Let.*

Although it is of the greatest importance to the interests of landed proprietors that, in regard to intelligence and practical skill, they should have first-rate farmers as tenants on their estates, still we often find men of very inferior abilities occupying that position. This is the more surprising when we consider that landed proprietors in most other respects act differently. For example, when a gardener, a farm-bailiff, a gamekeeper, or it may be a butler, or any other head-servant, is required, the employer is careful to learn the antecedents and qualifications of the person before engaging him; and afterwards, if he find the servant at all deficient in the necessary knowledge for his department, or in the performance of the duties he was expected to perform, he takes the first opportunity to discharge him, and get a more competent person in his place. This is all right and reasonable; but one may ask, should not the same rule be acted upon in regard to an incompetent farmer as in regard to an unsuitable gardener, &c.? One would think that should be the case, but still it is not so, generally speaking. Then, why is not the case of the inefficient farmer dealt with as promptly as that of the inefficient gardener or butler? So far as I am able to judge in the matter, the reason is this: proprietors are, generally speaking, less acquainted with farming than they are with home management, and, consequently, the farmer, although a very unfit person for the position, is kept on year after year, and lease after lease is granted so long as he pays his stipulated rent; the landlord all the time being under the impression that his tenant farms well enough, because he is able to pay his rent; not thinking that the subject might be made vastly more valuable to both parties under an improved state of things carried out by a more intelligent and otherwise more competent tenant.

It must be admitted that tenants of an inferior stamp are a great drawback to the advancement of an improved state of things on landed property, as in most respects they are a drag on the wheels of improvement; and therefore I consider that in all cases landed proprietors should arrange with intelligent men only when letting their farms, and never with uneducated nor unskilful men. I am aware that the general objection to the removal of inferior tenants is, that they cannot be got rid of without serious inconvenience to the management on an estate. But this need not be the case if things are gradually and properly gone about in dealing with them. For example, when a proprietor has made up his mind to introduce improvements in the cultivation of the farms on his estate, he has only to intimate his intentions to the tenants, giving each of them an outline of what is proposed to be done for the improvement of any particular farm, and an idea as to the probable advance of rent, which will fall to be paid by the tenant on account of the improvements when effected. If the improvements proposed are judicious in their bearing on the respective farms, and calculated for the general advantage of the tenants as well as for that of the proprietor, the intelligent part of the tenantry will at once enter into them in conjunction with the proprietor, while it is to be expected that the more ignorant portion will not do so; and in the event of such being the case, they should be got rid of, and superior men obtained to occupy their places. It would, perhaps, be an injudicious step to make a total clearance of the tenants from any estate, although they might be all of a comparatively inferior description; but it is not necessary to do this, for on most estates there are a few fair agriculturists, who, although not of any considerable standing in respect of education and skill, are usually men of common sense and of considerable perseverance, and are therefore likely to be able to enter into the views of the proprietor, and to carry out, under the directions of the agent, the improvements he wishes made on their farms.

With a part of his tenants of this character, and with a few highly intelligent and skilful men put in place of those who were of so inferior a character that they could not comprehend the advantages to be derived from the improvements proposed, and had therefore to be dismissed, any proprietor may safely go on with, and carry out, the improvements of his estate. In such a case as this, the newly-introduced tenant-farmers would show the others an example, which, for their own interest, would carry them on from one step of improvement to another, till they had become nearly as efficient as the new incomers, and in this way the proprietor would have attained his object.

It has frequently come under my observation that really good farms could not be let to a superior class of tenants, from the fact that the farms had been allowed to get into such a backward and wretched state that good tenants were unwilling to undertake them. In a case of this kind there are two modes by which the farm may be got into condition previous to letting it to a tenant. One way is for the proprietor to take the farm into his own hands and have all the necessary improvements carried out and finished before letting it. After he has had it in his own management for some time, and completed all the necessary drainage, fencing, roads, buildings, and general improvement of the soil, it would then be in a condition to let to a superior tenant, and at an advanced rental. In a case of the kind referred to, the proprietor could also—if he did not wish to take the farm into his own hands—carry out the greater portion of the improvements while the old tenant was still in possession of it, but independent of him. I have improved farms under both circumstances, but I have found that the farms were got into better condition in a shorter time under the proprietor's own management than when the tenant continued to reside on the farm. At the same time, this mode of improving farms has its disadvantages when there are many farms on an estate requiring extensive improvements; it takes a large outlay of capital for some years, and, unless the farm-bailiff is sharp and active, it is very apt to be a very expensive operation. The only drawback to improving a farm while the tenant still holds it is, that he does not usually keep the farm up in condition, nor does he voluntarily do anything to improve it, and he is very apt to throw obstacles in the way of improvements on his landlord's part. But if the tenant will leave everything to be done according to the agent's plans, then the farm can be got in order in this way.

It would be superfluous to add much more on this subject; I shall only state, therefore, with reference to what has been said, that in filling the places of inferior tenants, whom the proprietor may find it necessary to remove, and in bringing new tenants to the property, from that or any other cause, he should be very careful to make arrangements, as far as possible, only with such men as have received a proper practical training, and are in possession of such an education and general qualification as will enable them to conduct their business with skill and intelligence.

There still remains, however, one material point to be taken into consideration in the selection of a tenant. It is quite possible that a man may possess the highest abilities as a farmer, in a scientific as well as a practical point of view, but if he is not possessed also of a sufficient amount of capital to enable him to stock and work his farm in a proper manner, his professional abilities will be of comparatively little avail. It is quite true that professional knowledge and skill give him a vast advantage over those who do not possess such qualifications, as he will thereby be enabled to turn his capital to better account, but they will not do away with the necessity for having the command of capital sufficient to allow him to carry on his operations.

Men without capital are extremely apt to become the highest bidders for such farms as are thrown open to public competition; and it has frequently happened that agents, desirous of making a show by means of an increased rental of the farms on estates under their management, have selected the highest offerer as tenant, without first assuring themselves that he had sufficient capital as well as skill to render him a desirable person to place in the occupancy of a farm. Conduct of this kind very soon defeats itself; the shadow has been taken in preference to the substance, and the promised increase of rent becomes a myth, from the inability of the tenant to meet it and the other demands upon him. In a short time he becomes bankrupt, leaving the farm, most likely, in worse condition than he got it; and the result is, that when let to another tenant the rent is even below that which was received for it previous to its occupancy by the promising but non-performing tenant.

It is desirable, therefore, that in selecting a tenant due caution shall be exercised to choose one possessed of sufficient capital, as well as professional skill and knowledge.

The question naturally arises, What is a sufficient amount of capital? This must partly depend upon the agreement entered into between the landlord and the tenant. If, as is the case in some districts, the proprietor leaves the tenant under the burden of effecting most of the permanent improvements required on the farm, with the understanding that the tenant will be repaid the value of those improvements at the termination of his lease, or under some other arrangement designed to reimburse the tenant at a future time, then he will require to have more capital at command than would be necessary in the event of the landlord effecting those improvements, charging interest on the outlay, and leaving the tenant's capital for its legitimate use in stocking and carrying on the working of his farm.

It has been asserted, and with a great deal of truth, that, generally speaking, want of sufficient capital is, and has been, one of the greatest drawbacks under which British agriculture labours. Mechi and other advanced agriculturists speak of £15 to £20 per acre, and even more, as being an amount of capital which may be profitably employed in the cultivation of a farm. That such an amount of capital will be required will in fact be shown in a succeeding chapter—that is, where improvements are contemplated on a scale equal to the requirements of modern agriculture. Professor Low, in his work 'On Landed Property,' estimates the amount of capital required to stock an arable farm, managed on a five years' rotation, as practised in the eastern and border counties of England and Scotland, at about £7 per acre, taking it for granted that every payment is made in ready money, and on the supposition of a large amount of live stock being required. Professor Low's estimate is rather higher than that given by Mr Stephens—that is, after deducting the receipts of the first year from the first year's outlay; but since the time when those estimates were made, a considerable change has taken place in certain points of farm practice; and the advanced farmer of the present day has to provide for an outlay in artificial manures and artificial feeding-stuffs which was not heard of fifteen or sixteen years ago—an outlay which amounts annually, in many instances, to more than the full yearly rent of the farm. No doubt the farmer gets credit from his manure and cake merchant, but still these sources of outlay must be taken into account aud provided for in calculating the amount of capital required to work a farm to advantage under present circumstances. The price of labour has also increased since those estimates were made; but against this we may set the use of certain kinds of farm implements and machinery calculated to save labour, which is also a new feature; at the same time, the cost of purchasing these adds considerably to the expense incurred in stocking a farm.

As a general rule, it is estimated that a capital equivalent to at least £10 an acre is required to work an arable farm with any prospect of success; and although farming may be entered upon by a skilful man with perhaps a less amount of capital than this limit, yet it should always be borne in mind that a tenant who has a sufficiency of capital at command for all purposes is a much more desirable tenant than one who is likely to be frequently pressed to make both ends meet.

CHAPTER V.

FARMS.

SECTION 1.—*Size of Farms.*

THAT too small farms are objectionable in the economy of landed property, is a fact which of late years has been fully exemplified in the experience of several proprietors who have had to deal with them; and hence, in some parts of the country, we find many large farms which have been made up from the consolidation of numerous small holdings. I shall just advert to the principal difficulties experienced in regard to having numerous small farms to deal with in the management of an estate.

First, they are expensive to keep up. On the score of farm-buildings alone there is nearly as much expense incurred by the proprietor in erecting these for a farm of from 30 to 50 acres, as there is where the buildings are suitable for one of 100 acres; and for a farm of, say, 150 acres, there is nearly as much expense necessary in preparing building accommodation for it as there is for one fully one-third larger in extent; and so on in proportion; in all cases the larger the farm the smaller is the expense on it per acre for buildings. This, therefore, is of itself a strong objection to the continuance of small farms, because they involve more expense to proprietors, both in the erection of the necessary buildings in the first instance, and also in keeping them in proper repair afterwards, than is experienced in dealing with larger subjects.

But small farms are objectionable on another score of expenditure; namely, that of fencing. The expense of erecting fences, and of maintaining these in proper condition, on small farms, can be understood only by those who have had experience in dealing with them; and I have found the expense of the fencing necessary on small farms to be a very serious drawback to the profitable management of an estate encumbered with a great many such holdings. This is to be expected from a simple common-sense view of the matter, for on a small farm there must be necessarily small enclosures in proportion. Say that a farm of 100 acres has to be subdivided into ten equal portions, as fields; this gives each a square of 10 acres to be surrounded by a fence. Take, on the other hand, a farm of 300 acres for subdivison into fields. One of this extent would probably be laid off into compartments of about 25 acres each, so that on it there would be a fence surrounding each square of 25 acres only, instead of each 10, as in the other case. This makes a vast difference in the expense of managing a large property, inasmuch as the larger the farms on it are made the fewer fences will fall to be erected on them, and therefore the expenditure from this source will be less on them both for the present and future. Taking the items of buildings and fences as described, where these have to be dealt with in connection with small farms, they are a continual drain on the purse of the proprietor, as well as a constant source of annoyance and anxiety to the parties who have to look after them and keep them in order.

Although the objections already stated against having a large proportion of small farms on an estate may be considered sufficient to prove their general unfitness where economical management is an object on an estate, still there is another objection which I have yet to bring forward against them, and which is a great bar to the improvement of a property on which they exist—namely, that they can be occupied only by an inferior class of tenants. The men who occupy small farms—I do not speak of gentlemen who may hold small pieces of land in the country in connection with their dwellings, but of tenant-farmers only, who make their living by the cultivation of their respective holdings—are generally those who have not sufficient capital for larger farms, and who are therefore, from necessity, mere labourers on their small holdings. Speaking from my own experience in regard to tenants of this kind, I have in most cases found them obliged to work much harder than labourers generally do, while they are oppressed with anxiety on account of the fear they have that the value of their substance probably may not meet the demands which will fall to be made on it at the end of the year.

There can be no doubt that small farms are useful as a field of employment for a large number of industrious men with small capital; but it is evident that it is not advantageous in the economy of the estates on which they exist, to have too many of them in proportion to the size of the estate. No proprietor, having only small farms on his estate, can induce intelligent and moneyed men to become tenants with a view to their making agricultural pursuits their business. It is only the proprietor who has large subjects to offer who can command the intelligence and capital of a superior class of tenants to assist him in the improvement of his property; while, on the other hand, the proprietor who has only small subjects to offer must be content with a number of inferior men and low profits, and to see his estate fall far behind in the general march of improvement.

Viewing the subject of small farms in the light of their effect on the aspect of the country, they are equally as objectionable as when seen from the points already indicated. Their small buildings, and their crowded and generally badly-kept fences, together with their necessarily small enclosures, give a mean appearance to any district in which they prevail, while the generally inferior live-stock in the fields betoken the want of enterprise and prosperity in their owners. In all respects, therefore, they are objectionable, and should be dealt with so as to give place to large and extended fields of operation, where men of superior intelligence, with large capital, will have scope for their energies, and from which both proprietors and tenants will be certain to realise good profits as the result and reward of skill and industry.

But although it is advisable in many respects to consolidate small farms into larger holdings, still there is a medium size of farms which is desirable. Farms of all sizes are found all over the country, from the small "cow-gate" and croft of the English cottager and the Highland crofter, to the mountain grazier with his farm several miles square. Farms on which mixed husbandry is carried out range from three hundred to six hundred acres, and even more, in extent; and in districts where dairy farming is practised, the farms range from one hundred and fifty to three hundred acres. As a general rule, farms should not be larger than the tenant can thoroughly superintend himself; and, of course, the kind of husbandry carried on will have to determine this. The enlargement of farms to a certain point, as regulated by circumstances, and then letting them to tenants with the necessary capital and skill to insure first-class cultivation, is the best and quickest means of bringing about improvements on an estate. With improved husbandry, one man can generally produce more from a medium-sized farm than from a very large one. Keeping this in view, it is always best, on a large landed property, to have farms of different sizes so as to suit different farmers. As a general rule, taking into account the generality of estates in this country, first-class farms, conducted on the principles of mixed husbandry, should range from four hundred to six hundred acres in extent, a second-class farm from two hundred to three hundred acres, and a third-rate farm about one hundred and fifty acres.

But although I have pointed out several objections against having small farms as a rule on estates, yet it must not be supposed that I condemn them altogether. The many different classes of people in this country demands that we should have farms of different sizes, and therefore there ought to be a few small farms on an estate; but, as already stated, not too many. As to what proportion of an estate should be allotted to small farms, this must depend upon special circumstances, chiefly of a local nature. In high-lying districts, I should say that small farms would be cultivated with advantage.

A few small farms on an estate are an advantage to many an industrious man. We often meet with clever, intelligent, and industrious men who are first-class farmers, who would do well on a small farm, but, from the want of capital, cannot undertake a large one. Therefore, to encourage such men, a few small farms should be kept on estates. As I have already stated, much depends upon circumstances in deciding upon having a few small farms on an estate. Fifty acres of good soil will produce as much if not more than two hundred of poor soil. And small farms have often been, and will be, the stepping-stone to the steady farm-labourer, and not a few of our most extensive agriculturists of the present day have themselves begun farming on small holdings. What I wish to point out is, that there are many estates, in England especially, which are still entirely allotted out in small holdings, and that they could be very much improved by a judicious combination of some of the small farms, so as to make them into larger holdings.

SECTION 2.—*Size of Farms suitable for Tenants with Skill, Capital, and Energy.*

There are, as I have already intimated, different kinds of farming pursued in this country: First, the pastoral system practised on the hilly parts, where little or no grain can be grown, and where the rearing of sheep and cattle is the chief object of the farmer. Next, we find a system of farming the chief object of which is the growing of grain crops, pursued on the deep, heavy, and rich soils often found on the sides of some of our largest rivers, where grasses and roots do not succeed well, nor cattle in consequence, but on which grain can be reared in great abundance. There is also the system known as dairy farming, in which the chief business of the farmer is the management of milch cows, and the production of butter, cheese, and milk. Besides these there are other modes generally pursued in the immediate neighbourhood of large towns, where vegetables are much in demand for the market, and where food for horses and cows meets with a ready sale. It is not to any particular one of these systems of farming, however, that I mean to advert in giving my opinion as to the least extent of land which may be considered fit to make a suitable farm for a superior tenant, but to the mode which, in my opinion, may be considered above all others the true characteristic of British farming, and which is known by the name of *mixed husbandry.* This system is, generally speaking, that practised in the best cultivated parts of Scotland, and especially in the southern counties; and it prevails also in the northern counties of England, especially in Northumberland. It embraces all the kinds of farming referred to, and therefore requires a high degree of intelligence, varied skill, and strong sound judgment, with a considerable amount of capital, in the man who pursues it. In taking up any of the other modes described, the farmer has only one particular branch to attend to, and therefore needs to be skilled only in that which he may choose to take up; but in mixed farming, which combines the cultivation of grain with that of sown grasses, turnips, and potatoes, and also the breeding, rearing, and fattening of cattle and sheep, much ability, skill, and attention are needed to conduct all the branches embraced, so as to make each capable of supplying the demand the one necessarily makes upon the other, and to carry on the proper and profitable working of the whole as one complete and perfect food-producing manufactory, if it may be so called. It is to this kind of farming that I would recommend the intelligent and skilful man to devote his energies and capital, because it has in itself advantages not to be found in any other mode; inasmuch as it enables those who follow it to combine the produce of all the others, and thus secure many chances of realising profits which are not within the reach of those who confine their attention to any particular branch of farming.

It is very well understood that this kind of farming cannot be carried on without a pretty large field of operation, and hence it is that we never find it attended to on small farms with the satisfactory results it produces when followed on a large scale. It is the system which of all others pays best, and therefore it is generally resorted to in farms of all sizes; but, as already inferred, it is only on a large scale that it is found to be really profitable. In considering the question, What is the smallest extent of land, farmed according to this system, which may be considered fit to make a farm suitable for a tenant of superior skill and education, and possessed of considerable capital and enterprise? I should say, certainly not less than 300 acres. With this extent of land, and with sufficient capital to provide a superior class of live stock, and all the apparatus necessary for an improved state of arable culture, &c. &c., a clear-headed and skilful man may undertake the kind of farming recommended with every reasonable hope of realising fair profits from the capital laid out on his business. I have known several farmers who followed this system of farming on subjects somewhat smaller in extent than I have stated, but these I invariably heard complain that their small space prevented them from getting their business carried out in all its branches with sufficient profit. Although an intelligent and skilful man may certainly make fair profits in farming on a subject of 300 acres, still, if he can secure a subject of 500 or 600 acres, or even more, all the better, if he has capital enough to do it justice. In short, in farming, as in all other branches of business, the larger the field of operation, and the larger the capital embarked in it, the greater the profits which may be expected from it, provided it is not too extensive to interfere with its being efficiently superintended.

SECTION 3.—*Profits from Farming as at present pursued.*

I am aware that it is not possible to arrive at anything like a really correct estimate of the profits in connection with farming generally over the country, as most men engaged in the pursuit are unwilling to give information on the point; still, from having had experience on this branch, I feel satisfied that I have been able to form at least a pretty correct opinion as to the average profits arising from it, and I shall therefore venture to give my opinion. Keeping out of view altogether the subject of exclusive sheep-farming, which for some years past has yielded unusually high returns, I shall confine my remarks to profits from mixed farming as usually carried out in the purely agricultural parts of the country.

I have known five men in the same county who had farms ranging in extent from 150 to 350 acres, and who had laid out on them an aggregate capital equal to £10 on each acre of the land they held, who did not, on an average of years, realise once 6½ per cent per annum on taking the medium of their profits altogether. These were men, let me observe, who kept correct accounts of their transactions, both in regard to income and expenditure; and as they showed me their respective books, I had no hesitation in believing their statements. In several cases of farms, however, I have had good reason to know that their tenants realised fully 20 per cent on their capital in use on them; but these were instances of superior land placed under good management; still they proved what good management can effect. But to counterbalance these cases of comparatively high returns, I must state that I have known many farmers who did not realise anything as profits, but lost heavily in their farms, partly from bad seasons overtaking them, partly from their farms being of an inferior description of land, partly from their not having sufficient capital to improve their subjects, and partly to their want of sufficient skill to enable them to conduct their business profitably. It would be superfluous to multiply words on this subject, because, as is to be inferred, they could not lead to any decidedly correct conclusion as to the profits from farming, and I therefore conclude this chapter by stating it as my opinion, formed from an intimate connection with the subject for many years, that on the average, farmers engaged in mixed husbandry, as that is at present pursued, realise, on an average of years, about 10 per cent per annum on the capital they have engaged in their business; of course after paying rents and all necessary expenses in connection with the working of their farms, but including the value of produce used by them and their families.

CHAPTER VI.

HOME FARMS.

The term "Home Farms" is applied to the farms which landed proprietors retain under their own management. They are usually kept in hand for the purpose of affording a pastime and amusement to the landlord and his family, and also for the purpose of supplying the numerous articles of farm produce required by a large establishment, and occasionally with the view of showing an example in farming to the tenants on the estate. Many proprietors take, from time to time, farms into their own management which have got into poor condition, or one in need of improvement, but what I more immediately mean to treat of under this head is the *bona fide* "home" or domain farm as first mentioned. It is a notorious fact that very few home farms are considered remunerative as agricultural speculations. Where this is the case they cannot be shown off as examples to the tenants, as of course it is all very well cultivating the land in a very perfect manner, and having the stock, buildings, and everything else on it of the most approved description, but so long as the home farm does not return a fair profit it cannot be regarded as a model worthy of imitation. A proprietor has many opportunities for conducting operations in a superior manner on his home farm, with the view of inducing his tenants to do the same; but so long as these operations, whatever they may be, are not conducted profitably, they must fall short of the object in view. It is a very common opinion that home farms cannot pay. They are looked upon as experimental farms, or as the hobby of the landlord. I cannot see, however, why home farms should not pay, unless the proprietor interferes too much with a good farm-bailiff, or unless the farm-bailiff is incompetent.

Let us look into some of the reasons why home farms do not pay; and, in the first place, I have found a very common opinion amongst labourers employed on such farms, that they need not work so hard for a proprietor of a farm as they would have to do for a tenant. This is a great evil, and unless the farm-bailiff is sharp enough to prevent any waste of time by those employed on the farm, this cause alone will interfere with any profits arising from it.

Another great drawback to making a home farm pay directly is, that generally, if there is any cartage to do about the proprietor's residence, and about the home garden, the farm-horses have it all to do, and the farm is not allowed any recompense for it, unless there is a proper system of accounts kept. I have known home farms supply all the cartage-work to a large establishment at a landed proprietor's residence, besides carting every year manures, gravel, &c., to the garden, and no allowance made; and I have also known the proprietor's establishment supplied with milk, butter, and eggs, together with beef, mutton, pork, hay, and oats, from the home farm, where the housekeeper and coachman had a better chance of getting credit for good management than the bailiff, as those functionaries did not pay for the articles mentioned, and the bailiff could not credit the farm with their value from not keeping proper accounts. Under such circumstances it is impossible to tell whether a home farm pays or not.

Landed proprietors in general cannot have the same reason to apply to their farms not paying as in the case of some tenant-farmers—namely, want of capital.

The chief objects to attend to in carrying out a home farm are the following:—

1st, The employment of a skilled, sharp, shrewd, and active farm-bailiff, who is thoroughly honest.

2d, All the farm-servants should be thoroughly honest, and zealously faithful in the discharge of their duties.

3d, When it is practicable to do so, it would tend to a good result if both farm-bailiff and labourers had an interest in the farm; that is to say, if they were allowed a certain wage and a percentage besides on the profits.

4th, The proprietor should take an active supervision himself; if this cannot be done, his agent should do so; but avoiding, at the same time, unnecessary interference with the arrangements of the bailiff, and no step should be taken without consulting him.

5th, If any experiments are tried, they should not be done at the expense of the farm.

6th, Every article, however small, that is supplied by the farm to the proprietor's establishment, and also any cartage to any other department of the estate, should be regularly charged for, and each department debited with the amount. Accounts for such articles and other claims should be sent in by the farm-bailiff monthly to the person in charge of each department.

If these rules are attended to, there is no good reason why home farms should not pay. If any extra improvements are done on the farm, it should be determined what is the landlord's share as proprietor, and what is his share as tenant. The bailiff should keep a proper statement of everything done under each head, in books kept for the purpose; and every item, and all work done for any other department of the estate, should be regularly entered, whether paid for or not. There is another mode of dealing with a home farm in regard to the improvements on it, which I adopted on estates under my management. The bailiff is placed on the farm as if he were tenant—of course subject to his employer's authority. A great number of improvements were carried out on the farm, in the way of drainage, new roads, new fences, new buildings, and reclamation of waste lands; but the bailiff had merely his duties to attend to in the ordinary cropping and working of the farm, while the permanent improvements were carried out, under my own superintendence, by a separate staff, and quite independent of the farm. The bailiff paid the rent of the farm along with the other tenants on rent-audit days, and he also paid interest on the outlay on the improvements on the farm, after allowing it to have full six months' benefit from the improvements before the interest commenced; and when the farm-horses had time to assist in the improvements by the cartage of stones and other materials for buildings, roads, and fence-walls, the farm was credited with the work done at the same prices given to others.

It is a good plan for the bailiff to furnish a weekly report of his stewardship, as thereby the proprietor or his agent can always have a check upon him. The following is a form of farm-bailiff's report which I have used:—

FARM

FARM OF FOR THE WEEK ENDING ON THE DAY OF 186

	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
1 WEATHER.						
2. HIRED FARM-SERVANTS.						
3. LABOURERS.						

HORSES.		CATTLE.										SHEEP.						PIGS.				DAIRY.	£	s.	d.
4	5	6	7	One-Year old.		Two-Years old		Three-Years old		14	15	16	17	18	19	20	21	22	23	24	25	Milk sold during the week, pints, at *warm* *cold*, per pint, ...			
				8	8	10	11	12	13													Butter, do., lb., at per lb. of oz.			
Work Horses.	Young Horses.	Cows.	Calves.	Stots.	Queys.	Stots.	Queys.	Stots.	Queys.	Bulls.	Total.	Ewes.	Lambs.	Hoggs.	Wdrs.	Tups.	Total.	Sows.	Sucking Pigs.	Other Swine.	Total.	Cheese, do., ...			
																						Per last Report			
																						Added			
																						Remain			
																						Deducted			
																						Remain			

BARLEY.				OATS.				WHEAT.				.			41	42	HAY.		45	46	
26 Stacks.	27 Qrs. in Granary.	28 Weight per Bushel.	29 Price per Quarter.	30 Stacks.	31 Qrs. in Granary.	32 Weight per Bushel.	33 Price per Quarter.	34 Stacks.	35 Qrs. in Granary.	36 Weight per Bushel.	37 Price per Quarter.	38	39	40	Total Stacks of Corn.	Oatmeal. Bolls.	43 Stacks.	44 Stones Imp. supposed.	Potatoes. Bolls supposed.	Turnips. Acres supposed.	
																					Per last Report
																					Added
																					Remain
																					Deducted
																					Remain

INCOME FOR WEEK.					EXPENDITURE FOR WEEK.					REMARKS.
		£	s.	d.			£	s.	d.	

It may not be out of place for me to remark here that receipts should be got for everything paid for by the bailiff, when it is practicable for him to do so. It is not usual to give receipts for cattle or stock bought at a public market, and yet it is always advisable for a farm-bailiff to get one for such payments. I knew one case where a farm-bailiff did not produce receipts for stock bought in the public markets: he entered his sales and purchases regularly in his books, and these were examined by the agent on the estate weekly and passed; but it turned out afterwards that a great amount of the stock certainly had been bought, which were not paid for, and ultimately this was the cause of a great loss to the proprietor. There are, however, many upright and thoroughly honest farm-bailiffs, and for their own sakes these should never omit getting receipts for money paid by them, and giving the same for money received.

There is one cause which frequently interferes materially with the profits of a home farm—namely, the damage done by game of all descriptions. This is more especially the case where the farm is situated within the bounds of the park, as in such a case game is generally rigorously preserved, no matter what injury may be done. So much is this the case, that on several home farms which could be named it is useless to attempt to cultivate winter vetches, carrots, and other crops to which hares, &c., are partial. Another drawback under which home farms labour is the loss occasioned by the crops being shaded with trees, and closely hemmed in with plantations—much more so than is usual in the case of ordinary farms. Altogether, the remunerativeness of home farms cannot be judged on the same principles that we would apply to farms held by tenants, or even those retained temporarily in the hands of the proprietor for the purpose of improvement. They are, however, establishments of considerable importance; and in many instances their management is so conducted that they are valuable agencies in promoting the general improvement of agriculture on the estate, from the superior kinds of live stock bred on them, and other reasons. They are, in fact, an essential part of a resident proprietor's establishment, and the management pursued in their case should invariably be of a high order.

In the case of a proprietor entering to a farm in the usual way, where there is an outgoing tenant-farmer, there is generally an inclination on the part of the latter to get as much as possible from the landlord, whether such is exactly just or not, because he thinks there is nothing unfair in taking advantage of one rich in purse and high in position. Besides being a good agriculturist, the bailiff should be a shrewd active person, able to detect any attempt at imposition on his employer's property. I have known several instances where the landlord, on entering a farm, and purchasing stock and implements at the public sale of the outgoing tenant, unless the bailiff was aware of what was going on around him, the landlord was sure to pay high for any cattle or implements bought for him, as it generally happened that the outgoing tenant, being aware of the landlord's intention to purchase at his sale, arranged to have some one to bid against the bailiff, and put whatever he purchased to a high figure Even in a mutual agreement to have a fair valuation of the stock and crop on the farm it becomes the business of the bailiff to look sharply after his master's interests. I would recommend any landed proprietor about to enter a farm to stock it entirely anew, and purchase nothing from the outgoing tenant. In most cases it will be found that better and more improved implements can be bought as cheap, and more to the ultimate benefit of the farm, than any which the outgoing tenant is likely to have.

CHAPTER VII.

APPLICATION OF STEAM TO AGRICULTURAL PURPOSES.

STEAM-POWER is now employed for several purposes in agriculture; and this is an evident proof that, when it can be made properly available, farmers are ready to lay hold on the advantages it is calculated to bestow on them, not only in respect to the saving in labour which it effects, but also in what is gained by the work performed by it being better and more quickly done than it could be by men and horses.

There is no department of agricultural operations to which steam-power has as yet been so well applied as to that of thrashing and dressing the crops of grain. In the best-improved parts of the country we now find fixed steam-engines established for thrashing on many farms. Where the farms are large, fixed steam thrashing-machines are being generally adopted, especially in Scotland, as they effect an immense saving in the thrashing and cleaning of the grain compared with the work as done by employing horses. I believe that I am right in stating that we can now prepare grain ready for the market at something less than the fourth of the cost when done by horse and hand labour.

These machines are now constructed so as to thrash and dress the grain of all kinds usually grown on our farms, in as perfect a manner as can be effected.

Besides fixed thrashing-machines there are also portable ones; that is, steam-engine and thrashing machinery both constructed so as to be moved about on wheels from one place to another, for the purpose of thrashing grain wherever it may be found necessary. This kind of steam thrashing-machinery is now very generally adopted for use in many parts of England; and it is used in Scotland also, but not to the same extent, comparatively, as in England. The advantages of this kind of steam thrashing power are, that it can be taken to the field, and the corn-ricks thrashed on the spot with it; and also, that where farms are small, one such engine can be made to thrash the grain on many farms, and thus obviate the necessity of each tenant maintaining thrashing machinery exclusively for his own use. It is usual for those who are in possession of these portable engines, with their accompanying thrashing-machinery, to travel about the district in which they live, and thrash the grain of the farmers at a certain rate per bushel or quarter, or per day, as the case may be, the farmer always giving a certain amount of assistance in the working of them. But, in my opinion, although this kind of steam thrashing power has the advantage of being easily removed from place to place, there are, at the same time, disadvantages attending it as compared with the fixed machine. For example, I have seen one of them come to a field on a given day, according to appointment between its owner and the farmer. The morning looked threatening, but the work had to be gone on with, as the farmer had to pay the party engaged. The machinery and engine were set, and the work of thrashing begun, but before the first rick was finished rain came on, and the result was that both grain and straw got wet. This, it is true, does not always happen; still, it is liable to occur any day in our wet climate, and it is certainly a very undesirable thing to have grain wetted under any circumstances. Now, this can always be avoided by storing the grain in the stackyard adjoining the steading, and thrashing it out under cover of the barn, by means of fixed machinery there. Another objection to portable thrashing machinery is, that it is much more liable to get out of order, and therefore more expensive to keep in repair than fixed machinery. It cannot be out of place to remark here, with regard to a thrashing-machine, that every farmer who has not got one, and intends to purchase one, should procure the *thrashing machinery* of an approved kind, and fix it in a proper site adjoining his barn; and at the same time he should procure a portable steam-engine, constructed to drive this when necessary, and of sufficient power and suitable construction to be used either to work a steam cultivating apparatus, or to perform the work of a traction engine to haul heavy loads on the farm-roads. By adopting this plan in regard to an engine, it may be made available for many purposes for which a fixed engine could not be made applicable.

But besides the purpose of thrashing, the steam-engine is now extensively used on farms for churning, cutting fodder for cattle-feeding, bruising corn for horses, stone-breaking, sawing timber, &c. In short, in so far as these operations and the thrashing of grain are concerned, the application of steam-power may be said to be a perfect success; but these form comparatively a small part of the work of the farm, the cultivation of the land and bringing home of the produce being the most important and expensive operations; and to these I now propose to attend for a little, to see how far steam-power has been brought to bear on them up to the present time.

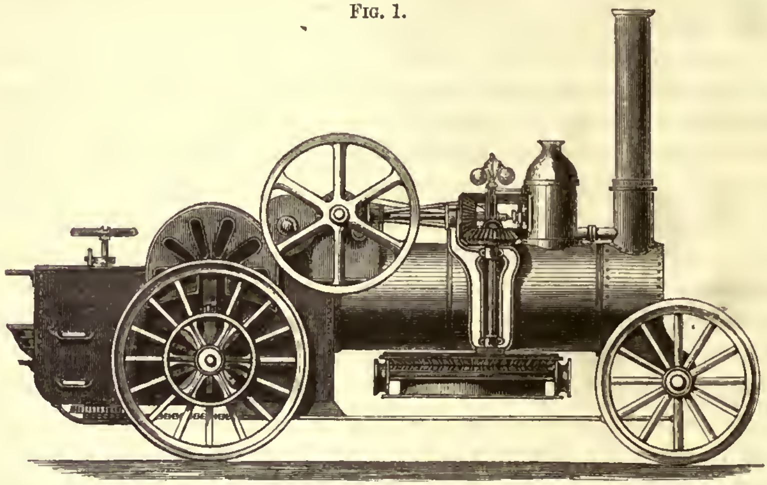
In a work of this kind it would be superfluous to enter into details in regarding the various kinds of machines which have been invented from time to time with a view to the cultivation of the land by steam, and therefore I shall at once refer to those which are now in use in various parts of the country. As is well known among agriculturists, the machines chiefly employed are Fowler's of Leeds, and Howard's of Bedford, of both of which many sets are now in operation, and the demand for them is decidedly on the increase. The mode of operation in both is somewhat similar, and consists, generally speaking, of a portable steam-engine, having a drum, on which is wound and unwound a wire rope for hauling the implements, whether ploughs, grubbers, harrows, &c., over the land and along the successive furrows or ridges, between movable anchors, fixed on the opposite sides of the field operated on. The value of steam cultivating machines is generally admitted by those who have them in use, as the depth to which they are able to open up the land gives them a decided advantage over the horse-plough; but I have heard many complain of the expense of keeping them in repair—frequent breakages taking place, which often cause delay. Notwithstanding this, a number of the most eminent agriculturists in the country have them in use, and speak very favourably in regard to the amount of work they can go through, and of the satisfactory way in which they are capable of operating in ploughing, grubbing, and harrowing. For my own part, I have no doubt of their capability to perform these branches of farm-work, but at what expense, as compared with horse-work, is another thing, and is a point which has not yet been, so far as I am aware of, satisfactorily stated. I am not aware that any attempt has been yet made to take home the crop with the engines employed. A very great advance has, however, been gained by the application of this class of machines to agricultural work, as with them work can be accomplished which could not be done by the use of horses in the ordinary way; and I have every confidence that ere long—after they shall have had a more extended trial in the country, and defects remedied and improvements made in regard to them, so as to make them more generally applicable to all kinds of work —*they will become the grand motive-power in agriculture.* In the mean time, however, they have not arrived at the state of perfection and cheapness which is necessary to warrant farmers generally adopting them as a substitute for horse-power; but ere long they must come to this, as they have now attained such a position, and are so widely spread over the country, that many keen-sighted observers are interested in them—ready to find fault with what may be faulty, and ready, therefore, to amend whatever may be defective, or to add some decided improvements which had not previously been thought of.

In some parts of the country, steam cultivating and thrashing companies have been formed, who purchase the machines referred to, and let them out on hire at moderate rates to the farmers in the respective districts. A number of landed proprietors are at the head of these companies, in order to give encouragement to their farmers in the cultivation of their land by these machines. It is therefore to be expected that they must, in the hands of such companies, be subjected to fair trial, and in time made, if possible, more simple in their construction, and fit to be placed in the hands of farmers generally, who will at the same time become familiar with the mode of working those machines while employed on their respective farms.

I think it may not be out of place here to throw out a few hints as to what seems desirable to be attained in these steam machines, in order that they may become in all respects adapted for farm-work instead of horses. *First,* then, the principle on which Fowler's, Howard's, or Smith's machines are constructed seems the best adapted for the proper cultivation of the land that can be devised—viz., that of keeping the engine on the outside of the field, and dragging *the implements only* over the land; as by this method the land is not poached as it would be were the motive-power to be made to drag itself over the land along with the implements. *Second,* If the land was previously trenched, where such is necessary, the implements used for cultivation in connection with the steam-power could be made of a much lighter description than they require to be, in order to be worked safely in the present condition of most soils, as there would in that case be no stones to interfere with their action; and the land would be so open and porous as to allow the cultivators to pass through it easily, so that a great saving might therefore be effected in the construction of the tackle, as well as in the power of the engine. *Third,* The engine, besides being adapted to the cultivation of the land, should be so constructed as to be used for driving a fixed thrashing-machine when necessary, or to propel itself along the roads of the farm, hauling waggons of manure to the fields, or along the country roads generally with the produce of the farm to market, or to bring home the grain crop from the fields to the stackyard, or the turnips from the fields to the cattle-houses at the steading; and to do all these or any other work which may be found necessary on a farm, as is now done with horses. Until the engine and its accompaniments are adapted to perform all these operations in a complete and satisfactory manner, and at a much cheaper rate than is now accomplished by horse-power, it cannot be said that steam machinery is fairly available for all the purposes of the farm, or suitable to be put into the hands of every farmer for profitable use. Much experience is no doubt yet required on the subject before it can attain such results as are here indicated; but, looking at what has been accomplished within the last ten years, I have little doubt that in a few years hence we shall have attained such a position in regard to the application of farm steam machinery as will certainly enable every farmer, willing to avail himself of it, to dispense with, if not all his horses, at least a large proportion of them, and so effect not only a corresponding saving in expense, but also a great increase in the crops raised by an improved mode of deeper and more efficient cultivation by steam-power.

The steam-engine and apparatus of the Messrs Fowler first claim attention. Fig. 1 is a sketch of their steam cultivating engine.

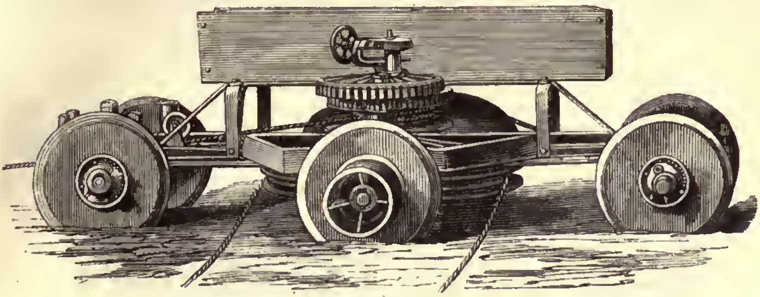
Fig. 1.



This engine is locomotive, with a windlass attached under it and under the boiler for the coiling of the rope. This rope, which is termed "endless," is coiled up and passed out from the windlass in a very ingeniously invented groove. There are what are termed "hinged clips," which take hold of the rope and prevent it from slipping from the drum. The wire rope to be worked in conjunction with this engine should be of a great length. If it is desired to plough the field without a shifting, the rope will require to be fully twice the width of the field. It passes round an anchor at the opposite side of the field from the engine. This anchor is upon four wheels, these wheels having sharp edges which sink into the soil, and thus they get sufficient hold to resist the pull of the rope. Fig. 2 is a sketch of this anchor.

It will be observed that the strain upon the anchor is from the side, and the motion of the rope working upon a part of the anchor causes it to move forward, and thus always keeps it in place for the engine to work opposite to it. There is a box at the back, which is a weight to prevent the anchor being pulled over when there is a very heavy strain

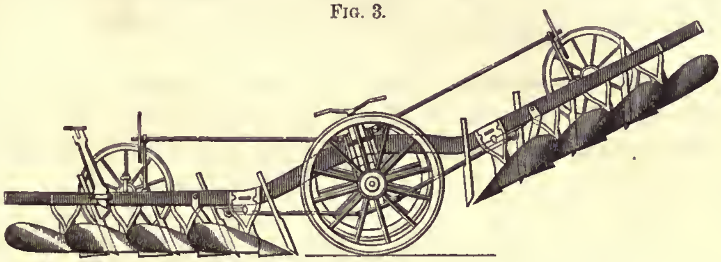
FIG. 2.



upon it. This machine is superintended by the boy, who also looks after the rope.

In fig. 3 is shown the steam-plough. It is made entirely of iron,

FIG. 3.



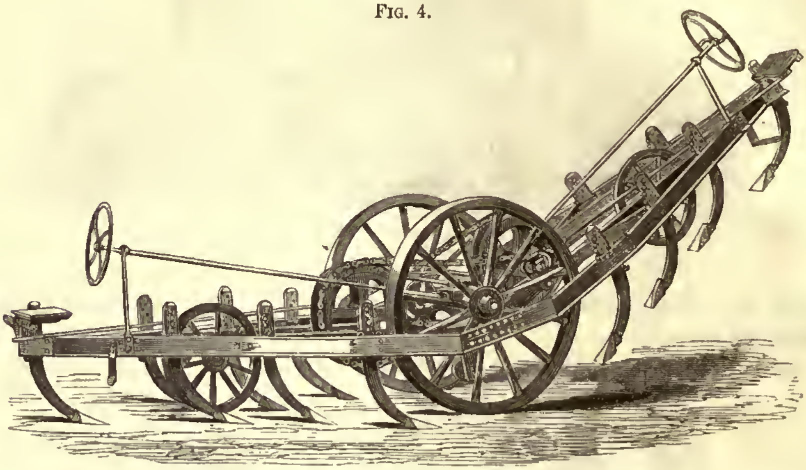
and the ploughs are made to shift, so as to give different widths of furrows. These ploughs can be procured with either two, three, or four plough bodies, as thought best; and if a 4-furrow plough is procured and found to be too much for the engine on some soils, then one or more of the bodies can be removed at pleasure. I have found this form of steam-plough make excellent work.

Fig. 4 represents Fowler's steam cultivator. It takes in a width of six feet. It cultivates to a depth of fourteen inches, and even on stiffish land will bear the pull of a 14-horse power engine, and will cultivate from twelve to eighteen acres per day. It is an extremely useful machine for breaking up stubbles in the autumn, so as to get them cleaned preparatory to ploughing. It is also a good subsoiler. I have used it with great advantage in the breaking up of new land.

The plough and cultivator are thus made to work to and fro between the engine and the anchor, as shown by fig. 5. The implements are not turned at the headlands, but in going one way, the one end of the implements are at work in the soil, while the other is in the air; and on returning, that which was in the air is put into the soil, and the other is thrown up, thus going on alternately.

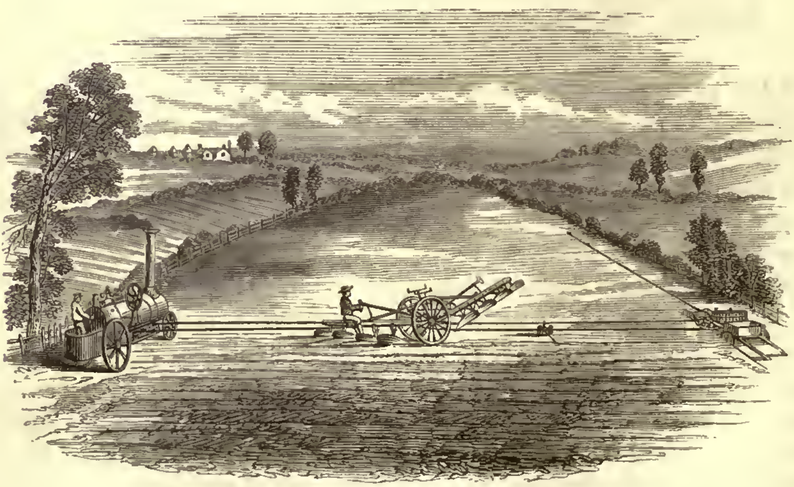
The Messrs Fowler also manufacture a system of steam-ploughing

Fig. 4.



apparatus with two engines. There is an engine placed at each headland; the one engine pulls the plough towards it, and when the implements are close up to the engine on the one side, that engine remains

Fig. 5.



stationary until the other engine pulls the implements back again. In each case the engine which is not at work pays out the rope and moves forward into position for the plough returning.

The engines are locomotive, and can be used at any time for thrashing, sawing, stone-breaking, &c.

The following are estimates of the expense of Fowler's steam cultivating apparatus :—

Estimate of 10-*Horse Power Single-Engine Tackle.*

10-horse power engine,	£550
6-disc anchor,	55
4-furrow plough,	97
7-tine cultivator,	70
800 yards steel rope,	84
Twenty rope-porters,	25
Extra wearing parts,	25
Water-cart,	25
Total,	£931

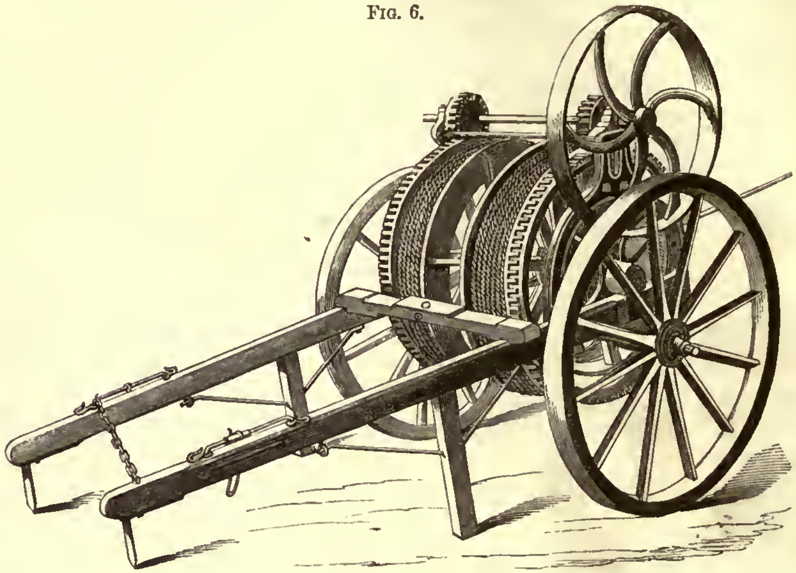
Some purchasers have not bought a cultivator, but take the mouldboards from the plough, and put tines in their stead. This answers the same purpose, but the time wasted in the removal of the one and the fixing of the other is considerable, and it is therefore advisable to procure both.

The following is an estimate of Fowler's 10-horse power double-engine tackle :—

Two 10-horse power engines,	£1100
One 4-furrow plough,	80
One 7-tine cultivator,	60
800 yards steel rope,	84
Ten rope-porters,	10
Extra wearing parts,	25
Water-cart,	25
Total,	£1384

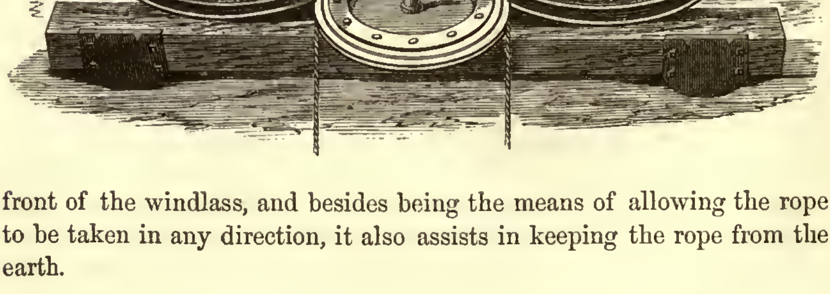
The Messrs Howard of Bedford also construct two sets of steam cultivating apparatus, one with a single engine and the other with two engines. In the single-engine system, the engine is made the same as the common portable steam-engines, only the boilers are larger and stronger, and capable of being worked at a higher pressure than the common portable engine. They are worked with double cylinders. There is no winding-drum for the rope attached, as in the case of the Messrs Fowler's. For this purpose there is a patent windlass, which consists of winding-drums revolving on an axle, with wheels attached, and thus it can be moved about to any place; and when the apparatus is at work, there is a simple process with a lever movement, which, when anything goes wrong, the winding of the rope can be immediately stopped. This is a great improvement, as in the case of land-fast stones and other obstacles which may impede the plough. In this case the work can be stopped, without stopping the engine, in much less time than the engine could be stopped. This windlass is shown in fig. 6.

FIG. 6.



For the purpose of having the power of taking the rope in any direction after it comes from the windlass, a machine is invented which is termed the "snatch-block," and is shown in fig. 7. It is fixed immediately in

FIG. 7.



front of the windlass, and besides being the means of allowing the rope to be taken in any direction, it also assists in keeping the rope from the earth.

The price of the Messrs Howard's apparatus stands thus:—

10-horse power engine,	£520
1 windlass,	
1600 yards of steel-wire rope,	
Joint for connecting engine with windlass,	
1 double snatch-block,	
5 single snatch-blocks,	
7 anchors,	
21 rope-porters,	
2 anchor-couplings,	
2 beetles,	
31 levers,	
2 crowbars,	
1 rope-coiler,	
Patent double steam-cultivator, 5 tines,	

In reference to the working abilities of the above, the following extract, taken from the 'Mark Lane Express' of August 27, 1866, gives a good description of what has been done by Mr Hope on his farm of Fentonbarns, in East Lothian, Scotland:—

Fentonbarns consists of 670 acres. This includes the space occupied by buildings, gardens, fences, and roads. The farm is held under a lease of twenty-one years, nearly two-thirds of which has expired. The farm was occupied by the father and grandfather of the present tenant, and has been in possession of the family for upwards of eighty years.

The lands being frequently difficult to reduce, involving a great amount of horse-labour, one of Howard's cultivating apparatus with engine was obtained in the autumn of 1864. The engine is of 10-horse power. The price of the whole was £650. The length of wire-rope originally obtained was 1600 yards; since that time 400 yards additional have been procured. The increased length of rope has tended to expedite the cultivation of the land, particularly where the fields are large. The additional length of rope has proved so decided an advantage that Mr Hope recommends that not less than 2000 yards should be obtained at first by those purchasing one of Howard's steam-cultivators. The cost of repairs of tackle has been almost nothing, the breakage having been so insignificant that £5 will cover the whole outlay. This expense for repairs, taking into account the number of land-fast boulder-stones and the extent of land gone over, is a remarkable example of the successful application of steam-power to the stirring of the soil. We were shown a heap of stones, weighing not less than 100 tons, which had all been taken from one field. These stones had been under the common plough-furrow, and it was only when the steam cultivator was used that their presence was discovered, and their consequent extraction from the subsoil effected. The land-fast stones are marked as they are touched by the points of the cultivator, and labourers afterwards remove them by means of spade, pick, crowbar, and frequently by the use of gunpowder. Where the obstructing rocks reach the surface they have in two or three fields been quarried, and earth carted on to form a soil. The fields, numbering twenty-seven, are generally large. The fences are usually straight—a condition favourable for the application of steam-power, even when the engine is stationary, as in this case. The time required to lift, convey, and lay down the cultivating apparatus takes from three to four and a half hours. The extent cultivated or grubbed is about 7 acres daily; extent harrowed about 10 acres. The depth the grubber enters the soil is from 8 to 12 inches. The harrow moved by the steam-engine is found to be a great acquisition to the other cultivating implements.

The steam-engine and cultivating apparatus have proved, during the springs of 1865 and 1866, of great utility in the preparation of land intended for turnips—expeditious and deep stirring being of advantage in the seeding of the land. On Fentonbarns the turnip crop, since steam-power was applied, has been got in early, and been superior.

Thirteen pair of horses are still kept. The reduction in the number required since the steam-engine with tackle was acquired has been only two pair. The saving in the keep and tear and wear of four horses is small. The explanation is, that the improvements at Dirleton which have been proceeded with during the last two years have involved a great deal of horse-work in the carting of clay, stones, &c. The carting of the farm manure and the large potato crops likewise involves a great amount of work to be done by carts. It is necessary to keep in view that the horses are now less severely taxed in the stirring of the land: they are consequently kept in better condition; the field-labour is always well advanced; the various operations of the farm are executed at those seasons the best adapted to insure efficient and perfect cultivation; and there is less anxiety felt for the delays arising from the occurrence of a tract of wet or unseasonable weather.

The price of the Messrs Howard's double-engine tackle amounts to from £1250 to £1350. The chief advantage of the double-engine tackle over the single-engine one is, that one half the time only is taken up in setting it to work, and as soon as ever the apparatus stops working the whole is packed up and ready for removal, and much less trouble and skill is required in laying it out; but it is too expensive for general use.

I have now to refer to the steam cultivating apparatus of Mr Smith of Woolston. Mr Smith has applied the apparatus of other inventors to a good purpose. He, in the first place, makes use of the ordinary portable steam-engine, the same as is usually employed for thrashing purposes. This, by a connecting belt, drives two winding-drums upon which the rope, is coiled. While the one drum is winding the pulling part of the rope, the other drum coils up the loose portion. The apparatus of the Messrs Howard is connected to the engine by means of an iron rod; that of Mr Smith's is driven by a fly-wheel and belt. The rope is attached to a steam cultivator, grubber, or plough, as may be required. He, however, chiefly uses a three-tined grubber, with which he breaks up the soil in one direction, and then goes over the land again across the path of the first working. Mr Smith's implements have to be turned at each end, while the apparatus of the Messrs Howard is simply pulled back.

Mr Smith's apparatus costs as follows:—

One 8-horse power engine, ...	£230
Four-wheeled windlass, with anchor snatch-blocks, .	110
1400 yards of rope, ...	61
Cultivator, ...	15
Licence, ...	21
	£437

In some instances, where there is not constant work for the engines, all the apparatus can be purchased excepting the engine; this would cost £207, and the common portable engines used in the country for thrashing purposes could be got to drive the machinery. This would only do, however, under certain circumstances.

There are many sets of apparatus at work in the country made by the three chief inventors, as I have described, and each in its own way has given satisfaction; but, on the whole, I am inclined to testify in favour of that of the Messrs Howard of Bedford. It is the cheapest, is not much liable to breakage, is easily worked by farm-labourers, and the engines can be used for any other purpose.

It is not easy to fix any definite sum which will show the exact cost of ploughing, &c., by the different sets of apparatus as supplied by those leading manufacturers whose names have been mentioned. A great deal depends, of course, on the nature of the soil, and the depth to which the apparatus is worked. The expense per day of a single-engine apparatus may be taken as follows:—

Engineman, ...	£0	3	6
Ploughman, ...	0	2	6
Anchorman, ...	0	2	6
Two boys for porters, 1s. 3d. each, . . .	0	2	6
Man, horse, and water-cart, ...	0	5	0
Coals, and carriage of them, ...	0	5	0
Oil, ...	0	1	6
Proportion of repairs, ...	0	0	6
Interest on capital (say), ...	0	2	6
Total per day, . .	£1	5	6

Taking this as the daily expenditure, the next part to be ascertained is the cost of cultivation per acre, according to this system. It is stated by the different makers that from seven to eight acres per day can be cultivated, but I am inclined to believe that five acres may be taken as the general average, and this makes the cost to be 5s. per acre. I know several instances in which the work has cost much more than the average stated, but at the same time other cases have come under my observatiou where the cost has been less; so that, on the whole, I believe the quantity stated may be regarded as a fair average under a medium condition of soil, form of field, &c.

CHAPTER VIII.

LEASES AND YEARLY TENANCY.

Farm Leases are no doubt necessary in order to define the nature of the arrangements entered into between landlord and tenant, as without such documents matters would certainly ere long come to be misunderstood; but in these days of intelligence and progressive improvement, to tie an intelligent man down in a lease to cultivate his farm according to a certain strictly-defined mode and course of rotation in the cropping, seems highly injudicious, and is, without doubt, injurious to both parties. Among a poor and ignorant class of tenants it may be, and indeed is, necessary to lay down certain rules to guide them in the cultivation of their farms, as without such they would be likely to exhaust them from constant cropping without the application of manures; but with a class of well-to-do tenants, who have even moderate education and skill, the case is very different, for they must and do understand it to be for their own interests to keep their lands in the best bearing condition possible. I have before me, while I write this chapter, the regulations and conditions on which the farms are let on a number of estates, and which are embodied in the leases, some of the restrictive clauses in which I shall here quote: "The tenant is neither to outlabour nor mislabour the farm; in particular, he is, on no pretence whatever, to take two white or corn crops in succession. The course of cropping to be pursued shall be the five years' rotation, as follows—viz., The ground broken up from grass shall be cropped the first year with wheat, barley, or oats; the second year it shall be fallowed or cropped with drilled green crop, being first properly cleaned and dunged, which green crop shall consist of at least four-fifths of turnips; the third year the land shall be cropped with wheat, barley, or oats, along with which shall be sown a sufficient quantity of ryegrass and clover seeds, but where wheat is taken after grass it shall not be allowed after fallow or green crop, as no more than one wheat crop shall be permitted in the course of the rotation; and the fourth and fifth years the land shall be in grass."

From such instructions as these being given to intelligent tenant-farmers in regard to cropping, people are apt to conclude that they must be very ignorant in regard to their business, and require their landlords to teach them the rudiments of agriculture. I believe, indeed, that such restrictions were originally intended for the guidance of the tenant, and to prevent him from exhausting his farm; but now, generally speaking, the case is very different. What intelligent farmer, for example, would ever think to "outlabour or mislabour" his farm? As already remarked, poor and ignorant men might do so, and therefore they require some such restrictions to be placed on them; but no intelligent farmer who understands his own interest would "mislabour or outlabour" his farm, and therefore he requires no such restrictions to be laid upon him. With regard to the restrictive point, that the tenant "is on no pretence whatever to take two white or corn crops in succession," I am decidedly of the opinion that under good management this may be occasionally practised with advantage to all parties concerned. In fact, if the land is kept clean and in high condition, corn crops may be grown for two seasons in succession without exhausting it; all depending on the management applied. Next, as to the rotation of cropping to which the farmer is restricted, I consider it as injurious to the interests of both farmer and landlord; because, were a farmer not restricted in the way inferred from the quotation given above, he could frequently crop the land much more to his own advantage, and would therefore be enabled to give the proprietor a much higher rent. In fact, all such restrictive clauses in leases have the effect of tying the hands of the farmers who are bound by them, and consequently prevent them from taking up and practising superior modes of culture; and thus the proprietors are prevented from getting higher rents than they would under a more liberal way of dealing with their tenants. Look to the system of cropping practised by market-gardeners in the neighbourhood of large towns. They grow crops of all kinds in succession, as it may suit their interest in meeting the demand in the market. What they have to attend to is the thorough cleaning and manuring of the land, so as to secure its being always kept in the highest condition possible. Why should not farmers be allowed to deal with their land as market-gardeners deal with theirs? The latter have, so far as I am aware, no restrictions laid upon them in regard to their mode of cropping; and where, I would ask, is there land to be found on any farm in the country in nearly so high a condition as that occupied by market-gardeners? They see it to be for their own interest to keep the land in the highest bearing condition possible, by the frequent application of manures, and by deep and thorough cultivation; and in like manner farmers would be certain to deal with their subjects were they but allowed to act for themselves, because they, as well as gardeners, see that it would be profitable for them—I mean, of course, the advanced class of farmers.

With regard to leases, therefore, my opinion is, that no educated and skilful farmer, having abundant capital for the proper working of his farm, should be restricted under heavy penalties to a certain mode of cropping, from which he dare not depart under any circumstances; but he should be bound to keep up a high state of fertility in the land he may occupy, and thus far only—viz., *that he is to maintain his land in the highest possible state of fertility, and to keep it perfectly clear of weeds, at all times during the currency of his lease.* With a well-qualified class of tenants, having ample means at command, there would be no further restrictions found necessary, as their own interest would lead them naturally to attend to this. With poor, ignorant, and unskilful tenants, however, the case is very different. One thing seems clear in regard to the practice of restricting farmers in their leases to certain modes and rotations of cropping; to wit, that if landlords continue to enforce these restrictions, they will get only inferior tenants to submit to them, as it is not to be expected that any really independent and well-educated man will submit to be tied down in the way indicated by the letter of the leases in general use. It should therefore be a matter of serious consideration with proprietors how far they can secure an improvement in this respect when letting the farms on their estates.

The following remarks on this point, from Wilson's 'British Farming,' deserve consideration:—

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, &c.—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 enforced, is to hinder a tenant from adopting it even when disposed to do so. We hear nowadays 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 grain 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 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.

But although I have stated that no restriction should be put upon really intelligent tenants, this does not refer to a large class of farmers in this country who are semi-educated, and who cannot see that there is any advantage to themselves in improving and keeping their farms in high condition; and restrictions are also all the more necessary where yearly tenancy exists. No rule can be laid down as to what kind of cropping will answer for any farm, as so much depends upon the soil and climate. In fact, no one rule will do for one estate of any considerable size. There is often a great mistake made in this respect on many estates. Certain rules and conditions are drawn out to which all the tenants are bound alike, notwithstanding great diversity of natural circumstances; and thus we sometimes find, on the same estate, farms with a clay soil and subsoil lying at an elevation of from 200 or 300 feet above sea-level, and others having a light-loam soil resting on rock, situated at an elevation of from 700 to 850 feet above sea-level, all managed under the same set of rules and regulations. To farm both kinds to advantage, it is impossible to do so when both are worked under similar conditions; if the rules, whatever they may be, suit the one, they cannot do for the proper working of the other.

All intelligent farmers should have leases of their farms—in fact, very few farmers with capital at command will take a farm at the present day without a lease; and indeed the landlord is as much benefited by giving leases as the tenants are themselves; in fact, in my opinion, a landlord gains much more by a system of leases on his estate than the tenants do. A lease is a great advantage to a tenant, and it is much more so to the landlord. Where a tenant has his farm from year to year, he has no security beyond twelve months before him, and the consequence is, that he does not feel justified in expending his capital on the farm, as he knows well that he is liable at any time to receive a few months' notice to quit. He may know that it would benefit both himself and the soil he tills to have it thoroughly trenched or subsoiled; but he also knows that it will take some years for him to reap sufficient benefit from such improvements, and consequently when he has not got a lease he has no security for such an outlay.

A liberal application of manures, along with a thorough opening up of the soil, will give an increase of produce for many years; but a tenant holding a farm without a lease cannot be expected to make such improvements when he is liable to be ejected from his farm the following season. In fact, a yearly tenant only does such work as will benefit himself for the year—he has no encouragement to look beyond the year; and we cannot blame a man in such a position for not expending his capital when he has no security for its return. On many estates, if a tenant-at-will were to lay out his capital in improvements, and thereby enhance the value of the land, the rent of that farm would be raised; and this in many cases is a prohibition against the improvement of his farm by a tenant-at-will.

In recommending leases for tenants, it must be understood that I only do so for tenants who are intelligent, trustworthy, and who have capital at command. I have met with many farmers—too many, I am sorry to state—who are so far behind the age, and who are men of no education, that I could not consistently recommend any landlord to give them a lease. It is much better to have a yearly tenant than to have a poor ignorant tenant with a lease, who is a fixture on the estate for a number of years, and cannot be got rid of.

Although I am of opinion that any stringent rules in leases are unnecessary when dealing with farmers of intelligence and capital, yet I think that a landlord ought to have it in his power to put a stop to bad farming when this may take place with ignorant farmers. When a landlord has a really good tenant, he should give him full scope to crop as he may think best; but yet, I repeat, where poor farmers are apt to get wrong, there ought to be sufficiently stringent rules in their leases to prevent them from impoverishing their farms. No doubt a farm will always be kept in high condition by a good farmer, but there are so many different classes of men who take to farming in these days, that it is necessary to have some check upon them. If all men who farm were known to be thoroughly honest, then all restrictive measures in leases might be done away with; but as landlords and agents have all characters of men to deal with, they have the possibility to combat of a tenant or his heir becoming a bad farmer, or he might be able to do some considerable amount of damage to his occupation from a vindictive feeling against his landlord, and consequently we must take some measures to check any such bad farming where necessary. When tenants are known to be thoroughly first-class farmers, all restrictive clauses should be relaxed during the greater portion of a lease; and it may serve to meet any contingencies which may arise by taking measures for checking a tenant from overcropping during the latter years of his lease.

It is a matter of great importance that the conditions of a lease should be expressed in plain terms, as disputes often occur from a want of the terms of a lease being intelligibly stated.

On most estates a form of lease is usually printed, which is made to answer the purpose for every farm, no matter whatever diversity of soil there may be on the different farms. Where all the farms on an estate are of the same character of soil and climate, then one form of lease will do for all; but where each farm differs distinctly from another in soil, subsoil, elevation, and general character, then each farm requires a separate form of lease.

I shall proceed to give a form of a lease as adopted and now in use on a large estate in Scotland, and shall afterwards take it up and comment upon it.

I shall also give a form of an agreement as used on several large estates in England, and under which the farms are let from year to year, or what is termed a "tenancy at will," and upon which I shall also make a few remarks; but I consider it only right to mention that, although the examples are given of existing leases, I must not be held as agreeing with all the conditions set forth. I give them as illustrations, not as models. What a model lease should be has frequently been discussed, but the question has not as yet been definitely settled, although certain agreements are drawn up in a much more judicious spirit than others, and consequently better suited to promote the mutual interests of all concerned.

The following, then, is a form of lease now in use on large estates in Scotland, and following which I shall proceed to make a few remarks thereon:—

ARTICLES, REGULATIONS, and CONDITIONS under which the Farms, Possessions, and Crofts on the Lands and Estates belonging to , in the Counties of , are to be let, and which are to be held as specially referred to in the leases or minutes or missives of lease to be entered into between the proprietor and the tenants, and which shall be obligatory on the parties, in so far as the same may not be modified or altered in the respective leases or minutes or missives of lease.

ARTICLE 1. *Destination of Leases.*—The farms, crofts, and possessions will be let for the periods specified in the leases or minutes or missives of lease to be entered into, in favour of the tenant and his heirs, without division, expressly excluding assignees and sub-tenants, whether legal or voluntary, without the special consent of the proprietor in writing, it being provided that the tenant shall have power, by any writing under his hand, to appoint any one of his children, or of his heirs, to succeed him in the lease, but always without division; and that, in the event of his intestacy, leaving only heirs being females, the eldest of such heirs shall succeed him, excluding heirs-portioners; provided also that it shall be in the power of the tenant to assign the lease in trust for behoof of any one or more of his family after his decease, but such assignation shall in every case remain in force during the whole currency of the lease, and be conceived in favour of one individual as trustee, and who, as such, shall be liable, individually and personally, for payment of the rent and performance of the stipulations incumbent on the tenant; but with this proviso, that it shall be competent for the tenant to appoint one or more such trustees in succession, or to act, the one failing the other.

2. *Bankruptcy or Insolvency.*—Provided also that, when a tenant shall become bankrupt, or convey his effects, or part thereof, in trust, for behoof of his creditors, without being rendered legally bankrupt, the lease shall *eo ipso* become void and null, without any declarator or process of law to that effect, and the claims and rights of the tenant, in virtue thereof forfeited and annulled, and the farm shall revert to the proprietor at the first term of Whitsunday or Martinmas thereafter, at which term the tenant shall be obliged to remove; and it is hereby declared that the proprietor shall have the right to bring an action before the Judge Ordinary to have the tenant and his assignees ejected at the said term of removal, and the Judge Ordinary shall have jurisdiction in such action, and power to decern therein both for removal and ejection, and to enforce the same: provided also that nothing herein contained shall be construed as depriving the proprietor of any legal remedy to which he is otherwise entitled, or of his rights under the tack.

3. *To enter into Leases.*—The period of entry and the amount of the rent shall be specified in the leases or missives or minutes of lease, and the tenants shall be bound, when called on by the proprietor, to enter into formal leases on stamped paper, bearing special reference to these articles, should that not have been already done, and containing all other usual and necessary clauses, and to pay one-half the expense thereof.

4. *Payment of Rents.*—The money rents shall be payable at the terms of Martinmas and Whitsunday, in equal portions, after the ingathering of each respective crop, except in the case of the last crop of the lease, the rent of which shall be payable in one sum at the term of Martinmas; excepting also all sums of rent of ten pounds and under, which are hereby stipulated to be due and payable at the term of Martinmas in one sum, and such rents shall include all customs and services, except road-money and other public and parochial burdens, imposed, or to be imposed, by Act of Parliament; and the victual rents shall be converted at the fiars-prices, and be payable at the term of Whitsunday thereafter.

5. *Minerals, &c.*—The proprietor reserves to himself, his heirs, and assignees, all mines and minerals of every description, including coal, limestone, freestone, slate, marl, and clay, with power to search for, work, and carry away the same, and to build

houses for the accommodation of persons so employed, and to make the necessary pits, roads, and levels, or watercourses. The proprietor also reserves to himself and his foresaids the power of regulating and conducting away springs and streams of water for meal-mills, thrashing-mills, or other machinery, or for watering lands, or for other purposes. The tenant to be indemnified for surface damages only, as the same shall be ascertained by arbiters to be mutually chosen, or by an oversman in the event of difference of opinion.

6. *Marches.*—The proprietor reserves power to himself to settle all disputed marches, and to make any excambion or transactions with conterminous proprietors, as to him may seem proper; and also to straighten the marches and settle the boundaries of the farms and crofts on his own estate, and the tenants shall be bound to acquiesce therein: providing that where ground is added to any farm, additional rent shall be paid therefor by the tenant of such farm, at the valuation of arbiters, to be mutually chosen as aforesaid; and where ground shall be taken from any farm, a corresponding deduction or abatement shall be fixed in like manner.

7. *Roads.*—The proprietor also reserves power to make roads, in any direction, and to take all the materials for that purpose, without giving any deduction from the rent, or allowance of any kind therefor, unless such roads or operations shall happen to injure corn or grass fields or enclosed ground, in which case the tenant shall be allowed surface damages, as the same shall be ascertained by arbiters or an oversman, as aforesaid.

8. *Draining.*—The proprietor also reserves power to make drains, open cuts, and ditches through any part of the lands, either for the drainage of the respective possessions, or of the lands contiguous, and shall not be liable to pay any surface damages therefor, nor shall the tenant be entitled to demand any abatement of rent in consequence thereof.

9. *Commonties.*—The proprietor also reserves full power, at any period of the leases, to divide or allocate commonties, and to restrict the number of sheep or cattle, which may be kept thereon by the respective tenants, in proportion to the amount of their rents; and if he sees fit to employ a shepherd to take charge of such sheep and cattle on the common, the tenants shall be bound to pay the shepherd's wages in proportion to the number of stock kept by them, which payments shall be made to the proprietor or his factor, as additional rent.

10. *Mosses.*—The proprietor also reserves all mosses upon the estates, with free ish and entry thereto, and with full power to enclose, regulate, or divide them as circumstances may render necessary; and when liberty shall be granted to the tenants to cut peats, they shall be bound to cast them in a regular manner, and on the allotments set apart by the moss grieves (whose regulations and orders the tenants are in all cases bound to obey), and they shall carry the banks equally forward without pitting, and lay the surface turf regularly down in the bottom of the peat-hags, and make channels, when necessary, to free the hags from water, under a penalty of twenty shillings for each offence, or in default of payment, to be excluded from the moss. The cutting of peats for sale is strictly prohibited, except by special written permission, granted by the proprietor or his factor; and in the event of such permission being given, a charge of twopence per cart-load in name of lordship shall be leviable by the proprietor.

11. *Woods.*—The proprietor also reserves the woods of every description, whether natural or planted, growing or to grow, upon the respective possessions, with power to preserve and enclose the same; and no tenant shall suffer his bestial or sheep to pasture in any part of the forests or plantations without special agreement with the

proprietor; and the proprietor reserves for himself and his assignees the right to sell, cut, manufacture, and carry away, by floating or otherwise, the said wood, and with liberty of access through the farms for this purpose, when and as often as he may think proper, the tenants to be indemnified for any damage their corn or grass lands may thereby sustain, to be ascertained by arbiters or an oversman, as aforesaid.

12. *Planting.*—The proprietor further reserves power and liberty to enclose and plant such portion of the respective possessions as he may judge suitable for that purpose, the tenant being indemnified for loss of any ground so taken off, as the same shall be ascertained by arbiters or an oversman, as aforesaid.

13. *Game.*—The proprietor also reserves the whole game and fishings, of every description, upon the estates, with liberty, privilege, and power of hunting, coursing, fowling, and fishing for the same, not only by himself, but by others having his permission, and his or their gamekeepers; and the tenants shall be bound to protect the game as far as in their power, and not to permit any poachers to shoot, hunt, or fish, but to give timely notice to the factor, or the district gamekeeper, of any trespass which may come to their knowledge: declaring that the tenant shall have no claim on the proprietor for recompense or damage for, or in respect of, any injury which he may sustain by reason of the proprietor, or others as above, so sporting or hunting, or for, or in respect of, any injury which he may sustain in the occupation of the lands let, by or through the instrumentality of game themselves, or by reason of any increase thereof; but reserving to the tenant any claim which he can substantiate against the party actually sporting, hunting, or fishing, for any injury or damage which may be thereby done to new grass, grain, or green crops.

14. *Dogs.*—No tenant shall be entitled to keep more than one dog, unless otherwise stipulated for in the lease; and in the event of any tenant keeping more than the stipulated number, he shall be liable in an additional rent of one pound sterling for each dog so kept; and it shall be in the power of the gamekeepers of the proprietor, or of the tenants of the shootings, to destroy any dog found straying in pursuit of game, without being accountable to the owner of such dog.

15. *Grazing Cattle.*—No tenant shall be at liberty to take in sheep to consume the produce of his farm at any season of the year, unless the same shall be his own property, or be confined within properly-enclosed parks, nets, or hurdles, without special consent given by the proprietor or his factor; neither shall any tenant be allowed to take in sheep, cattle, or other bestial, not their own property, upon common or divided grazings.

16. *Straying Cattle.*—It is hereby stipulated that all and each of the tenants and possessors shall, upon all unenclosed grounds, herd their horses, cattle, sheep, or other bestial, in winter as well as in summer, and shall be bound to pay one shilling sterling for each beast found upon his neighbour's ground or farm, for which the beast may be poinded and detained, besides the actual damage: and any horses, cattle, sheep, or other bestial found straying upon the public road, or in any of the forests or plantations on the estates, may be poinded and detained, and their owners amerced in the same amount of penalty, and which may be recovered by decreet of the baron bailie.

17. *Muir-Burning.*—The tenant shall be bound not to burn, either by himself or his dependants, any heather or muir, on any part of the property, at any season of the year; but, in the case of hill-pasture, a portion may be burned every year at the discretion of the proprietor or his factor, and by persons under his or their orders, but at the tenant's expense; and for any muir burned without such permission, the

tenant shall be charged ten shillings per acre for every acre of muir so burned, and in the case of a commonty, the tenants collectively shall be so charged.

18. *Mills.*—The tenants shall be bound to grind all the corns which they require to make into meal at the mills situated on the foresaid estates, unless in cases where the tenants, or the lands occupied by them, are thirled to mills on other estates; and where so thirled, they are to pay the accustomed multures, knaveships, mill dues, and services; but where not so thirled, they may select any mill on said estates they please, unless otherwise provided for in the leases.

19. *Conditions and Penalties.*—The tenants shall be accountable for the due preservation of the growing wood of every description upon their possessions, and shall do their utmost to prevent their bestial from destroying fences around plantations; and in case any of them, by themselves, families, or servants, be guilty of cutting, peeling, or destroying any growing wood, or of kindling or raising muirburn at any season of the year; or of illicitly distilling or vending spirits; or of cutting up muir green or meadow ground for fuel or divot, or of killing or destroying salmon, or black or spawning fish, or of resetting the same, or of killing game of any description, or injuring embankments, by himself, his bestial, or others, such offender shall, for the first offence, be liable in a sum not exceeding five pounds sterling; and for the second offence, in a sum not exceeding ten pounds sterling, to be fixed by the proprietor or his factor, on the said offence or offences being established to his satisfaction, besides reparation for damages; and in the event of any party being a third time guilty of any of the above offences, whether committed by themselves or any of their families, then every such tenant or possessor shall, at the will of the heritor, forfeit his or her lease for the remainder of it, and it shall be in the heritor's power to remove him or her, with their families and stocking, from the whole of their farm or possession, at the first Whitsunday after such third offence; and the Judge Ordinary shall have jurisdiction and power to decern in such removing, and to enforce the same; declaring further that the penalties and forfeitures above set forth shall be without prejudice to all and every other remedy competent to the proprietor at common law, or by statute for all or any of the offences above enumerated.

20. *Cropping.*—Every tenant shall be bound and obliged to give personal residence on the farm, unless otherwise consented to by the proprietor, and to keep at all times a sufficient stocking, his own property, on the premises during the whole currency of the lease; and further, he is neither to outlabour nor mislabour the farm—in particular, he is, on no pretence whatever, to take two white or corn crops in succession; and it is hereby stipulated that the course of cropping to be pursued shall be the five years' rotation, unless in cases which may be otherwise provided for in the leases; and that no misunderstanding may arise as to what is meant by a five years' rotation, it is hereby declared to be as follows—viz.: The ground broken up from grass shall be cropped the first year with wheat, barley, or oats; the second year it shall be fallowed or cropped with drilled green crop, being first properly cleaned and dunged, which green crop shall consist of at least four-fifths of turnip; the third year the land shall be cropped with wheat, barley, or oats, along with which shall be sown a sufficient quantity of ryegrass and clover-seeds, but where wheat is taken after grass, it shall not be allowed, after fallow or green crop, as no more than one wheat crop shall be permitted in the course of the rotation; and the fourth and fifth years the land shall be in grass, and the first year's grass only shall be cut for hay; and further, the tenant is bound to leave the whole arable land of the farm, at the termination of the lease, strictly in terms of the above regulation. And in case of any deviation from the preceding rules as to cultivation and cropping,

the tenants shall be bound to pay the sum of five pounds sterling per acre of additional rent for every acre so miscropped, and proportionally for a smaller quantity: declaring that this additional five pounds per acre is to be paid as pactional rent, and not in name of penalty or damages; and in case of any tenant subletting his farm, or any part thereof, or failing to give personal residence thereon, without permission from the proprietor in writing, or failing to have a sufficient stocking thereon, his own property, or in case of his infringing these regulations in any respect, for which no other penalty or forfeiture is specially provided, he will be held to have thereby incurred a forfeiture of his lease, and the same shall be forfeited and annulled accordingly; and the Judge Ordinary shall have jurisdiction and power to decern in any action of removing or irritancy brought against him in respect of such infringement.

21. *Entries.*—The tenant shall be bound, at the Whitsunday of his removal, to deliver over to the proprietor or incoming tenant the two lots of land in one and two year old grass, and the lot in preparation for fallow (which last must have received two ploughings and one harrowing), together with all the dung then unapplied on the farm, for all which he shall be entitled to receive payment from the proprietor or incoming tenant, as the value thereof shall be ascertained by competent persons to be mutually chosen. The outgoing tenant shall be obliged to allow the proprietor or incoming tenant to sow grass-seeds in the lot which had been in fallow crop the previous year, and the outgoing tenant shall be bound to harrow and roll the same without charge. The tenant shall in no case gift, sell, or carry away any of the straw or turnips, the produce of the farm, but shall be bound to consume the whole thereof by bestial on the premises. He shall also be bound to sell to the proprietor or incoming tenant the whole of the last crop of corn and straw, the quantity of which to be ascertained on the ground by arbiters mutually chosen, or an oversman appointed by them; and the proprietor or incoming tenant shall be bound to harvest said crop, for which the outgoing tenant shall pay according to the valuation of the same arbiters; the price of the corn and straw to be fixed and determined in like manner immediately after the fiars prices of the county in which the farm is situated have been struck, at which time one-half the price shall be payable, and the other half at the term of Whitsunday thereafter.

22. *Buildings.*—The tenants at their entries shall be obliged to accept the houses on their farms as tenantable and sufficiently commodious, and the dykes as in good repair and fencible, unless the contrary be specifically detailed in the leases, and to receive the same at the valuation of men mutually chosen; and to pay to the outgoing tenants the meliorations, if any, they may be entitled to, the amount of such melioration being first admitted and certified by the proprietor or his factor; and they shall, during the currency of their leases, keep, and at their removal leave, the houses and dykes in complete, substantial, and sufficient state of repair, and of the same value as they were received at entry; and if left at waygoing of this value, according to the valuation of men mutually chosen, they shall then be entitled to receive from the proprietor or incoming tenant the sum they paid to the outgoing tenant at their entry, but no more, whatever the valuation may amount to; and if the buildings and dykes be not then of the full value as at entry, they shall be bound to pay to the proprietor the difference of value; and it shall be in the power of the proprietor to inspect, or cause to be inspected, from time to time, the said houses and dykes; and if he should observe any dilapidation, it shall be in his power to have the necessary repairs executed thereon, and to charge the tenant with the expense thereof, which, with legal interest from the date of outlay, the tenant shall be bound to pay at the

first rent-term after the same shall have been executed, and the tradesmen's receipts for the sums expended by the proprietor shall be deemed sufficient voucher for ascertaining the amount thereof. And in no case shall any house or houses, to be hereafter erected by the tenant, be included in the valuation, unless the site, plans, and specifications thereof shall have been approved of by the proprietor in writing, and the same shall have been built of stone and lime, and slated or tiled ; and in no case shall the tenants be allowed, at the expiry of their leases, or their removal, to injure, destroy, or carry away any part of the houses on their respective farms, or the materials thereof, on the ground or pretence of such houses having been erected at their own expense, and of their not getting value for the same, or otherwise.

23. *Insurances.*—Each tenant shall be bound to pay annually to the proprietor, along with his rents, one-half of the annual expense of insuring the houses against fire, to the extent of the landlord's standard therein, the other half to be paid by the proprietor, in whose name the houses shall be insured.

24. *Cottages.*—All dwelling-houses and cottages, with the gardens or yards attached, if any, on the farm, with the exception of the dwelling-house of the tenant, and the cottages of the ordinary farm-servants, are reserved from the let of the farm, and are to belong to, and be held directly of, the proprietor ; and without his permission in writing, no tenant shall be entitled to erect any dwelling-house or cottage, or give permission to any other person to erect such on any part of his farm, or to have or maintain thereon any sub-tenant, cottar, or other resident, besides his own family and ordinary servants on his farm.

25. *Embankments.*—The tenants shall be bound to keep all embankments and sluices, at all times, in proper and sufficient repair, and to keep clear all open drains on their respective possessions, and regularly scour all march ditches ; and in the event of any injury being done to the embankments, they shall immediately repair the same, and it shall be in the power of the proprietor to cause the same to be inspected from time to time, and to call on the tenants to make such repairs as he may see necessary ; and if they should fail immediately to do so, then it shall be in the power of the proprietor to order such necessary repairs to be made, and to charge the tenant with the expense thereof: provided always that the tenants shall not be held liable for injuries caused by excessive floods, and without any neglect on their part.

26. *Fences.*—The tenants are bound to keep in good order and repair all fences on their respective possessions, it being understood that all fences round plantations shall be kept up at the mutual expense of the proprietor and tenant, and all march fences at the mutual expense of the conterminous tenants ; and in the event of any fences being neglected, or suffered to go out of repair, the proprietor shall have power to cause the same to be repaired, and charge the tenants with the expense of the work, or such part thereof as they are bound to bear under the above regulation : and the tenants are expressly prohibited from cutting any underwood or bushes for the purpose of erecting or repairing the said fences, without the consent of the proprietor.

27. *Weeds, &c.*—And every tenant shall be bound to cut or pull the whole weeds, on every part of his farm, including roadsides as well as fields, when required to do so ; and on his refusal or failure, the landlord shall be entitled, at any time, not exceeding twice in one year, to employ work-people to cut or pull the same, and to charge the tenant with the expense thereof.

28. *Baron Courts.*—Farther, each and all the tenants and possessors on the estate shall give suit and service at the courts of the baronies when summoned thereto, and shall submit to fulfil and obey the rules and regulations of the heritors' baron bailie courts for the good government of the estate in all respects.

29. *Removing.*—All the tenants and possessors on the estates, whose leases shall bear reference to these articles, shall become bound and obliged, and hereby bind and oblige themselves, at the termination of their several leases, or on the irritancy thereof, to flit and remove themselves, families, servants, and others resident upon their respective farms or possessions, together with their goods, gear, and effects, forth and from their respective farms or possessions, and leave the same void and redd, without warning or process of removing to that effect; and in case they shall counteract the said obligation to remove, it shall be optional for the proprietor or his agent to proceed against them as law directs, or to exact, for every year thereafter that such tenant or possessor shall contemptuously possess, double the rent stipulated for by the respective leases, besides all damages and expenses which the proprietor may thereby suffer, and which they become hereby bound and obliged to pay, without any modification.

30. *Testing Clause.*—The said and the several tenants who shall enter into leases, agreements, missives, or minutes of tack, having reference to the foregoing articles, conditions, and regulations, consent to the registration hereof in the books of Council and Session, or others competent, therein to remain for preservation; and that all necessary execution may pass upon a decreet to be interponed hereto in common form—and for that purpose they constitute

procurators.—In witness whereof,

(Signed) .

(Signed) , witness.

, witness.

Payment of Rents.—In article 4 it is stipulated that "the money rents shall be payable at the terms of Martinmas and Whitsunday, in equal portions, after the ingathering of each respective crop, except in the case of the last crop of the lease, the rent of which shall be payable in one sum at the term of Martinmas." In England the rents are generally payable at Ladyday and Michaelmas—that is, on 25th March, or 6th April, and October; but in Scotland the terms of payment are frequently as stated in article 4 of the form of lease; but in a great many cases the terms of Candlemas and Lammas are preferred, and I believe that the latter are the best. At Whitsunday and Martinmas—that is, in May and November—all the farm-servants, labourers, and tradesmen's bills have to be paid; and it is a relief to many farmers to have their rent to pay at another period, and not when other heavy payments take place. At Candlemas—or in the month of February—the farmer will have had time to dispose of his grain, and thus be enabled to meet his rent. At the term of Lammas—that is, in the month of August—all his fat stock, both cattle and sheep, will have been sold, and this will enable him to meet his other half-year's rent.

Game.—This is a much-vexed question between landlord and tenant, and such rules as shown in article 13 of the form of lease will not certainly tend to make matters any better. The tenants under such a rule are not only prohibited from shooting or otherwise destroying game, but it is also stated that they "shall have no claim on the proprietor for recompense or damage for, or in respect of, any injury which he may sustain in the occupation of the lands let, by or through the instrumentality of game themselves, or *by reason of any increase thereof.*" A farmer certainly cannot rest contented with the knowledge that he is rearing crops to feed game; and nothing can be more hurtful to a man's feelings, and to his pocket also, to find, on walking round his farm, that his grain and green crops are being destroyed by game which he dare not interfere with. It is of little avail to insert a clause to the effect of "reserving to the tenant any claim which *he can* substantiate against the party actually sporting, hunting, or fishing, for any injury or damage which may be thereby done to new grass, grain, or green crops."

Leases are often met with containing such a clause, and it certainly is not creditable to the present generation that such is the case. No doubt a proprietor has a right to deal with his lands as he may think best, and to give the use of it to a tenant under any conditions he may feel disposed to stipulate, as generally there are always farmers to be found who will take farms under almost any conditions. Many blame the landlord alone for such a state of things, but in my opinion both parties are in the wrong. It requires two to make the bargain, and all tenants should object to such a condition about game in their leases, and on no account to take a farm with such restrictions. From the experience I have had of farmers, I feel satisfied that the greater number of them feel pleased in seeing their landlords shoot over their farms in a sportsman-like manner, but they cannot be otherwise than dissatisfied when their crops are being reduced by hares and rabbits. I am of opinion that a respectable class of tenants would make the best gamekeepers; at all events, landlords should insist on having all hares and rabbits kept down on their estates—it is for their own interest that this should be done.

Cropping.—This is one of the most important clauses in a lease. I have already stated that no intelligent farmer should be strictly confined to any such form of rotation, and yet it must be admitted that the landlord should have some power over bad tenants, to prevent them injuring the farm. When a good tenant, who is known to be a thorough farmer, is strictly confined to a certain course of cropping, it is hostile to both the landlord's and the tenant's interests, and causing injury to the farm. I knew an instance last season (1867) in which a crop of clover entirely failed in the spring of the year, and the tenant was not at liberty, and was not allowed, to plough the field and sow another kind of crop. Some may assert that if he had been a good farmer the clover crop would not have failed; but this is a mistake, as the tenant was a thorough good farmer, and from some cause very little of the seed came up: very probably the stringent system of cropping was the cause of it, as there is no doubt but what some soils require a change in the system of cropping. The field which I refer to lay all the season with a crop of weeds, which proved very much against the interest of the farmer as well as the farm.

It is quite possible to insert a clause in a lease, in regard to cropping, which will give the farmer a certain amount of freedom in the tillage of his land, and at the same time prevent him from doing any injury to the farm. This might simply be done, precluding the tenant from taking two grain crops in succession—that is to say, that after each grain crop there shall be at least one green crop. A farmer with a lease always finds it to be to his best interest to keep his land in the highest state of fertility, and consequently he would never think of impoverishing the land by a continued succession of grain crops. Where there are farmers still working under the old-fashioned year-to-year system, I think it is necessary to confine them to a rotation, as there are, unfortunately, unprincipled men who would take advantage, and take all they could from their farms for a few years, with the view of leaving them as soon as they could not grow any more crops to profit. Even with a lease it is necessary, as I have already stated, to have some means of restricting a tenant towards the latter end of his lease, as there are many men who would not pay so much attention to the land as it would require, if they intended to leave their farms.

The chief systems of rotation in vogue in England and Scotland are the four, five, and six years' rotation. The four years' course is more generally followed in England than Scotland. It is as follows:—

First year—Green crop, turnips, rape, or mangold-wurzel.
Second year—A grain crop, sown with grass-seeds.
Third year—Clover-seeds.
Fourth year—A grain crop, and then back to a green crop again.

A five years' rotation is: The first year, a crop of wheat, oats, or barley; after that, in the second year, a green crop; the third year, a crop of wheat, oats, or barley, sown down with a crop of clover and ryegrass seeds; and in the fourth and fifth years the land remains under the clover-seeds, to be again ploughed up in the sixth year for a grain crop. A six years' course of rotation is as follows: First year, oats after grass; second, green crop; third year, wheat, oats, or barley, sown down with clover and ryegrass seeds; fourth year, the clover-grasses are usually cut for hay; and in the fifth and sixth years the land remains under pasture. The following is another six years' rotation, suitable for strong land in good condition: First year, potatoes, vetches, and turnips; second year, wheat and barley; third year, grass for soiling, hay, or pasture; fourth year, oats; fifth year, beans, swedes, mangolds; sixth year, wheat.

One kind of rotation is suited for one kind of soil and husbandry, and another kind of rotation for another description of the same; so that one set form of rotation is not suited for any district of country, or even for all the farms on one estate, where there is a diversity of soil and climate; but we generally find, as in the case of the form of lease given, that all the tenants on an estate are obliged to follow a fixed course of rotation, although their farms may be very different from each other in many essential respects. For the proper working of a farm, with advantage to itself and to the tenant who occupies it, conditions should be drawn out suitable to the circumstances in connection with the farm. If this is not attended to, a greater or less degree of disappointment in the working of the farm will be the result, as indeed it is the case in very many instances at the present day. Each description of soil requires special treatment peculiar to itself: a strong soil will bear more cropping than a thin weak one; a clay soil will be benefited by one sort of treatment, but the same system carried out on a light loam might be injurious to it.

This shows, therefore, the necessity of carefully considering the course of cropping best adapted to each farm; and the rotation best suited for any particular soil must be decided by the nature of the soil, and also by taking into consideration the amount of food which different plants take from the soil. As a rule, all plants which are allowed to produce seed before they are removed from the soil take more nourishment from it than those plants which are removed before producing seed; as, for example, wheat, barley, oats, and rye take more from the soil than turnips do if they are removed before being allowed to produce seed. But where turnips are grown for seed, they take a very large amount of food from the soil, even more than grain crops do. In practice it is generally found that wheat takes the greatest amount of nutrition from the land, and next to it oats take a place as being most exhausting; and then in order there is barley, rye, potatoes, peas, beans, carrots, turnips, mangold-wurzel; and, lastly, the least exhausting of all are the permanent grasses.

Taking these things into consideration, it may be safely inferred that all soils which are naturally rich will bear more cropping than those which are thin and poor. Of course, soils can be made rich by a liberal application of manures and deep cultivation; but if light soils receive such a course of cropping as tends least to exhaust them, they will be worked more profitably.

In reference to the four-course rotation, Mr Wilson expresses his views as follows in his work on 'British Farming:'—

No better rotation has 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 been annually 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 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 ryegrass, unmixed with any other plant, is now frequently taken instead of clover on part of the division usually allotted to it, and proves a grateful change both to the land and the animals which consume it. In like manner, instead of sowing turnips invariably every fourth year on each field, a portion of the annual division allotted to this crop can advantageously be cropped with mangold-wurzel, carrots, or cabbages, care being taken to change the site occupied by each when the same fields come again 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 equalise the main divisions both as respects amount of labour and the different staple products. A closer cover of grasses and a better pasture are 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 interest of all concerned, than by a rigid adherence to the customary rotation.

The rotation of a farm must also in a great degree be decided by the kind of husbandry which is adopted. For instance, it may be desirable to grow a large portion of green crops on a farm in the neighbourhood of a large town, and consequently a course will have to be adopted which will admit of this being done; and in the case of a farm of mixed husbandry it will be necessary to have a regular quantity of straw and grain to meet the wants of the live stock on the farm; a certain number of stock on a farm every year necessitates the having a given quantity of food of different kinds, and therefore all this must be taken into consideration. Where there is a large proportion of permanent pasture on a farm, it is not necessary to have the clover-seeds in rotation to lie long. Where there is a considerable extent of old permanent grass, the four-course shift is one well adapted for this, other conditions being favourable.

In some parts of England a two and sometimes a three course rotation of cropping is carried out on strong soils. In the first place, I shall illustrate the plan adopted of following out a two-course shift or rotation, and will suppose that we have a farm to deal with to the extent of 400 acres; then the course would be—the first year, 200 acres under a crop of wheat, with a heavy application of manures, and the remaining extent of 200 acres is put under a crop of beans without manure. The following year the cropping is just reversed—that which was under wheat is sown with beans without manure, and that which was under beans is sown with wheat, with a liberal application of manure; and so on each year alternately, the land receiving an application of manure each second year when the wheat is sown down. A farm of this description requires to have a proportion of permanent grasses to provide hay for winter feeding of the stock. A large quantity of manure is made on the farm, using the hay, straw, and bean-stalks as food for the stock, and also using straw as litter. It requires soil with some substance in it to bear this frequent cropping. It is not often found in practice—only where the land is very strong.

A farm of 400 acres under a three-course rotation would be laid out as follows:—

		Acres.
First year—Green crop,	Turnips,	50
	Potatoes,	5
	Beans,	35
	Fallow,	40
Second year—Grain crop,	Wheat,	100
	Barley,	35
Third year—Grass,	Hay crop,	60
	Pasture,	75
		400

This rotation is, on the whole, an easy rotation for the soil, especially when the green crops are liberally manured and the soil well opened out.

The two and three course rotations are adapted only for very stiff clay soils with a good stamina in them.

The four-course rotation is adapted for clay soils not too stiff, but it is not suited for light soils. Light soils are very much benefited by having a part under grass, and therefore the five or six course shifts are best suited for that class of land. On very light soils the six-course rotation is by far the best, as the land is allowed to lie under grass for three years; and this rotation is an excellent one for keeping land clean. Generally speaking, for light-loam soil, gravelly soils, and sandy peats, I consider the six-course shift the best adapted.

Such are the different modes of cropping usually in operation in this country; but crops sometimes fail, and it may be necessary to alter the system for the benefit of the land. On this subject Mr Stephens states in the 'Book of the Farm,' paragraph 5105:—

> Adherence to a good rotation conducts the operations of the farm with regularity and ease; but a slavish adherence to any particular rotation evinces want of judgment. The judgment ought at all times to be exercised according to circumstances and the character of the season; and modifications thus introduced will most probably benefit both the soil and its occupier. A legitimate mode of deviating from a rotation is this: The field which grew a crop more exhausting than the rest in the course of one rotation, should bear an ameliorating crop in the following one. For example, where potatoes grew in one rotation, turnips should be substituted in the next; and potatoes, in like manner, may follow turnips. An interchange of soil should take place between the different kinds of turnips, so that swedes being more severe upon the land should alternate with the white turnip. The bare fallow on strong land should alternate with a green crop; and so should barley with wheat. Even a severer course is at times justifiable, such as taking wheat after lea, where there is reason to suspect that oats will fail. A root crop of a different nature—such as mangold-wurzel, or carrot, or even cabbage—should alternate for a season with the ordinary roots cultivated. When any crop fails — and clover sometimes does — it should be ploughed up, and another of a different kind taken in its stead. Potatoes often fail; they should be ploughed up, and turnips substituted. Sometimes the swedes are destroyed by insects; then let white turnips be taken as a substitute, or late rape, or bare-fallow the land for autumn wheat. In short, whenever one crop fails, another useful one should be substituted in its place; for if the soil is not occupied with a useful crop, it will be soon taken possession of by a host of weeds. Where a change has been forced upon the rotation, a field may be miscropped to bring it again under the rotation; and of all means of miscropping a green crop is the safest, and with additional manure will recover the tone of the land sooner than any other device.

In the example of the lease given, under the rule on "Cropping," it is stated, "And in case of any deviation from the preceding rules as to cultivation and cropping, the tenants shall be bound to pay the sum of five pounds sterling per acre of additional rent for every acre so miscropped." This is all very necessary, as I have elsewhere stated, when dealing with inferior tenants, but certainly not when treating with men of superior skill and education; but under any circumstances, where such a sentence is necessary in a lease, a clause should be inserted to the effect that, "if the tenant can show any advantage to be derived from any deviation from the rules, then the landlord will grant him permission to do so."

Entries to Farms.—In Scotland, farms are usually entered to at Whitsunday and Martinmas, and in England at Ladyday chiefly to the buildings and grass-land, and to the arable land at Michaelmas. These terms are not favourable in a great many kinds of farming. On a dairy or grazing farm it is convenient to enter at Whitsunday, as then the tenant has the full summer's grass before him, and has also time to rear winter food for his stock in the form of turnips, &c. To a farm of mixed husbandry, it is most convenient to enter to it also at Whitsunday, as then he also has time to rear green crops for the winter feed of his cattle, and to prepare land for winter wheat. Where a tenant enters at Martinmas, he would have to purchase all his winter feeding. The most convenient time for farmers generally to enter is at Whitsunday in Scotland, or Ladyday in England, as then they have possession of the houses and grass-land, and also of all the arable land at the separation of the crop from the ground at the end of harvest.

In the example of the lease given, it is stated in rule 21 that "he shall also be bound to sell to the proprietor or incoming tenant the whole of the last crop of corn and straw." On many estates the straw belongs to the proprietor, and the outgoing tenant is bound to hand it over to the proprietor free of all charge, and the proprietor conveys his right to the incoming tenant. This in Scotland is termed "Steelbow." It is a great advantage to many farmers to have the straw handed over to them free of charge, as it represents so much capital equal to the amount of its value. It thus enables a farmer to take a farm with less capital than he could if the straw had to be paid for; or if he has sufficient capital to pay for it, it leaves so much more at liberty for other uses. In many instances the manure also is "steelbow," or is handed over from one tenant to the other free of charge. This has the same advantage as the other, in making it easier for a farmer to enter. There is, however, a disadvantage attached to the giving of manure and straw free of charge, which is, that it makes the outgoing tenant careless as to whether a large quantity of manure is made on the farm or not, and also as to whether the straw is properly taken care of. Where the outgoing tenant has to be paid for the manure and straw, he generally is careful to collect and make as much manure as possible on the farm, and also to preserve the straw. This is all in favour of the farm and the incoming tenant, although it may cause him to lay out more money at the commencement. Again, we often find that outgoing tenants are allowed to sell their standing crops by auction. They divide it into lots of so many acres, as thought best, and the incoming tenant has to take his chance of purchasing the crop along with the general public. This, in my opinion, is not a good system; as, if the crop is sold to other parties to go off the farm, then the farm suffers in consequence. The incoming tenant can of course purchase elsewhere; but the distance may be great, and other circumstances may cause it to be too expensive for him to bring it to his farm. Taking all things into consideration, I should be in favour of handing the straw and manure over to the incoming tenant at a valuation—that is to say, two valuers should be appointed, one by each party, or one man mutually chosen, who shall value all the straw and manure on the farm, for which the incoming tenant pays the outgoing one. This causes all parties to pay more attention to the making of manure and the preservation of the straw.

Where the crop is valued standing, and handed over to the incoming tenant at that valuation, it is generally done in the following manner:—

It is estimated, in the first place, how many quarters or bushels there may be to the acre. This is charged at so much per quarter, according to the price of the kind of grain at the time; and the value of the straw is also taken, if it has to be paid for. The expenses of reaping, leading, and thrashing the grain are then deducted from the gross amount.

We will presume that there is a crop of oats to value, and that we estimate the quantity at six quarters per acre. Then it would stand thus:—

Six quarters oats at 30s.,		£9 0 0
Straw, worth 6s. per quarter,		1 16 0
		£10 16 0
Deduct per acre—		
Reaping,	£0 10 0	
Leading,	0 5 0	
Thrashing and preparing for market, 1s. per quarter,	0 6 0	
		1 1 0
Value of the crop per acre,		£9 15 0

Wheat straw is usually taken at about 9s. to 10s. per quarter on a fair crop, and barley straw at about 4s. 6d. per quarter.

In the form of lease given it is stated, rule 21, "the price of the corn and straw to be fixed and determined in like manner immediately after the fiars prices of the county in which the farm is situated has been struck." This mode of arriving at the value of grain, which is practised in Scotland, is far from being correct. It may at times come somewhat near the truth, but, as a rule, it is only a rough mode of coming at a fair valuation. The average price is taken in the months of February and March, and at that time in Scotland a large proportion of the grain is not sold, a great many farmers purposely holding back until the fiars prices are declared. After the averages are taken, many changes might take place in the sale of grain, and thus a great portion of one harvest might be sold very differently from the first sales.

Buildings.—It is quite proper that a tenant should keep all the buildings in good repair, but he should receive them in thoroughly good condition. Every landed proprietor should put the buildings on a farm in good condition before letting it to a tenant, and then he is perfectly justified in binding the tenant to keep them in good order. This may take some expenditure on the landlord's part; but he cannot expect a farm to let to so much advantage with the buildings in a dilapidated state as it would if all were in thorough good order. In fact, a farm should never be put into the market with the buildings out of order. Let the proprietor first see that the buildings are adequate for the purposes of the farm, and then bind the tenant to keep them in order; and every lease should contain a clause to the effect that, if it be found necessary to extend the buildings, the landlord should erect these at his own cost, the tenant paying a reasonable interest on the outlay.

Insurances.—All farm-buildings should be insured, as also the grain in the granary and stackyard. Great facility is given in these times for insuring, and it is cheaply done. There is, therefore, a want of judgment in any one who does not insure against fire. The landlord should see that all the buildings on his estate are insured, and that the tenants have insured their stock and crop. The following are the rates of the North British and Mercantile Insurance Company for farming property in the United Kingdom:—

1st. Thatched farmhouses not in towns or villages, but standing detached and apart more than fifty feet from other thatched houses,	5s.	per cent.
2d. Thatched farm outbuildings on a farm,	3s.	"
3d. Farm outbuildings, brick, and tiled or slated; timber, or any other construction, and tiled or slated, not less than	3s.	"
4th. Agricultural produce and farming stock, whether for a year or shorter period,	5s.	"

Steam thrashing-machines are allowed to be used without any extra charge; and if an insurance is made for a period of seven years, six years' premiums are only charged. Besides these charges there is a Government duty of 3s. per cent per annum upon buildings.

I now come to give a specimen of an English agreement between landlord and tenant, as used on several large estates in the north of England, for farms let from year to year. I do not give it as a model agreement for yearly tenancies, but as a sample of what is usually done; but I may state that it is one which is much more liberal in its terms than is usually to be found. After having given it, I shall proceed to make some remarks on it:—

This indenture, made the day of , between of , in the county of York, on the one part, and of and of , in the same county, farmers, of the other part, witnesseth that, in consideration of the rents hereinafter reserved, he, the said , doth hereby demise, lease, and to farm let unto the said , his executors, administrators, and assigns, all that messuage and farm-buildings, and all those pieces or parcels of land now or late in the occupation of , situate in the townships of , Extent. or one of them, in the county of York aforesaid, containing , be the same more or less, to hold the said premises, with the appurtenances, unto, the said , his executors, administrators, and assigns, as to all such Entry. parts of the said farm as for the time being shall be in tillage from the 2d day of February, and as to all the remainder of the said premises from the 6th day of April , for the term of one whole year from those respective times, and thenceforth from year to year, so long as both parties shall agree, yielding and paying therefor Rent. yearly during the continuance of this demise the clear yearly rent of of lawful English money, free from all taxes, charges, and assessments whatsoever, except the property-tax, by four equal quarterly payments at Ladyday, Midsummer, Michaelmas, and Christmas-day, Old Style, in every year; the first payment thereof to be made at Midsummer , and also paying in manner, and on the days before mentioned, Miscropping. the further yearly rent or sum of £10 of like money (to be recovered by distress, as in cases of rent in arrear) for every acre of meadow or pasture ground, parcel of the said farm, which the said lessee, his executors, administrators, or assigns, shall plough up or convert into tillage without the consent in writing of the said lessor or his agent, and so proportionably for a greater or less quantity than an acre, the first instalment of such additional rent to become due and be paid on the first of the said quarter-days which shall next happen after every such ploughing up or Execution of improvements. conversion. And whereas the said , at the request of the said , hath undertaken to execute, on the behalf and at the expense of the said , certain works for the drainage of the said lands. Now the said and hereby agree with the said , that on the execution of the said works the said and , their executors, administrators, and assigns, will thenceforth pay unto the said , his heirs and assigns, an increased yearly rent for the said lands hereby demised, equivalent to five per cent upon the amount of the moneys to be expended in the said works of drainage, such additional yearly rent to be paid by equal quarterly payments on the days and times hereinbefore appointed for the payment of the rent hereinbefore reserved in every year, and to commence from the 6th day of April next following the execution of such works; and the said and , for themselves, their heirs, executors, and administrators, do hereby covenant with the said , his heirs and assigns, that they, the said and , or one of them, shall pay unto the said , his heirs or assigns, the said reserved yearly rent of , and all further increase of rent which may become due as aforesaid, at the times before mentioned for the payment of the same, and all taxes, charges, and assessments, except as Repairs. aforesaid; and shall, at their own expense, during their occupation of the said farm, keep in good repair and condition all the buildings, ditches, drains, and watercourses, hedges, fences, gates, stiles, and bridges, upon the said farm, and leave the same respectively in good repair and condition on quitting the said farm; and in case at any time any such repairs as aforesaid shall remain unexecuted for two months after the said shall have been directed by the said or his agent to perform the same, it shall be lawful for the said , his heirs or assigns, forthwith to cause the same to be completed, and charge the whole expense thereof to the said and , their executors, administrators, or assigns; and also that he, the said , shall during his occupancy manage the lands hereby demised in a husband-like manner, and shall not at any time grow a greater quantity of hay than he can consume with his own stock—that is to say, the usual number of stock that he has been accustomed to keep during the preceding summer; and shall in the autumn and spring of every year destroy the moles upon the said farm; and shall yearly and every year scale the meadow and pasture ground, mow the thistles, rushes, and weeds, and stub the whins, brambles, and brushwood growing thereupon, and upon the sides of the arable land, and in the roads and lanes adjoining to the said farm; and also shall cause all the hay, straw, clover, and fodder to be produced from the said farm to be consumed within the foldyard or other buildings of the said farm; and shall leave in the foldyard of the said farm, when he shall quit the same, all the manure, dung, compost, and ashes which shall be produced within the last six months upon the said premises, without any recompense for the same; and shall not lop or fell any trees, nor buckhead any of the hedges, except for the necessary repairs of the fences, and then plash or lay the hedges or fences from which any thorns or other wood shall be cut in a proper manner; and shall not assign or part with the possession of the said farm, or any part thereof, to any person whomsoever; and shall manage the arable land in the four-course husbandry, and have one-fourth part of the arable land in fallow every year, and spread upon every acre thereof three chaldrons of clod-lime, one-fourth in clover or seeds to be eaten on with stock, one-half of which said clover or seed quarter may be drilled or planted with beans or peas upon the wide-row system, and well manured and horse-hoed or scuffled, and hand-hoed during the summer, and two-fourths in corn or grain; and on his quitting the said farm, the landlord or succeeding tenant shall pay him for the clover-seeds sown the preceding spring, provided they are not eaten off with any kind of stock; and in the last year of his occupation the landlord or succeeding tenant shall have the liberty to sow clover or grass seeds among the away-going crop of corn, and harrow, brush, roll in, and preserve the same; and the said tenant shall permit free entry to the said , and his or their steward, agent, or workmen, to come upon the said premises and inspect the condition thereof, and to cut down and carry away timber and wood therefrom, and likewise, with their friends and servants, to sport over the said premises; and the said hereby engages to preserve all the game he possibly can upon the said farm, and to assist in the detection of poachers, and allow actions to be brought in his name against any person who may be found trespassing over the said premises; and that and shall have and enjoy the exclusive right of killing and destroying rabbits on the said farm and premises, either by themselves, their friends, or servants, and in any manner they shall think proper; and that in case any damage or injury to the crops on the said farm shall be occasioned by rabbits, it shall be lawful for the said to give notice thereof in writing to the said , by a letter addressed to him at his usual place of abode, and also by a written notice to the like effect delivered to the agent of the said and at , if there be one, and transmit through the post, or deliver

Management of the land.

Moles.

Weeds.

Consumption of hay, straw, &c.

Manure.

Repairs of hedges.

Subletting.

Rotation.

Outgoing.

Inspection of land and premises.

Game.

Damages by rabbits.

the same notice; and in case, within seven days from the sending or delivery of the latest of such notices, the destruction of the rabbits on the said farm shall not be commenced, and from thenceforth effectually prosecuted, then that the said and shall pay to the said such sum of money, by way of compensation of the said damage, as shall be determined by two arbitrators or an umpire in the usual way. And lastly, as to the mode of quitting the said premises, that the said , his heirs and assigns, or the succeeding tenant, may enter upon three-fourth parts of the arable land on the 2d day of February previous to the tenant quitting the premises; and that in case he or they shall be obstructed in such entry, the said , his heirs or assigns, shall be forthwith entitled to maintain an action in ejectment for all the premises comprised in this demise; and that the said shall be entitled to an off-going crop of corn or grain from one-fourth part of such lands as in the regular course of cultivation shall have been regularly fallowed in the summer next before such corn or grain being sown (or shall have been in turnips eaten on by sheep); and it shall be lawful for him to set such crop in the stackyard of the said premises, and to thrash it out in the barn on the said premises on or before the 2d day of February next, after the expiration of the demise, paying the same rent and taxes for the land on which the said corn shall have grown as the average of the farm stands to (such rent to be recoverable by distress, as in cases of rent in arrear) before he is permitted to reap or take away the same, and also leaving all the straw and chaff on the said premises without any recompense for the same; and also that the said tenant shall not during the last six months put upon the said farm any number of cattle beyond the usual and common stock he has been accustomed to keep. Provided always that if the said several yearly rents or sums hereinbefore reserved, or any part thereof respectively, be unpaid by the space of forty days next after any of the times hereinbefore appointed for payment thereof, or if any of the covenants or agreements hereinbefore contained on the part of the said shall not be duly performed, or if either of them, the said , shall become bankrupt or insolvent, or make a compromise with his creditors for less than 20s. in the pound, then and in any of such cases it shall be lawful for the said , his heirs or assigns, at any time thereafter, to enter upon the said demised premises, or any part thereof, in the name of the whole, and to repossess the same, as in his and their former estimates, but which entry, if made, shall not defeat or prejudice any right of action or other remedy which the said , his heirs or assigns, might by law have had for arrears of rent or breach of covenant on the part of the said and , their executors, administrators, or assigns. In witness whereof the said parties have hereunto set their hands and seals the day and year first herein written.

Payment of damages by rabbits.

Mode of quitting.

Signed, sealed, and delivered (being first duly stamped) by the within-named,

Witness,

L.S.

From the example of the English lease given, it will be found that the entry is "to all such parts of the said farm as for the time being shall be in tillage from the 2d day of February, and as to all the remainder of the said premises from the 6th day of April;" but this excepts one-fourth of the arable land, which remains in the possession of the outgoing tenant until the crop is reaped from it. It must be remembered that the farm for which such an agreement is given is worked under the four-course rotation, and the one-fourth of the arable land which the outgoing tenant holds for the time is that part of it "as in the regular course of cultivation shall have been regularly fallowed in the summer next before such corn or grain being sown, or shall have been in turnips eaten on by sheep."

This form of entry is favourable for a farmer in many respects: it enables him to prepare winter food for his stock, and also to prepare his land for autumn wheats. Were a tenant to enter at the end of harvest —say at Michaelmas or Martinmas—he would have to purchase everything required for feeding all his stock, and this is a serious consideration.

The clause as to miscropping is also proper, especially as applied to the old permanent pastures of England. Few such pastures are to be met with in Scotland, and then only in proprietors' parks. If some of the old pastures were once ploughed up, it would take many years to bring them back to their former state again. Indeed, very few farmers would wish to plough up their old pastures, as on an average they pay better than the arable lands. The only exception to this might be where the pasture was very poor, and the grasses growing on it of inferior quality; and in a case of this kind it might be advisable to have it ploughed up, and after being thoroughly cleaned and manured, laid down again under good permanent grasses.

The clause for the execution of improvements is, I think, a good one, and the interest charged is not heavy; in fact, very few proprietors are to be found who will perform improvements on their farms for less than 6½ per cent per annum.

As stated in regard to the other form of lease given, it is just and proper that the tenant should keep all ditches, drains, watercourses, hedges, fences, gates, buildings, &c., on his farm in good repair; only it is proper that he should receive them in like condition. In some agreements it is added to the clause on repairs, that the tenant is bound to keep all in good repair, but damage done by "fire and tempest excepted." This is proper, as, where the buildings are insured, in the case of their being destroyed by fire, the money received from the insurance company should go towards rebuilding them, and at all events the landlord should make them good.

The clause on the repairs of hedges states, "Nor buckhead any of the hedges except for the necessary repairs of the fences, and then plash or lay the hedges or fences from which any thorns or other wood shall be cut in proper manner." As a rule, the fences in England are kept in very bad condition; and when such clauses are inserted in an agreement, it cannot be wondered at that an improved mode of managing them is not adopted. Such a clause prevents a farmer from keeping his fences in good order, if he should wish to do so. The hedges should not be allowed to grow beyond a certain height, and they should be properly and regularly switched.— See "Hedges."

In many agreements, as in the one given, the outgoing tenant is prohibited from grazing the young grass with stock. This is proper, as, if the outgoing tenant were allowed to graze it, he would probably have it very bare up to the time he left the farm, and the incoming tenant would have little benefit from it for a long time.

The clause regarding game, as I have already stated, with reference to the Scotch lease, is a very vexatious one between landlord and tenant all over the kingdom, and it is one which deserves the serious consideration of all landed proprietors. It is the landlord's interest to keep down the head of game on his estate, although many may not think so. So long as the tenant suffers, the landlord must in time come to suffer also. If the rabbits are not given over to the tenant, I would recommend that proper rabbit-trappers should be appointed on an estate, whose duty should be to see that they are kept down. It is a good plan, where this is done, to give the man so much per rabbit he kills, and not a day's wage; then he will try and get all he can. It is stated in the agreement that compensation will be paid for rabbit-damages, but these damages can never be fairly estimated. A certain amount of produce may be taken as the quantity the rabbits may have eaten, but there is the loss of manure which would have resulted from that produce, and the quantity of grass and the harm done to it can never be calculated justly. The best plan is in all cases to see that hares and rabbits are kept at least within reasonable bounds on the estate.

On many estates in England the tenancy commences on the 25th day of March, and notices to quit must be given on the 25th day of September —this is what is termed the Old Style; and it is also a rule, where the four-course rotation is carried out, instead of the outgoing tenant having one-fourth of the arable land as his waygoing crop, he is allowed one-third, paying a rent for the same either after the average rent of the farm, or at a sum stated in the agreement. The same agreements state that the landlord or his incoming tenant shall be at liberty, on and after the 1st day of December preceding the expiration of the tenancy, to enter upon the arable land which the tenant may be entitled to sow with corn—that is, the one-fourth or one-third, as the case may be—to sow seeds with such crop, and to enter upon the arable land which the tenant may not be entitled to sow as an awaygoing crop, for the purpose of ploughing and cultivating the same.

CHAPTER IX.

IMPROVEMENT OF LAND.

SECTION 1.—*How to increase the Fertility of our Soils.*

THERE can be no doubt that as yet agriculture, comparatively speaking, is only in its infancy; for although it must certainly be admitted that much has been done for the improvement of the land since the beginning of the present century, still it is equally evident that we have not attained to anything like clear and definite views as to how its latent capabilities can be fully brought out and made available for the benefit of all concerned. But to illustrate the point, let us take a rapid survey of the present state of some of the leading branches of practical farming. This will enable us to judge as to how far its cultivators are acquainted with or understand the nature of the latent capabilities of their land.

First, then, with regard to the manner in which *the tillage of the land* is conducted. When a piece of cultivated land is prepared for receiving a fresh crop, its surface is broken up by the plough. This is made to operate by cutting and turning over to one side successive slices of the surface, averaging from five to nine inches deep, by about ten inches in breadth. In those parts of the country where a superior kind of cultivation is carried out, however, we frequently find the land ploughed to an average depth of twelve inches; but, generally speaking, the operation is not carried deeper than about nine inches. This latter depth, then, may be said to be that to which in most cases the land is cultivated in this country, and upon this thin stratum of soil all the manures are applied and all the crops grown. From this we are naturally led to conclude that farmers, generally speaking, are of opinion that all the capabilities of the land lie only in the upper stratum of the soil, and that under this there exists something injurious to crops, which should not be disturbed nor in any way called into action, lest some hidden evil be thereby aroused and thus blight their crops. It is indeed a fact worthy of remark in regard to a large proportion of the farmers in this country, that they are very much averse to disturbing the subsoil of their land. They have not, generally, any well-defined reason to give as to why they are of opinion that it should not be disturbed, but affirm that, when they have happened to turn up any of the subsoil, they have found it do more harm than good to their crops. From entertaining this prejudice against breaking up the subsoil, many of them rear poor, scanty, and unremunerative crops; and those men, although experiencing this state of things, never attribute the true cause of their failure to their neglect in not making a deeper soil for the better development of the plants, but blame the land itself as being either "too cold bottomed" or "too retentive" for a more profitable state of things; and so in this opinion they go on year after year, getting poor returns for themselves, and in consequence paying only a poor rent to the proprietor. Many of the intelligent class of farmers are now, however, of a different opinion, and therefore practise deep ploughing, so as to break up the subsoil and mix it with the upper, and by this means make a deeper soil for the better development of all the plants they cultivate. Still there are comparatively few, even of the intelligent class of farmers, who cultivate their land deep enough to secure the full advantages of its latent capabilities; and therefore, with regard to the tillage of the land as generally practised in this country, it is evident that but few of its cultivators understand how to deal with it in order to bring its capabilities into full exercise for the advantage of all concerned. If they knew how to do this, they would not confine the cultivation of their land to a few inches—seldom exceeding twelve—on the surface, while they have a storehouse of wealth lying below this, which requires only deeper cultivation to render it available. It is but reasonable to suppose that, were this fact generally known and received among farmers, it could not fail to be as generally practised. In short, the depth to which a farmer ploughs is a sure index of his intelligence as a cultivator of the soil.

Drainage is the next branch of farming operations to which I shall refer. Since 1835, when Mr Smith of Deanston first brought into public notice his well-known system of drainage, much has been done through its means for the improvement of large tracts of arable land. Of what has been drained in this way, a large proportion has been made valuable crop-bearing land by the operation, while in other cases the land has been only partially benefited by it, but all less or more improved, according as the respective depths and distances apart of the drains were calculated to produce the desired state of dryness in the land operated on. When Mr Smith first made known his system of thorough-draining, however, it was understood that it should be followed by a system of deep-ploughing, in order to make it thoroughly effective to dry the land; and wherever deep-ploughing has been put into operation after the drainage, the land has been vastly improved, while in those cases where the drainage has been done without deep-ploughing following it, comparatively small advantages have been obtained from the operation.

There is a great variety of opinion in regard to the drainage of land, some holding that drains of the depth of three feet, put on at from fifteen to eighteen feet apart, are the most efficient for general purposes; while others have taken the opposite extreme, and recommended drains to be made five feet deep, and from thirty-five to forty feet apart. But, generally speaking, the most intelligent part of agriculturists adopt a medium between these two extremes, and make their drains from three and a half to four feet deep, and from twenty-five to thirty feet apart. I mention these points in regard to drainage, to show that as yet no really well-defined rules have been laid down for the guidance of farmers in dealing with it for the improvement of their subjects. It is no doubt very difficult to prescribe any definite style of draining, as a great deal depends on the nature of the soil and subsoil; for a depth and distance apart that will be perfectly effectual in one case, may be utterly useless in another—and this may happen within the bounds of a single field. Still it must be acknowledged that, in carrying out this most important work, there is a great deal of hap-hazard practice, even among some who profess to be practical drainers and experienced agricultural engineers.

Of late years I have had to deal with a large extent of land which had been previously drained, but on which the drains had ceased to be effective. This I had for the most part redrained, and while engaged in this work, I found the old drains only about twenty-seven inches deep, and large portions of the pipes choked from mud which had been washed down into them from the soil above, thus proving that drains of that depth are not out of the reach of injury from the surface, especially in a light and porous soil. Shallow drains I consider equally as objectionable as over-deep ones, and my own opinion on the subject is, that parallel drains should in no case be made shallower than three and a half feet, nor, except in some particular cases, deeper than four and a half feet. As to the distance apart, that must in all cases be regulated by the nature of the land to be operated on. Land having a stiff clayey subsoil cannot be made thoroughly dry for profitable farming with drains put in at distances greater than from eighteen to twenty feet. On moderately stiff land the distance may safely be extended to twenty-four feet, while on land having a porous bottom they may be twenty-six or even twenty-eight feet apart; and where the subsoil is found very open and porous, the land may be perfectly well dried by drains at from thirty to thirty-three feet, but beyond the latter distance it is not advisable to lay drains with any hope of success. Seeing, therefore, that the comparative porosity of the soil is the only sure guide by which a farmer is to drain his land effectually, he should study the nature of it in all respects for this end, otherwise he is as likely to fail in his attempts to dry his fields as to succeed in his object.

There are in this country few pieces of land that will not be much benefited and made more productive from being thoroughly drained; and without this, in fact, no piece of land can be made so productive as it will be after it has undergone the operation. Indeed, without thorough drainage the latent capabilities of any kind of land cannot be fully brought out, inasmuch as it not only removes superfluous water from the subsoil, but also insures the circulation of air through the soil, and thus secures a healthiness in the subsoil which could not otherwise exist. Looking, therefore, at the extent of land which has been drained in this country within the last thirty years, and considering the very large proportion which at the present day is still in a very imperfect state of dryness from the defective drainage, and therefore requiring to be redrained, and at the same time from seeing the many different opinions which still obtain on the subject, it is evident that farmers have yet much to learn in regard to it before they understand it so well as to be able to make it thoroughly available for developing the hidden capabilities of their land. Any one not convinced of this has only to look around him to see the many failures which have taken place in respect to drainage, and in doing so he will obtain some knowledge as to how much money has been, as it were, thrown away upon it. Experience has been gained, however, although certainly at a great cost, and the intelligent farmer will use this experience as a guide to better success in future. But it must be kept distinctly in view that no system of drainage can be made thoroughly operative on the land unless it is followed by a thorough opening up of the soil lying above the drains; as without this the land will remain to a great degree impermeable to the passage of water to the drains, as well as to the roots of the plants cultivated on it.

The Application of Manures falls to be noticed in the next place, and this is a branch of agriculture as yet very imperfectly understood among us. It is from the want of sufficient knowledge in regard to manures fitted to rear particular kinds of crops on their land, that farmers are so often disappointed in the results of the artificial manures they purchase. If a farmer happen to have raised a very abundant crop by the use of a particular kind of artificial manure, he proclaims his success among his neighbours, who probably all purchase the same kind of fertiliser next year for their subjects, and the result is likely to be very variable among them, all depending on how far the manure used is suitable for the wants of the land in order to raise the crops to which it is applied. For example, the farmer who tried the experiment first may have land naturally rich in phosphate of lime; if so, and if he applies a manure containing a mixture of nitrogenous matter, potash, and lime, it could not fail that he should have a good crop, because the phosphate of lime previously in the land, united to the ingredients in the manure applied, produce a perfectly suitable medium for the growth of plants. But, on the other hand, if the neighbours who use the same manure have land containing little or no phosphate of lime, it must follow that they would have inferior crops without this substance; for it is known that where there is no phosphate of lime in the land, any manure of the character described would be ineffective, and even injurious to plants grown on it. Now, the same results will follow in respect to any other kind of manure that may be used, all depending upon its adaptation to the soil for supplying the necessary food for the growth of the plant which is to be cultivated. Seeing, then, that a thorough knowledge of the application of manures is of so much importance to farmers, it becomes essential that they should be well acquainted with the subject in all its bearings; and still it must be admitted that they are very deficient in this branch of their business, and have much to learn in order to know how to deal with their land so as to call up its latent capabilities. Until farmers can understand clearly the constitution of their lands, and the kinds of manures they require to insure heavy crops of different kinds, their success must continue to be only partial, and very much regulated by chance.

Every farmer ought to be an intelligent experimenter on manures himself—that is, he ought to experiment for himself as to what kinds of manures are most suitable for the rearing of particular kinds of crops on his land. Any farmer can do this with certainty in this way: Let him choose a corner in each of three or four of his fields which contain the different kinds of land embraced on his farm. On each of these let him sow and plant a small portion of all the different kinds of crops he rears, applying to portions of each kind of crop the different kinds of manures in use. When this is done in spring, at the end of the season he will be able to judge for himself as to what particular kind of manure is best suited to rear the different kinds of crops on his land, as will be indicated by the results of the experimental crops respectively. This any intelligent man may manage at a comparatively small cost, and so avoid being disappointed by using manures which are not suited to his land. Were all farmers to attend to this, the advantages gained to agriculture would be incalculable, as then every farmer would be enabled, from his own experience, to decide as to the kind of manure which gives the best crop of wheat on his farm, the best crop of turnips, the best grass, &c.

But I have still another point to discuss in regard to the application of manures—to wit, that they should be applied to a greater depth of the soil than is generally attended to, or indeed can be, in the present superficially-cultivated surface of the land. We have only to look at the way in which gardeners deal with their land in regard to manures, to be convinced how much farmers lose by not attending to the manuring of their land in the same way. I happen to know a first-class gardener who trenches his land thirty inches deep or thereby once in every five or six years, and who at each trenching applies manure not only throughout this depth as he proceeds with the trenching, but lays also a coat of it in the bottom; so that, in fact, the land is thoroughly manured to the depth specified. In the land so prepared he grows all kinds of vegetables to an extraordinary size, of first-rate quality, and in wonderful quantities. He informs me that, although it costs him a good deal to treat his land in this way, it pays him well, and in fact three times what it would do were it treated in the ordinary way of manuring only on the surface. Now, if farmers would manure their land in this way, the result could not fail to be of the highest degree advantageous, and in fact would be certain to bring about a new state of things altogether in the productiveness of the soil and the management of landed property. Farmers will no doubt ask, Where could the manure be got to supply such a state of the land as is here inferred? I answer, that were the land dealt with in the manner described, there would be such an increase in the quantity of straw and green crops raised on it, that the means for manure would be supplied in proportion. But I need not say more on this subject of deep manuring at present, as I shall have occasion to refer to it afterwards.

The Quantity of Seed which should be sown per acre on land is a point in farming on which there has been much controversy, and on which there is still held a variety of opinions—some recommending thin, and others thick sowing. I know of many who had adopted thin sowing, and who have again returned to the sowing of a larger quantity per acre; and it is my own opinion, that the sowing of a moderate quantity of seed is always a safer practice than either of the extremes of thin or thick sowing. Much, however, must in all cases depend upon the state of the land, as to whether it is in high condition or otherwise. Still, even with land in high condition, it is always the safest way, in order to insure a good crop, to sow a moderate quantity—say two bushels of wheat to the acre—than very much less or very much more. Some recommend to sow little more than half a bushel, or even a peck of wheat per acre; but although good crops may have been raised from such thin sowing, it is not to be depended upon for general farming, as in this case any slight accident or disease, or it may be mismanagement, may result in a serious loss in the crop, from there not being sufficient plants to keep good the crop when part of the plants are injured from any cause. When very thick sowing is resorted to, the ear is generally small, from the plants not having sufficient room for full development. It may be remarked, that when any kind of grain is sown in drills by a proper machine, considerably less is required than when sown by hand broadcast; generally speaking, one-fourth less is found sufficient.

As this point has a strong bearing on the success of farmers generally in the cultivation of their crops, they should not fail to ascertain carefully from experiments what quantity of seed per acre gives them the best return. I am aware that but few pay any decided attention to this, and sow generally too thickly, and consequently reap an inferior crop of grain —and not only inferior grain, but poor root-crops as well. It frequently happens that we find farmers not giving either the potato or the turnip sufficient room for development, and the result is that the crops produced are generally light compared with what they are under a system of culture by which greater space is given to the plants, and which, therefore, is better calculated to secure their full development in all respects.

Having in the foregoing remarks on the tillage, drainage, manuring, and sowing of land, shown that farmers, generally speaking, at the present day, are not sufficiently acquainted with these operations so as to insure their full efficiency in bringing out the latent capabilities of the land, it is therefore to be inferred that they do not understand the nature of the powers which they possess capable of increasing the productiveness of their land by the right application to it of those agencies. It is not enough that a farmer should be what may be generally termed well acquainted with these departments of his business; he must be possessed of an intimate knowledge of all of them in order to insure his having, as it were, a complete command over the latent capabilities of his land; for without this he would fail in having complete success as a profitable cultivator, and probably would also fail to be able to guard against being a robber of the soil. I have known men who perfectly understood the nature and application of draining, and the advantages of it to the land and crops, who notwithstanding made but indifferent farmers, just because they did not understand how to deal with and apply tillage and manuring along with it. Indeed, there are many men to be found who make one particular branch of farming their special hobby, and who carry out that hobby in all their views, as if in it alone lay the essence of good farming. One takes up draining, another fine ploughing, or it may be deep ploughing, another manuring, and another something else, to the neglect of nearly all the other branches, and the result is that they are only partially successful as farmers. The proof of these remarks is exemplified on farms in most parts of the country. But, as has already been stated, the farmer who would be successful in his business must not only be possessed of an intimate and perfect knowledge of all of the branches referred to, but must also, in good earnest, put them all into practice, for the proper and harmonious working of all of these points, which are as wheels necessary to make the machine of agriculture complete in all respects.

From what has been stated, it must appear evident that there is at least very great room for improvement in farming as practised at the present time, and that were an improved mode of dealing with the land, in respect to its tillage, draining, and manuring, acted upon with intelligence, skill, and decision, both the produce and profits from its cultivation would be vastly increased. The farmers themselves would be the first to be benefited by an improved mode of dealing with their subjects, because by this they would be enabled to grow a much greater quantity of straw, grain, and green crops than they do at present, and in consequence to rear many more beasts from the produce; and under such a state of things proprietors would come in for their share of the profits in the shape of higher rents. Both proprietors and tenants have, therefore, a mutual interest in seeing an improved state of farming, such as is here inferred, put into operation without delay. But the general public also would participate in the advantages of an increased amount of produce from the land, inasmuch as there would be a more plentiful, and probably a cheaper, supply of food than is at present enjoyed; and so all classes of the community would be benefited by this proposed improvement of the land. Seeing that such is the case, the next question is,—By what particular system of farming can this desirable state of things be brought about?

Having for many years past had to deal with the improvement of landed property in its various departments in several parts of the country, I have seen much to convince me that the mode of farming at present generally practised is very far from being calculated to bring into action the dormant capabilities of the land, so as to materially increase the produce and profits from its cultivation. The mode of tillage generally practised may justly be characterised as *a scratching of the surface-soil*. It is in some respects nearly as primitive as the mode of cultivating the land practised by the poorer class of settlers in the backwoods of Canada. There the new settlers draw the plough over their land so as to break the surface just deep enough to receive and cover the seed, and here pretty much the same mode is in many instances put into operation; the only apparent difference between the two modes of tilling being, that in this country the operation is more systematically and neatly gone about, simply because there are no tree-stumps to interfere with the work, as the settler has to contend with in Canada. It is certainly a matter of surprise that in an old country like Britain, with all its wealth and available resources for the improvement of its soils, there is not at the present time a very much better mode of cultivation put into practice than that which prevails in many parts of the country. I am aware that there are farmers in this country who have adopted an improved mode of dealing with their land in regard to its tillage, and I give them all due credit for the example they have set; but even of these there are comparatively few who have carried out their improvements in tillage to the extent which the importance of the subject requires.

From seeing that in most parts of the country the mode of tilling the land is generally very defective, and but ill calculated to remunerate its cultivators for their trouble, I have for a number of years past been led to consider whether a better system could not be adopted; and as I have had extensive opportunities, from daily practice, of seeing the effects of certain modes of operation in different districts, I noted their results, and stored them up as proofs in favour of the system I am about to recommend. From my inquiries on and experience of the subject, it is clear that the great defect of the system of tillage in general practice is its shallowness, whereby only a thin stratum of the land is supplied with food for the roots of the plants grown on it; and that, consequent on this state of things, the plants cannot possibly be fully developed, nor attain such perfection of growth as to produce highly profitable crops. I have, of course, long observed that drainage has the effect of materially improving the surface of the land for the better growth of plants cultivated on it; but, on the other hand, it has been clearly demonstrated that the complete efficiency of drainage is to a very great degree prevented by the compactness of the undisturbed subsoil lying between the cultivated surface and the drains, as this in many cases forms a complete barrier to the descent of the water from the cultivated surface to the drains, and the admission and circulation of air throughout the soil. Indeed, it seems beyond doubt that on most lands the full efficiency of drainage cannot be obtained while the compact subsoil lies undisturbed, and that, in order to secure the full advantages of draining, it is absolutely necessary to open up the subsoil to admit of the free passage of the water downwards, and the circulation of air. I am well aware that subsoil-ploughing has in many cases been adopted with a considerable degree of success; but to me this does not seem to answer all the ends desirable to be attained by the opening up of the subsoil, and I therefore have looked for a more complete method of dealing with it, and find that this can be fully answered by *manual trenching*. I can see no other mode by which the work of opening up the subsoil, and thoroughly disintegrating it in all its parts, could be so well done. A great objection to this, however, is the expense it would involve, and the question which naturally arises is, therefore, Would it pay? I have no doubt in my own mind as to its profitableness, for I have seen many instances of land which had been trenched paying much better than untrenched land of the same quality, even after taking the expense into account. To many persons to whom I have mentioned trenching as the very best means of improving land by its opening up the subsoil, and making it afterwards available as a storehouse of food for the plants cultivated on the surface, the scheme seemed wild; but all admitted that if their land were trenched they could not fail to have a large increase in the crops they could raise, as compared with untrenched land, and would therefore be able to keep more live stock in proportion. No one denied this, for all had observed that the deeper the land is cultivated the easier is it to work, and the higher are the returns from it. I shall just refer to four cases, out of many others I have observed and could bring forward, in proof that trenched land pays its cultivators far better than the same character of land in the untrenched state.

The first case to which I shall refer was brought under my notice on an estate I had to do with in the west of Scotland. In that case about fourteen acres of waste land were drained where it was wet, and trenched in order to remove stones and underwood from it, so as to make it fit to be added to an adjoining arable field, and the operation was performed to the depth of two feet over all. After the stones and roots were cleared, the surface was left in a rough state all the following winter—the trenching was performed in the month of September—in order to allow the weather to act on the land, so as to ameliorate it as much as possible before spring. In the month of June it was manured and green-cropped along with the field of which it now formed a part, and in all respects it had the same treatment as the old arable portion of the field. The crop grown was of the kind called green-topped yellow turnips, and it was remarked by all who saw it, that it exceeded in weight any crop of the kind they had ever seen before. The expression used by some of the old farmers of the district in referring to it was, "the land was a perfect mat of turnips." No correct account was kept of the weight of the crop, however, but comparing it with that on the other portion of the field, it must have been fully double the weight of it. This, therefore, was a proof of the advantage of trenching land, even on the crop of the first year after the operation. As the field was to be sown down the following year with young grass along with a crop of barley, I requested the farm-overseer to keep a note of the produce of the latter, both on the trenched and untrenched parts of the field. He did so, and the result was that on the trenched portion there were *sixty-four* bushels per acre, while on the untrenched there were only *forty* bushels to the acre; thus giving twenty-four bushels more of crop on the trenched than on the untrenched land. This result, therefore, speaks for itself. I may also mention, that as I had occasion to pass through this field after it was in pasture, I noted the condition of the grass on both portions of it, and was much struck by the superiority of that on the land which had been trenched, compared with that on the part which had not been touched. Indeed, the farm-overseer told me that the grass on the fourteen acres of trenched land was at least equal to that on the other twenty-five acres embraced in the field. The next example to which I shall refer is one of about three acres of land which were drained and trenched in order to be prepared as a nursery for the rearing of young trees. In doing this, road-scrapings, horse and cow manure, together with a quantity of rotted vegetable matter, were laid in the bottoms of the trenches, which were made to the depth of two feet. Here, also, the operation was performed in the autumn, and the rough surface allowed to lie over the winter for improvement by the weather. The part chosen, and to which I now refer, was in the corner of a field, and from subsequent arrangements it was found necessary to abandon it for a nursery, and therefore it was again added to the field. The field being under grass at this time, however, it was necessary to put a temporary fence round the trenched part in order to keep it in crop till the whole could be brought into the same rotation, when it was intended to throw it into the field again. Following out this plan, it was well manured and sown with turnips. The crop was very heavy as compared with any other crop of the kind in the neighbourhood, and also proved the immediate advantage derivable from trenching. The following year this piece of land was sown down with grass and oats, and the quantity produced per acre was nearly seventy-three bushels, while in the neighbouring fields the average of the crop of oats did not exceed forty-eight bushels. In this case the young grass was very much injured by the heavy crop of oats, and in fact had to be resown the following spring. I have seen it since, however, and the grass on the trenched part was the best upon the estate on which it is situated. The next example I shall give is a case I observed on a place which I had occasion to visit in one of the central counties of England. In that instance I found a Scotch land-steward bringing into cultivation a quantity of cleared woodland, in order to add it to the fields of the home farm. In doing this he had the land trenched fully two feet deep, in order to remove the roots of the trees which had formerly occupied it. After the trenching was performed he had the land systematically drained four feet deep and thirty feet apart. I saw both the trenching and draining going on at the same time. The soil was a strong clay loam. The land-steward informed me that he had during the previous year improved upwards of twenty acres in this way, and added this extent to the arable lands of the farm. He showed me a portion of nine acres of this which he had sown with wheat. The crop was truly excellent, and as I saw it in the beginning of the month of August, I had a good opportunity of judging as to what quantity of grain it was likely to yield per acre when thrashed out. Comparing this portion with the wheat crops in neighbouring fields, I was of opinion that it might probably yield from ten to twelve bushels more per acre; and as I was anxious to know the result after harvest, I requested the land-steward to inform me on that point after he had got the crop thrashed. He did so, and the following is a copy of the letter I had from him on this subject: "I have now had the wheat thrashed which you saw growing on the nine-acre field which I had trenched the year before, and the whole quantity is, excluding refuse, after being cleaned, four hundred and ninety bushels, or equal to forty-five bushels to the acre. I may mention, also, that the field you looked at on the side of the nine acres of trenched land has yielded me only thirty bushels to the acre. I wish I could have all our land trenched, and I am determined to do as much in this way as I can; for though it costs a good deal at first, it comes to pay well." In another case similar to this, which came under my notice on an estate in Yorkshire, the return of wheat after trenching was forty-seven bushels per acre; while on the neighbouring fields, which had not been trenched, but dealt with in the usual way, the average yield was thirty-one bushels per acre.

These examples are sufficient to prove the advantages of trenching land for farm cropping. I could give many more of the same purport, as I have for several years past had my attention directed to it, and therefore took note of every case which came under my notice, but more would be superfluous. They all prove that land which has undergone a course of trenching as a preparation for cropping produces about one-half more crop than the same kind of land which has not been trenched, all other conditions being equal. But I need not say more in commendation of a system of cultivating our lands, the advantages of which are so evident. I have proved these advantages to my own satisfaction, at least, from observation and experience in regard to them in various parts, and I am anxious that every one having to deal with the cultivation of land should prove them to theirs also. In order to this, then, I proceed to give the following statement as to the particular system of cultivation which I would recommend to be adopted in order to increase the fertility of arable land, and consequently the returns from it:—

1st. The particular stage in the course of cropping at which land can be most advantageously improved is preparative to its being put under green crop, as all the succeeding crops in the rotation will have the full benefit from the improvements.

2d. In taking up the green-crop portion of a farm for improvement, the work should always be performed in the autumn, and before winter sets in, in order that the land, after the works have been completed, may lie exposed to the influence of the weather till spring.

3d. If the land has been drained previous to being taken up for improvement, and if the drains are found in all respects in good order, then no further drainage will be necessary, as, after the works shall have been completed, the system of drainage in operation will be rendered very much more effective to dry the land, from its greater porosity. But if the land has not been previously drained, then this should be attended to as the first branch of work to be performed in carrying out its improvement; for no land, if at all available for agriculture, can be made thoroughly fertile until it is drained—unless, indeed, the subsoil is of so porous a nature as to form a natural drainage. In putting the drainage into operation, it should be kept in view that, as the land is to be trenched two feet deep, the parallel drains may very properly be put on at a greater distance apart than would be found necessary were trenching not to be applied. If, for example, it should be considered necessary to open drains at seven yards apart on the land without trenching, then they may be opened at nine yards apart when trenching is to follow, and even at this greater distance prove very much more effective in drying the land. It may be stated that on most lands where trenching is applied, the distance apart of the drains may be made from six to ten feet wider than would be necessary to dry the same lands were trenching not applied to them. The depth of the common or parallel drains should be about four feet, and in these pipes only should be used, with collars, and never tiles with soles; as in the case of the former there is a continuous pipe formed for the passage of the water, while in that of the latter there are great risks of displacement and obstruction from various causes.

4th. Simultaneously with the drainage, the trenching of the land should be carried on. This should be performed by *spade* or *fork* *labour,* in a regular and systematic way, to the depth of two feet over all, taking the measure on the solid or old land-side. In doing the work, special care must be taken to bury the top spit of each trench upside down in the bottom of the one last opened, and to lay all the others, also upside down, regularly and successively above this, till the bottom spit of the trench which is being excavated is laid on the top of the one being filled. As the trenching proceeds, all stones down to the size of two inches diameter, as well as all roots, &c., should be thrown out on the old land-side—never on the trenched land; and every spadeful of soil, as it is laid on the new trench, should be well broken with the spade, so as to separate all its parts into an ordinarily fine condition of earth. No attempt should be made to level the tops of the trenches as they are finished, because the more surface that is presented to the action of the weather during winter, the greater will be the degree of pulverisation in the new soil in the spring, when it falls to be worked for the seed. As the trenching proceeds, all stones, &c. &c., thrown out on the untrenched side, should be removed at once, and never left to interfere with the work of opening the next trench as the last is finished. No heavy animal nor cart should be allowed to pass over the new surface thrown up, as the more open it is left the more decided will be the action of the weather to penetrate and ameliorate it in all its parts during winter. Where the fork is employed, the top spit is first taken off by the spade, and the underlying soil thoroughly broken up with the fork; all stones and roots being also removed at the same time.

5th. As the trenching goes on, all spare manure, of whatever kind, should be collected and applied to the lower half of the newly-turned-over land. This should be done regularly, in alternate courses, with the lower spits as they are laid on in each trench. The more manure that can be applied in this way, the more fertile will the land afterwards be found for the rearing of all kinds of crops; inasmuch as the manure not only of itself enriches the lower half of the depth of land now made available for the roots of the plants to be cultivated, but preserves its openness for a greater length of time, and thereby insures water, air, and heat passing readily into it.

6th. Besides the manuring referred to under the last head, the land should be regularly and deeply manured in the spring following, as a preparation for green crop. By attending to this in a proper and thorough way, the land will then have been manured throughout its whole available depth of two feet, and will in this condition be found in the highest possible state of fertility for the growth of any kind of crop suitable to the climate.

7th. In ploughing the land for crops after it has been trenched, it should in all cases be stirred to the depth of fourteen or fifteen inches.

8th. In order that the fertility of land dealt with in the way described under the foregoing heads may not be impaired, but in all respects preserved for the good of the crops alone, no weeds should be allowed to grow on it; and to facilitate the destruction of weeds as they appear, the crops should as far as practicable be grown in drills, so that the hoe may be readily applied to them.

9th. In the same way each green-crop portion of a farm should be annually dealt with till all the land on it is put into like condition with the first part taken up; and this will of course be at the end of the period required to complete the rotation, whether that may be in four, five, or six years, according to the course of cropping pursued on the farm.

10th. At the end of every second rotation of cropping, the process of trenching and subsoil-manuring as described should be repeated, and then the soil which had been laid in the bottom will again form the top, and that on the top the bottom. By this means the soil will never become exhausted nor fail, as that which has rested in the bottom will again come to act its part on the surface in a fresh and renewed condition, while that which formed the surface will again be laid in the bottom, to rest for a period of years before being again brought up for use, and so on alternately.

I need only add, in regard to the foregoing statement, that if all our arable lands were dealt with in the way described as a preparation for cropping, the diseases now so generally prevalent in the turnip and potato crops, and which are so hurtful to the interests of farmers, would be unknown, and the crops of clover would become as luxuriant as they used to be many years ago; for there can be little doubt that these failures are caused chiefly by the continual cropping on the same surface. It may, indeed, be some considerable time before this desirable state of things prevails generally, as the necessary expenditure to bring it about will deter many from adopting it, although they may be aware of the advantages which would be certain to result from it. Be that as it may, I think that, beyond a doubt, the system recommended for the cultivation of the land will gradually become *the system* in all highly cultivated parts of the country where capital and superior intelligence are brought to bear fully on the subject of agriculture.

The system of trenching which I have recommended is undoubtedly the most effective in producing a thorough separation of the several parts of the soil, and in the removal of stones and roots of trees, and also in mixing and turning the soil. It is no doubt an expensive operation, but I am convinced that the extra expenditure would pay a fair percentage. There are less expensive means of upturning and trenching soils, which are treated of under the chapter on the Reclamation of our Waste Lands. Among the principal of those which have come under my notice are the Tweeddale plough and subsoil trench-plough, and the steam cultivating machinery of Messrs Howard of Bedford and Fowler of Leeds. All of these are excellent for the purpose, and I have seen land of a very poor quality which has been permanently improved by their means. There is no doubt but that all our arable land would be immensely improved and rendered much more productive by being trenched and opened out by means of either the Tweeddale subsoil-plough, or by any of the steam cultivators now in use; and yet, judging from the work which I have seen done by these implements, the trenching is not done so completely or effectively as by manual labour. I repeat that our soils can be very much improved, and rendered much more productive, by being subsoiled by either steam or horse power, but that the implements which are now available to be worked by either of these powers do not perform the work of trenching so perfectly as when it is done by manual labour.

When large farms and whole estates have to be trenched by manual labour, there would be great difficulty in procuring labourers to do the work, but this in a great degree might be obviated by having the work done gradually, as recommended.

Although I have recommended the mode of trenching by manual labour, yet I am aware that the greater number of landed proprietors and farmers would shrink from the first outlay. It is therefore a question of very great importance, "If manual labour is difficult to procure and very expensive, what is the best, and at the same time the least expensive, mode of carrying out the trenching of land thoroughly?" I am inclined to think that, for the proper carrying out of all our *heavy operations*, we must look to steam power for aid; but as yet we have no implement which steam can work to perfection in the thorough upturning of our soils.

The Tweeddale plough, in conjunction with the Tweeddale subsoil trench-plough, works admirably on some soils, and the same may be said of the steam cultivators now in use. It has been remarked that "the Tweeddale implements *worked by* steam power would be the perfection of culture;" if this could be accomplished, I am inclined to believe that the work would be very thoroughly done.

Section 2.—*Probable Cost of Improving Land.*

In taking up any estate for improvement in the way recommended, there would only fall to be taken into account the cost of draining and trenching, as any extra manure that would be applied must go to the general account for the working of the farm, as this would be merely giving an extra quantity with the view to secure an extra immediate crop. Then, with regard to drainage, I should say that there are few estates in this country on which at least one-third of the extent of the available arable lands are not already drained, although on a considerable proportion of them the drains may, from the retentive nature of the subsoil, not be found to act well. Therefore I assume, as a basis of calculation for the probable cost of drainage in connection with the improvement, that on any estate of considerable extent not more than two-thirds of the acreage of the available arable land would require to be drained, and that, although a large proportion of this may not be so satisfactorily operative as is desirable, still, after trenching is applied, it would become more efficient in drying the land.

I have already stated that, where drainage is to be followed by trenching, the drains may very properly be put at wider distances apart than would be necessary to dry the land were no trenching to be performed on it; and keeping this in view, I shall assume twenty-seven feet as a medium distance apart for drains to be followed by trenching, and shall calculate the cost accordingly. Then, on an average of soils, and taking an average of the cost of draining as I have had the work performed in different parts of the country, I have found that, at twenty-seven feet apart, drainage can be performed at £6 per acre. Assuming this, and that only two-thirds of the land of an estate require to be drained, we have £4 given as the probable cost on each acre to complete this branch of work in the improvement of it.

Next, with regard to the probable cost of trenching. I have had this kind of work performed in many parts of the country, on arable lands and on woodlands, at various prices per acre, between £6 and £10; I shall therefore assume the medium between these two sums—namely, £8—as a fair cost for such work generally. It follows, then, that to improve an estate by draining and trenching as recommended, would cost on an average of cases £12 per acre. Now, in order to illustrate how an estate would be affected by an outlay such as this on each acre of it, I shall suppose that a proprietor of an estate of ten thousand acres arable is desirous to have it improved in the way recommended. The entire cost of improving the ten thousand acres by draining and trenching, at £12 per acre, would therefore be £120,000. But were this done on all the farms embraced on such an estate, it is evident that the existing buildings on them would not be nearly sufficient to accommodate the extra produce that would require to be dealt with, nor the extra cattle which that produce would maintain, therefore additional new buildings would require to be erected. In order to make the farm-steadings suitable to meet the improved state of things on the land, we then assume that a sum equal to £2 additional on each acre requires to be expended; and thus the whole expenditure for the full improvement on an estate of ten thousand acres would probably amount to £140,000. This does seem, at first view, a heavy outlay on such an estate, and the question now is, What would be the probable money advantage gained by such an outlay on it? I shall endeavour to make this clear. In the first place, then, I shall suppose that the land of the estate, before it was improved, was let at an average annual rent of 22s. per acre, one farm with another. This would give an entire rental of £11,000 a-year. With land improved in the way that this estate is now supposed to be, and with the farm-buildings all put into the best condition for the accommodation of stock and crop, the tenants could afford to the proprietor a high percentage on the capital he had laid out; and the question is, What percentage would be a fair additional rent on the expenditure per acre on each farm? I have already stated, as my experience in regard to the improvement of land by draining and trenching, that wherever I have seen this done, it yielded a half more crop than the same land did before the improvements were made on it. Let us apply this as a rule, then, to the case in hand, in order to find out the advantages which would accrue to the farmers from the improvements the proprietor had made for them. A farmer occupying land for which he pays 22s. per acre annually as rent, would require to have an average produce from it over all equal to twenty bushels per acre annually. Now, as the land is supposed to have been improved, it should yield in this condition one-half more bushels, or thirty bushels per acre instead of twenty. Taking the value of twenty bushels at 5s. per bushel, we have £5 as the entire money value the tenants realised from the crop per acre before the land was improved; and taking the value of thirty bushels also at 5s. per bushel, we have £7, 10s. as the entire money value the tenants will probably realise from their crops per acre after their land has been improved, and therefore they must be gainers by the improvements to the extent of £2, 10s. on each acre of the land they occupy; and here is a basis of calculation in regard to an advance of rent to the proprietor. It would not be right to assume that the proprietor should draw all this advantage to himself, as, even in the improved state of things which is now supposed to be in operation, the tenants have many risks to encounter and make good in order to meet their rents; but the proprietor is entitled, I should say, to have at least 7½ per cent interest on his outlay as additional rent. It being assumed, therefore, that the improvements cost in all a sum equal to £14 on each acre, this would add £1, 1s. as additional rent on each acre; and thus the rent per acre, after making a liberal allowance to the farmers as their share of the advantages, would be, under the improved state of their farms, £2, 3s., instead of £1, 2s. as before. From this it is evident that the tenants would not only sit under an improved state of things, but that the proprietor himself would realise a high percentage for his outlay in the shape of additional yearly rent. But independently of this, the proprietor would have very greatly enhanced the value of his estate. Before the improvements were undertaken on it, it has been assumed that the annual rental of the property was £11,000. In this case its market value would then be about £363,000, taking it at thirty-three years' purchase. In the improved state, however, the yearly rental would amount to about £21,500, and from this the market value of the estate would be about £709,500, taking it at the same number of years' purchase. This is a startling fact, and worthy of the best consideration of all landed proprietors. This case—which of course is partly assumed, but, notwithstanding, on good grounds for being actually realised—shows that, by laying out £140,000 on the improvement of an estate in the way recommended in the last chapter, a proprietor may realise an additional annual income of £10,500, and at the same time enhance the market value of his estate to the extent of about £346,500; and the same advantages are held out to every proprietor of land in proportion to the extent of his property, whether that may be greater or less, and whatever may be the natural capabilities of the land.

SECTION 3.—*How would Manure be obtained in sufficient Quantity for carrying out the improved System recommended?*

The heading of this section is the purport of a question which has been frequently put to me by farmers to whom I have spoken about the necessity of a deeper system of cultivation being adopted, in order to increase the fertility of our land, and consequently I think it right to notice it.

Whatever kind of husbandry may be pursued on a farm, or on a number of farms, and whether the crops be wheat, oats, or barley, beans or peas, turnips, potatoes, or mangolds, or all of these, or grass chiefly, as the local climate may best indicate, one essential requisite to success in the growing of any of them is a plentiful supply of good and suitable manure. If, under the shallow system of cultivating the land at present generally pursued, there is found on most farms a scarcity of this, how is a system of cultivation to be carried successfully out which would require nearly double the quantity of manure now used to fertilise the land to the depth of two feet? My answer is, that were the system of trenching and manuring the land to the depth of two feet to be adopted as I recommend, it would of itself provide a quantity of manure proportionate to the demands it would involve. This is evident from the following considerations: The bulk of crops of all kinds would be increased on the average to the extent of fully a half more than they are now, and the number of beasts which could be kept would be increased in proportion; and therefore the natural manure of the farm would also be proportionally great. Besides this source of increase in regard to manure, there would be others by no means of small importance in the economy of the farm—namely, a proportionate increase in the available *sewerage* from the dung-yards, &c., and also in the quantity and quality of the manure which would arise from the increased number of animals fed on the farm. Therefore, keeping out of view altogether the artificial manures which every intelligent farmer is understood to purchase, and which, when properly selected to suit the land and crops, always pay well for their cost, it is clear that the extra quantity of manures which would require to be used for carrying out the system of deep cultivation recommended would be obtained, in a great measure, from the increased resources of the farm alone.

No doubt, at the starting-point, a slight deficiency would be experienced; but after the first green-crop portion of the land of a farm had been dealt with in the way recommended, and the crop secured, the extra manure derived from its consumption would be sufficient to give an extra manuring to the next portion, and so on with the other portions, till all the farm had been dealt with in a similar way; after which period there would be such a quantity of vegetable produce grown and consumed on the farm, that instead of the manure being found deficient on it for the demands necessary to carry out the system, it would be found very much more adequate to supply this than the manure of the farm is now found to supply the wants of the mode of cultivation at present in general practice.

From what has been said in this and the preceding sections, it may be inferred that the proprietor of an estate should be at the expense of all the improvements suggested. I do not mean this, however, and have to explain that the statements given are merely meant to show in a general way the advantages of the improvements suggested, as they would affect the income from and market value of an estate. It would, indeed, be a very heavy task for a proprietor to trench all the lands of his estate for his tenants: although I am of opinion that it might be his best policy to do so, still the immediate outlay would be so great that but few proprietors could well afford to undertake it, even looking at the high interest which would be obtained from the outlay. In order, therefore, that proprietors may have their estates improved in the way suggested, and at the least possible outlay to themselves, I would recommend that they should engage with wealthy tenants only, who could undertake the trenching of the land on their own account, as it would be so much to their own interest. A very fair engagement between landlord and tenant, in carrying out the improvements suggested, would be, that the proprietor performed all drainage-works necessary, and also erect all necessary buildings, and charge the tenants interest on the cost as additional rent; and that, on the other hand, the tenants, in their leases, be taken bound to trench and manure the whole of their land in the way and in the order of rotation described, all to the satisfaction of the proprietor or his agent. By such an arrangement the expense of the improvements would be borne nearly equally by proprietor and tenant; while the former would have the interest on his money laid out returned in the shape of an increased yearly rental, and the latter would secure an ample interest on his outlay from the greater yield of crops of all kinds his land so treated would produce him. Then, in order to insure a farmer's being able to carry out agriculture on the principle suggested, he would require to be possessed, on entering his farm, of a sum at least equal to £15 or £20 on each acre of the land embraced on it. I am aware that this sum per acre will to many seem extravagantly high, as indeed it is high compared with the capital usually brought by farmers to bear upon their business; but it is not higher than is really needed to carry out farming as profitably as men are found to conduct other businesses. The trenching of the land involves a considerable expenditure of itself; but this is not all, for it involves also a much larger expense in manures than is needed under the present system of dealing with the land. The deep-manuring recommended to be applied to the land, both while it is being trenched and when it is put in crop in the spring afterwards, would take up all the farmyard dung available during the first two or three years of the lease, and so it would be necessary to purchase large quantities of other manures to apply to the surface above it, as without this double manuring the full advantages of the improvement could not be obtained. The trenching and manuring, then, would take up a large proportion of the farmer's capital for the first year or two, independent of any other of the many items of expenditure which fall to be attended to by an enterprising farmer; and therefore I would advise all proprietors, in arranging with tenants for their farms, to make sure that they are possessed of sufficient capital, as if they are not, proprietors need not expect to have their lands improved and increased in value, but probably made less valuable. In all commercial undertakings, the larger the capital embarked the larger the profits, and the same holds good in regard to farming as well. Bring large capital to bear on it, and dispose of the same with enterprise and skill, and high profits will certainly follow.

CHAPTER X.

MANURES.

Manures may be divided into three classes—namely, Animal, Vegetable, and Mineral.

There are many such substances which are allowed to go to waste by those engaged in agriculture. When we consider the value of manure to the farmer, it is clearly his wisdom to collect together all matter and substances that will fatten and enrich the soil.

In the soil, whatever the subject may be, we cannot continue to produce remunerative crops without a regular and abundant application of manure. Whether we may be engaged in reclaiming waste land, or if we wish to farm *high*, we must manure *high*, so as to increase the productiveness of the soil. It should be the aim of every farmer not only to cultivate every available square foot of land, but to try by every means in his power to increase the crops on his farm; but this cannot be done without a liberal application of manure to the soil after the land has been properly drained and stirred up, as described in former chapters.

I shall briefly notice some of our principal manures, and also several substances which are not usually taken advantage of as fertilisers, but which contain certain proportions of different ingredients beneficial to the soil for the supply of food for plants, and will consider them under the following sections:—

1. Farmyard manure.
2. Vegetable matter, leaves of trees, seaweed.
3. Dead animals, blood, &c., bones, nightsoil.
4. Road-scrapings, cleanings of ditches.
5. Liquid manures and sewerage of towns.
6. Peat as a manure.
7. Soot as a manure.
8. Guanoes.
9. Common salt.
10. Lime.

I shall take these under the several heads in which they are arranged, and commence with—

Section 1.—*Farmyard Manure.*

This is made up of the excrements of the animals lodged in the farm-steading, along with straw and the refuse of other food. It is usually conveyed from each of the buildings where the animals are kept, and thrown into the centre yard of the steading, and left uncovered; but sometimes it is protected from above by means of covered yards. There are usually young stock in the yard that press the manure down in layers as it comes from the stable, cowhouses, pigsties, &c.; it is then removed at convenience to the fields and thrown up in large masses, and there allowed to decay until it is applied to the land. When the manure is lying in the yard, it usually receives any rain which falls upon it, and also all the drippings from the roofs of the buildings adjoining. How often do we find a large amount of rain-water washing the chief fertilising matter out of the manure! and where there is no liquid-manure tank it runs away to waste. The eaves of all buildings should be spouted, not only as a protection to the walls, but as a protection against waste in the manures. The fall-pipes from the spouting should be conveyed into drains, so as to take the rain-water away from the steading in the drains, or, if necessary, preserved in tanks, but at least not allowed in any way to flow upon the manure. The urine from both horses and cattle should be conveyed in covered drains into the yard, and allowed to flow into the mass of manure. There is no doubt that farmyard manure is of the best quality in covered yards. It is always found to contain the greatest amount of fertilising qualities when allowed to lie in covered yards or boxes until it is required for the land. A liquid-manure tank should be formed in connection with each farm-steading at its lowest level—in the farmyard, if desired—to collect all the surplus liquid which the manure cannot absorb. It is the practice on many farms to make the tanks so as to drain off all the liquid from the manure-heap; it is, however, against the interests of the farmer to do so, as it makes the yard manure many degrees poorer. The tank should be made in such a position as it will only drain such liquid as the yard manure will not absorb, and no more.

In carting the manure into the fields to form it into heaps, the foundation of the heaps should be laid with some dry substance that will suck up the liquid which falls through the dung-heap—such as peat, or the dry portions of the farmyard manure; and when the heap has been finished it should be carefully covered over with earth to prevent the volatile parts from escaping.

It is, however, much better to cart the manure from the yard, and apply it to the land at once, and have it ploughed in.

Farmyard manure is also very much increased in value when the animals kept in the buildings are fed with a portion of linseed, rape, or cotton cakes; in fact, the quality of farmyard manure very much depends upon the substances upon which the animals are fed. Thus, if cattle are fed upon linseed-cake, the value of the manure obtained therefrom is worth about £4, 10s. for the quantity received from every ton of cake consumed; and, in the same way, the value of the manure received from the consumption of every ton of the following feeding-substances is worth the sum stated:—

Rape-cake, ...	£4	15	0
Cotton-seed cake, ...	6	5	0
Locust beans, ...	1	0	0
Malt, ...	1	10	0
Potatoes, ...	0	7	0
Mangols, ...	0	5	0
Turnips and carrots, . . .	0	4	6
Oat, wheat, and barley straw, . .	0	12	0
Oats, wheat, and barley, . . .	1	12	0
Tares, ...	3	14	0
Hay—clover, ...	2	5	0
Hay—meadow, ...	1	10	0

SECTION 2.—*Vegetable Matter, Leaves, Seaweed, Clovers, Rape, as Manures.*

There are many vegetable substances which can be applied to land as manure. For instance, the leaves of trees are generally allowed to blow about and get dried. These should be collected as soon as they fall, and formed into heaps, and allowed to lie for some time to rot, or mixed with other substances—such as cleanings of ditches and road-scrapings. Gardeners are generally fully alive to the value of rotten leaves as a manure for gardening purposes. Seaweed is another vegetable matter which is used along the coast as a manure, and ought to be used more than it is, as it is known to possess very great fertilising properties. There are many of the far-famed farmers in East Lothian who owe a great deal of their success to the application of seaweed as a manure. The land on some farms on the coast of East Lothian is worth 20s. per acre more than similar land which has not a right of way to the shore. In some of the best farmed land of the Western Islands of Scotland it is considered a good manuring to lay on eighteen tons of seaweed per acre. At Fort-William, Ballahulish, and Oban, on the west coast of Scotland, the fishermen collect the seaweed into heaps and sell it to the farmers at 1s. per cartload. It is used along the coast of Yorkshire chiefly as a topdressing to grass-land, for which purpose it answers well; the grasses are much improved by it. It is found, however, to act much better when mixed into compost-heaps along with road-scrapings.

It is the custom with many good farmers to plough in a crop of clover, rape, or mustard as manure, and it is a practice found to be of great benefit. Some excellent practical farmers affirm that a crop of rape ploughed in, enriches the soil twice as much as it would if the crop had been eaten off by sheep. It is a good practice to eat green crops on the ground by sheep, if the land be of a light nature; but to heavy land there is more benefit derived by ploughing the crop in, as the vegetable matter has the tendency to open the soil and make it free.

I have seen in Forfarshire a turnip crop sown broadcast on the land after harvest, and allowed to grow for about two months, when it was ploughed in, and the improvement to the land was very evident. In Kent it is a custom in the hop-plantations to bury all the prunings of the plants as manure.

Section 3.—*Animal Manures, Blood, Bones, Nightsoil.*

Any animal matter enriches the soil to a great degree. Dead animals —such as horses or cows—should not be buried in a mass, but rather chopped up and mixed in a compost-heap along with other substances; of course I mean when the animals have been killed by accident, or from non-infectious disease—in the latter case they should be employed as a manuring agent.

Blood makes an excellent mixture in a compost-heap. It is a great error to allow so much of the refuse of slaughter-houses in towns to go to waste, as is usually done. In some parts of the south of England compost-heaps are made with peat, peat-ashes, and charcoal, upon which the blood is thrown in the proportion of about five gallons of blood to two bushels of the heap mixed together; and this is applied at the rate of about forty bushels per acre by itself, or with twelve bushels of the compost, along with ten or twelve tons of ordinary farmyard manure. The blood is sold at 3d. per gallon in some of the southern counties. In Paris the blood is collected and dried, and applied to the land in the form of powder. It is sold in this state at £8 per ton.

Bones have been extensively used as a manure during the last forty years. They are used in two ways: they are either broken up by mills into a rough kind of powder and sold as bone-dust or crushed bones, or they are dissolved in sulphuric acid. The latter is the most immediately effective, both as a topdressing for grass and when used for turnips; and this is accounted for by the fact that the different small particles of the bones are more finely separated when the dissolving takes place; in this way the manure is more efficiently spread over the soil, and gets better about the roots of the plants than several large pieces of bones will do. There is no doubt, also, but that the sulphur in the acid has a beneficial effect, since agricultural chemistry tells us that sulphur is necessary in a small degree to the growth of plants. Dissolved bones are often got in an adulterated state; when a farmer is not certain about getting them pure, he should prepare them himself. The following description as to the way in which they are prepared is taken from Johnston's 'Elements of Agricultural Chemistry and Geology,' eighth edition, page 216:—

For the purpose of bringing bones into a state in which the substances they contain can be more readily taken up by the roots of plants, and at the same time more uniformly distributed through the soil, the method has been adopted of dissolving them in sulphuric acid. For this purpose, the bone-dust is mixed with one-half its weight, and sometimes with its own weight, of sulphuric acid (the oil of vitriol of the shops), previously diluted with from one to three times its bulk of water. Considerable effervescence takes place at first, from the action of the acid upon the carbonate of lime in the bones; but after two or three days, with occasional stirring, the bones are entirely dissolved or reduced. The solution or paste may now be dried up with charcoal powder, with dried or charred peat, with sawdust, or with fine vegetable soil, and applied with the hand or with the drill to the turnip crop; or it may be diluted with fifty times its bulk of water, and let off into the drills with a water-cart.

A simple mode of preparing crushed bones for immediate use is to mix them with dry peat-mould, and occasionally water the heap with liquid manure. Fermentation soon sets in, and the bones become dissolved. A quantity of salt mixed through the heap is of much use.

Nightsoil is a very strong and useful manure. It is one of the chief manuring substances used by the Chinese, who have taught us many useful lessons in cultivation. It has never been properly used in this country, most probably on account of the difficulty of its application and its smell. The best way to obviate this is to mix it with dried earth or peat, when it can be easily applied to the land. In Paris it is mixed with lime and allowed to dry in the open air, and then put into large stoves to dry still further, and is then sent throughout the country under the name of *poudrette*. It is said to be a very powerful manure in this state.

In China it is extensively used as a manure. It is mixed with clay and made into cakes, which are allowed to dry in the air, and are then sold under the name of *taffo*.

The fertilising nature of sewerage is shown in the case of the meadows in the neighbourhood of Edinburgh, and there is no doubt but that it is the nightsoil which gives the sewerage this character. The waste in this manure is enormous when we consider the amount which is conveyed away from water-closets into streams and rivers, where, instead of its being a benefit to mankind, it becomes a source of disease and general unhealthiness. The amount of capital spent each year in this country alone in guanoes is something wonderful, and yet in this substance we have a manure which has a greater amount of fertilising ingredients than guano, but which we allow in a great measure to go to waste.

A very good plan for the profitable working of nightsoil has been patented by the Rev. Henry Moule, Fordington Vicarage, Devon, and manufactured by the Messrs White & Co., 29 Bedford Street, Strand, W.C., London. It consists in applying dry earth to closets or commodes. It is thus described :—

> At the back of the usual seat and above it is placed a box or reservoir for the purpose of containing the dry earth. In the lower part of this is placed the machinery for measuring and delivering the quantity of earth for each time of using. Under the seat is a pan, and below the pan is placed a movable pail ; by lifting a handle, earth falls into the pail and covers the deposit, completely preventing all smell. The pail, as often as may be necessary, must be emptied, and the contents may be applied at once to the garden, or may be mixed either in the machine afterwards described or by spade, the process in either case giving no offence, and the earth when dry being again fit for use.

These earth-commodes cost £1 each, but with a case complete, £3.

Section 4.—*Road-Scrapings, Cleanings of Ditches, Mud from Ponds.*

The cleanings from roads and ditches, when collected together, make a good manure when they are formed into heaps and mixed with lime ; but it is necessary to mix a large proportion of lime with it, as there is usually a large number of weeds collected both with the road-scrapings and from ditches—and the seeds of weeds will also form a part of the mixture. The lime will act beneficially in destroying and decomposing both seeds and weeds.

The cleanings of both roads and ditches are very often thrown into ridges on both sides of the road and about the roots of hedges. In the former case, it has a very untidy appearance, and prevents water from getting freely off the road; and in the latter, it is hurtful to the hedges by encouraging the growth of weeds about them. Every particle of the cleanings of both roads and ditches should be carefully carted to a heap and mixed with lime and any other matter likely to make manure. I have made these compost-heaps by first placing a layer of cleanings in the bottom about eighteen inches deep, then a layer of lime about two inches, then cleanings and lime alternately to the top. Any other vegetable matter might be added to the heap with benefit; but guano should never be mixed where there is lime, as I have sometimes known it done, as lime always destroys the effect of the guano. I have used this kind of compost with a good result as a topdressing to permanent grass.

Mud from ponds is another very fertilising manure. It is the sediment which falls to the bottom, and is composed of earthy matter washed into the pond by rains. It is mixed up with leaves of trees, decayed water-plants, and many other collections of vegetable and animal matters. All ponds should be cleaned out from time to time, and the cleanings taken from them will more than pay for the trouble of doing so. The mud should be formed into a heap and mixed with lime. There is nearly always sure to be a number of seeds of different plants in the mud. These seeds will lie for years in a dormant state unless some means be taken to destroy them. If they are mixed in the proportion of one part lime to two parts of the mud, and turned over from time to time, they will die. If the mud be added to a compost-heap of road-scrapings and other matter, it will be better adapted for land than by itself even when mixed with lime. Salt is also a useful addition to all composts of this kind. The quantity must be regulated according to the extent of land the compost is calculated to cover, or say five cwt. to the acre.

SECTION 5.—*Liquid Manures and the Sewerage of Towns.*

I have already alluded to the liquid manure of the cattle lodged in the farm-steading. The urine of animals has a high chemical value as a manure, and surpasses that of the solid excrements. It, however, soon loses a great amount of its nutritive qualities if exposed to the air for some time, hence the reason for having it conveyed in covered drains to a covered tank, and there kept close until it is required for the land. It is a good plan to have dry peat or sawdust spread under cows and other cattle tied up in the houses, for the purpose of absorbing the liquid manure. One winter, while farming in Inverness-shire, I kept a herd of forty-six cattle tied up in houses. Fodder being scarce at the time, I determined upon feeding the stock with straw, by chopping it and steaming it in large boilers. We did not use any straw for manure, but had quantities of sawdust carted from the neighbouring saw-mills and spread under the cattle. I did this at the time without thinking of any benefit I might receive from the collection of the liquid manure, but purely with the view of economy in straw as bedding. The sawdust absorbed all the liquid, and it was applied as a topdressing to young clover. Part of the clover-field was not topdressed, and the difference was very apparent. In the neighbourhood of large towns it is sometimes the practice for market-gardeners and nurserymen to place large tanks, with spouts attached to them, to catch the urine of the workmen in the large manufacturing firms. The urine of the cow is also very valuable, for if we take 100 lb. of it, we find the following:—

	lb.
Water,	65
Phosphate of lime,	5
Urea,	5
Ammonia,	4
Muriate of potash,	12
Sal-ammonia,	4
Carbonate of potash,	5
	100

It is known that the fluid excrement from a cow in one year is a good manuring for an acre and a half per annum, and that the solid excrement for the same time will only manure one acre; it is therefore of the highest importance that farmers should take all care to preserve the liquid manure of the farm.

The great question of the day is, " How is the sewerage of towns to be conveyed into the country for the application of land?" There is no doubt but that it is a great and fertilising agent when applied to soils suitable for its reception; we have the instance of this in the meadows near Edinburgh, where land which was once worth comparatively little is now worth from £30 to £35 per acre annually. In the mean time it is only available to land in the immediate neighbourhood of towns; but a great extent of the light waste lands and along the coast might be made very valuable by the application of sewerage. There is a great value in town sewerage—it is worth a large sum of money per annum—and the only difficulty is in its application to the soil; and ere long every particle of this manure will be valued and utilised. Manure we must have to increase our crops, for it is well known in these days that we reap not as we sow, but as we manure for our farms; and therefore the excrements of every person and animal should be utilised and applied to the soil, not only from large towns, but from every farmsteading, house, and cottage in the land. Before we send to other countries for manures at a great expense—namely, guano—we should first use up and apply all the available manure we have in our own country. I conceive it might be possible to have it altered into such a form as would make it easily conveyed to farmers any distance, and yet contain all its fertilising qualities. This may be done,

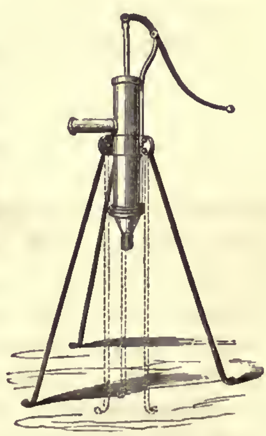
1st, By collecting all the sewerage, liquid and solid, into one or more large tanks.

2d, By causing the water or liquid portion of the sewerage to decompose in such a manner, or by applying some chemical processes to it, as will separate all the weak watery substance from it, leaving only the fertilising matter in a liquid state.

3d, Or by mixing the sewerage with substances which will absorb all the liquid portions of the manure, and by mixing this also with the solid parts, to have it then made into cake or powder, to be then conveyed to any part of the country.

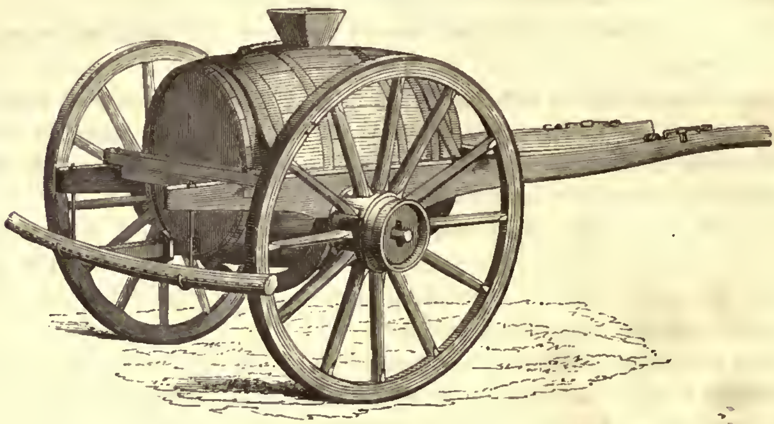
For the proper collecting and keeping of liquid manures from a farmsteading, a large tank should be formed at a little lower level than the dungyard, so as to catch all the liquid likely to come from all the buildings and yards. All the buildings should be spouted, to throw the water away from the manure. The tank should be built in the earth, of stone or brick, and should be well puddled with clay behind the walls, to prevent any escape of the liquid; or if the lime-mortar is mixed with a small quantity of cement, it will answer the purpose as well. The tank should be closely covered over. It is a good plan to arch them over with brick or stone, leaving an opening to admit of its being cleaned out from time to time. This opening should receive a close-fitting doorway. The liquid from the different yards and buildings should be conveyed in drains, with gratings to admit of the liquid entering the drains. The tank should be large enough to hold two or three months' liquid. If the liquid is very strong, it should be mixed with a proportion of water, and never applied in hot sunny weather. In removing the liquid from the tank, it should be raised into a liquid-manure cart (see fig. 9) by a pump, such as fig. 8.

Fig. 8.



This is a portable pump; the legs fold up and stand in the position shown by the dotted lines. The cost is from £2, 10s. to £3 each. It requires a short length of gutta-percha hose to attach to the lower end of it and to reach down into the tank. The hose will cost about 2s. per running foot for a size of one and a half inch diameter. This kind of pump will also be found to be very useful in removing water from excavations, &c. Fig. 9 is a very useful form of liquid-manure cart. It is a

Fig. 9.



form which can be made by any country carpenter. Liquid manure is also distributed over the fields by a system of underground iron pipes, through which the liquid is sent by means of the steam-engine and force-pump, or by simple gravitation if the tank is situated at a higher level than the fields to which the liquid is to be applied. The cost by the first plan is about £6 an acre; and by the gravitation principle about £4, including cost of tanks, &c.

Section 6.—*Peat as a Manure.*

Peat is an accumulation of vegetable matter, and therefore should possess many good manuring qualities; and there is no doubt but that it is well suited for some soils. It is well known that where peaty soils have been thoroughly drained and mixed with other soils of a mineral nature—such as gravel, lime, and clay—they have turned out good grain-growing soils. Such, therefore, being the case, why cannot we use peat as a profitable mixture with gravelly or clayey soils? I have tried with great advantage the following plan of using peat as a manure: We collect a quantity of peat and lay it in a heap any length or breadth that may be required, and about two feet deep; we then put on this a layer of common soil about six or eight inches deep, then a layer of farmyard manure about a foot thick, putting along with such layer a quantity of lime; another layer of peat is put over the farmyard manure, and finished at the top with a covering of earth, and have from time to time a quantity of liquid manure thrown over the heap. This, after standing for two or three months, with the frequent application of liquid manure, makes a first-rate topdressing for grass-land or for turnips. I have used dry peat with great benefit in the north of Scotland, by having it carted into the foldyard of the steading, and there allowed to lie to absorb the liquid manure. Charred peat has also been used, and must be recommended as a manuring agency; but it does not act so well as dried peat mixed with other substances.

SECTION 7.—*Soot as a Manure.*

Soot is a highly useful manure, especially as a topdressing for grass-land and grain crops. It is usually applied at the rate of from twenty up to fifty bushels per acre. It is said that there are nearly four hundred thousand houses in London, which produce one million one hundred thousand eight hundred and ten bushels of soot in each year. The average price of soot in London is 5d. per bushel; this would give the annual value of the London soot at £20,833, 6s. 8d. Soot contains, amongst other substances, the following in every 1000 lb.:—

	lb.
Sal-ammonia,	20
Sulphate of ammonia,	80
Gypsum,	247
Moisture,	237

At the same time, as it is derived from materials of variable composition, this analysis can only be regarded as giving a general idea of its nature. It is also usually mixed with rubbish by the dealers in it. I have used it with great effect as a topdressing to grass. Its value is increased when mixed with salt, but it should never be mixed with lime.

SECTION 8.—*Guanoes.*

Guano is the dung of sea-birds found on rocks situated chiefly on the west coast of South America. The birds have congregated together from age to age, until the droppings from them have accumulated to a great depth. The dung of all birds is highly valuable as a manure, and it improves by being kept for some time in the form of compost. In those parts where guano is found it is mixed up with bones of dead birds and feathers. It is imported into this country at prices averaging from £10 to £13 per ton. The effect of guano on all kinds of crops is very striking, and it must be so from its ingredients, as it contains much of the chief elements wanted in the soil for the food of plants, as will be seen by the following analysis of Peruvian guano:—

Water,	13.09
Organic matter containing ammonia,	53.17
Common salt and sulphate of soda,	4.63
Carbonate of lime,	4.18
Phosphate of lime and magnesia,	23.54
Silicious matter, or sand,	1.39
	100.00

This is, of course, pure guano; but for many years past farmers have been frequently imposed upon by manure-dealers. They receive certain stuffs called guano, but which are really collections of spurious articles. Sometimes, however, inferior guano is shipped from the guano-beds into this country by respectable dealers without their being aware at the time of the fact. The surface of the guano-bed contains a large quantity of sand, and this must be removed to get at the genuine article; and even where there is no sand, the surface is always inferior to the underlying portion, as it is exposed and deteriorated by the influence of the weather. It is a great advantage to deal with respectable merchants in the trade, as such men usually take care to have the article properly analysed before offering it for sale. However, from the present demand which there is for guano, there is always an inducement with unprincipled dealers to palm an inferior article on the farmer; and it therefore remains with all those who purchase guano, or indeed any artificial manure, to be certain it is good before purchasing, which can be got by having a written guarantee that it is good and up to an analysis given; and with a little attention to samples of really good guano, any one may come to know a good article on examination. Artificial guanoes and adulterated guano are mixed with gypsum, peat, coal-ashes, burnt earth to give them a light colour, and common salt; umber is also used extensively in adulterating guano. I have generally been able to test guano in this way: Put it into a glass with water, and stir it up and break any small lumps which may be in it, and then allow the muddy water to run off, when, if the article is good, there should not be any sand or small stones in the bottom, at least these ought to be in a very small proportion. If it has not the *genuine smell* on first seeing it, if good it will show it sufficiently when mixed with common lime. The article should be dry—it is a very common practice to water it to increase the weight—and it also ought to be of a light-brown colour.

In applying guano to the soil, great consideration must be had as to the state of the atmosphere. Guano should always be applied to the soil in rainy weather, or at least there ought to be a large amount of moisture present; and unless this be the case it will not succeed so well as it should do. If put on in dry weather, and a few days of the same weather continue afterwards, the greater part of the fertilising elements of the manure will escape and be lost; but if put on in moist or wet weather, the rain will wash the guano into the soil, and the roots of the plants will get the benefit of it.

In regard to the quantity to be applied to the land, this varies, or rather should vary, with the kind of soil to be dealt with. This is a point not usually attended to by agriculturists, but is nevertheless one of considerable importance, for different soils really require different treatment in applying guano to them. The particles of heavy soils—such as the clays and loams—are firmer, and their power of absorption is greater. They are not porous soils, and therefore this enables them to retain for a greater length of time any manure which is applied to them; and they prevent the action of the sun, or any atmospheric influence, from extracting the fertilising elements of the manures.

On the other hand, light soils—such as the gravels, chalks, and sands—are acted on very freely by the atmosphere; and in consequence of their texture being more open than the heavy soils, the atmosphere has a considerable influence to a greater depth in the soil; therefore, when manures are applied to them, they are decomposed very quick, and the crops only get a portion of what is put into the soil. Hence the reason I state that different soils require different treatment in the application of manure to them. Heavy soils may receive a liberal application of manure at one time for the reason formerly stated, but light soils should receive a smaller quantity at once, but the quantity should be repeated more frequently.

It is also of importance to apply guano properly to the soil—I mean in the mode of applying it. In doing this where the crops are drilled in, I prefer sowing half the quantity to be applied broadcast, and immediately before the seed is drilled in, and the other half along with the seed. Have a quantity of the manure close to them to start them in their growth, and when they spread their roots through the soil they must meet with the guano sown broadcast. In preparing guano for sowing with a drill, I have usually mixed it with a quantity of very fine dry earth or ashes; this enables it to be more equally divided over the ground than if it were sown by itself. The quantity per acre is so small that there is only a very minute quantity indeed to the square foot. If three cwt. are applied to the imperial acre, there is only about $1\frac{3}{4}$th drachms to each square foot of surface. Both the earth and ashes should be reduced to a very fine powder before being applied, and it is better to allow it to lie for a few days before using it. Whatever description of drill may be used for the purpose, there should always be from three-fourths to one inch of soil between the seed and the guano, the latter lying below the former. If both lie together in the soil, the probability is that the one will destroy the other.

I have used phospho-guano, for which Messrs Lawson & Son are the contractors in England and Scotland, for some years with very marked success, and especially as a topdressing for permanent grass. A field of this description which I have, had formerly been annually manured with farmyard manure, applied at the rate of about ten cartloads per acre, and the autumn crops of hay were from one and a quarter to one and a half tons. When I got possession of it I applied about the same quantity of farmyard manure per acre, and in addition two and a half cwt. of phospho-guano. The annual return of hay has since been about three tons per acre. The farmyard manure is usually put on to the land in December, and spread as equally as possible over the surface, and allowed to lie undisturbed until the middle of March, when it is then *bush-harrowed* — that is, with a harrow made of thorn branches. After this it is gone over with a chain-harrow, and then all loose straw, stones, and other foreign matters are collected and removed. It is then rolled over so as to compress and level the surface. The guano is then sown broadcast in the beginning of April, or if the season be anything cold and backward, I delay doing it for a few weeks longer. I always choose a wet day for sowing it—indeed, for the last three seasons it has been sown when it was pouring of rain. I have applied it with equal efficacy to wheat, oats, turnips, mangold-wurzel, beans, and potatoes.

There can be no doubt but that many of our farmers, especially in the north of England, would benefit greatly by a more general use of guano. Previous to 1860 very few of the farmers in this district used any guano — indeed, they seemed to have an idea that it was useless as a manure, and that it was a *quack affair* made up to rob their pockets. Some of my elder tenant-friends had, and indeed have yet, a very low estimate of the value of guano as a manure; they cannot conceive how such a small quantity can be sufficient manure for an acre. They say, "There is nought like management." "Management," in Yorkshire, means farmyard manure. This is like the old story of a Scotch laird who, when chemical fertilisers were first talked of, went to one of his tenants and told him that a new manure had come to the country, and it was so strong that the contents of a coat-pocket were sufficient to manure an acre of land. "May be that," said his old friend, "but I doubt your waistcoat-pocket will hold the crop."

Many intelligent farmers affirm that an application of about two cwt. per acre gives an average increase of about one quarter of grain per acre. Several farmers prefer giving their wheat crops an application of guano in the autumn; but when this is done it should only be a small quantity, as it is not judicious to force the crop too much at that time, on account of its suffering from frost.

I prefer giving only a small quantity in the autumn for the reason stated—one to one and a half cwt. being sufficient; and in the spring I apply about two cwt. per acre, and this on a wet day; and after the soil is somewhat dry, I then harrow it with very light harrows, or a good rough bush-harrow. Several farmers have told me that they cannot use guano on their soils, as it makes the straw too strong, and then it lies down before ripening. When this is the case, an addition of about three cwt. of salt to the acre will be found very beneficial, as salt has the property of strengthening the straw to a great degree.

The following is a table which I have drawn up, showing the kind of crops and soils, and the quantity of guano which I have sown with advantage to each, with the quantity of salt to strengthen the straw, and the time of applying it:—

TABLE showing the Quantity of GUANO applied to the different kinds of Crops and Soils, with the best Season for its Application, &c.

Kind of Crop.	Kind of Soil.	Quantity of Guano per Imperial Acre.	Quantity of Salt per Imper. Acre.	Season to apply the Manure.	Cost of Guano.	Cost of Salt.	Total Cost per Acre.	Manner of sowing Manure.
					£ s. d.	£ s. d.	£ s. d.	
Wheat . .	Heavy	3 cwt.	3 cwt.	1 cwt. guano in autumn 2 do. do. in spring Salt in spring	1 16 0	0 7 6	2 3 6	First, with drill Second, broadcast
Oats . . .	Light	2 do.	3 do.	At time of sowing	1 4 0	0 7 6	1 11 6	Broadcast
Barley . .	do.	2 do.	3 do.	do.	1 4 0	0 7 6	1 11 6	do.
Turnips . .	do.	4 do.	None	2 cwt. sown broadcast 2 do. drilled with seed	2 8 0	...	2 8 0	2 cwt. broadcast do. drilled with seed
Mangold-wurzel	Medium	4 cwt., with 10 loads of dung	$3\frac{1}{2}$ cwt.	Previous to sowing	2 8 0	0 8 9	2 16 9	Mixed with the soil before sowing by hand
Grass . . .	do.	$2\frac{1}{2}$ cwt.	None.	April	1 10 0	...	1 10 0	Broadcast
Potatoes . .	do.	2 do.	do.	After planting	1 16 0	...	1 16 0	do.
Field cabbage	do.	2 do.	do.	Before planting	1 4 0	...	1 4 0	Mixed with soil
Peas and tares	do.	2 do.	do.	April	1 4 0	...	1 4 0	
Beans . . .	do.	2 do.	do.	do.	1 4 0	...	1 4 0	
Clover . .	do.	2 do.	do.	do.	1 4 0	...	1 4 0	
Lucerne . .	do.	2 do.	do.	do.	1 4 0	...	1 4 0	

On referring to the foregoing table, it may be thought very expensive to use the quantities of manure stated, but the greater number of our best farmers use much more. It is affirmed by many farmers that an expenditure of £1 per acre in guano will give an increase of £2, 5s. per acre, or a net profit of 25s.; but it must be kept in view that guano should always be applied in wet weather—if not, I maintain that it is useless applying it. Many farmers do not use much of it, because they say it only does for one season, and that it does not remain in the soil. I believe that a portion of it does remain in the soil, especially after a turnip crop; but I think it much the better plan only to apply it in such quantities as will answer the purpose for one year, and to put it on in such a way as will give one crop only the full benefit of it, and apply similar quantities each year to the turnip crop as it comes in rotation. It is not wisdom to apply guanoes to the same land each year in succession without the application of other manures, especially Peruvian guano. Peruvian guano is an ammoniacal manure, and is deficient of phosphate, and therefore repeated manuring with Peruvian guano, without the addition of a phosphatic manure, has not been found to act beneficially; so that, in my recommendation of applying guanoes to crops each year, it must be understood that other manures containing phosphate are applied along with the guanoes, or that the different manures are applied in rotation.

Guano is also very beneficially applied to grasses in a liquid form. It would improve the pasture of many of the home parks of gentlemen's estates if they received a topdressing of guano in a liquid state. For this purpose it must be beat down finely, and then mixed with water in the proportion of one cwt. of guano to five hundred gallons of water, and applied with a liquid-manure cart.

Both superphosphate and guano have been used in a liquid state in growing root crops with greater success than the dry manure. Mr Pusey records, in the 'Journal of the Royal Agricultural Society,' certain experiments he made in order to test the merits of the "water-drill" as compared with the "dry-drill;" the results as regards a crop of turnips being exactly 100 per cent in favour of the water-drill. Drilling-machines for the express purpose of applying artificial manures in a liquid state are manufactured by different implement-makers, and there is every reason to believe, from experiments reported, that the use of the water-drill in dry seasons would frequently prove the cause of the difference between a crop and a total failure.

SECTION 9.—*Common Salt as a Manure.*

A certain quantity of salt is very necessary in most soils for the nourishment of all the crops we cultivate on a farm. Arable lands along our coasts frequently get a sufficiency of this manure from the strong winds blowing off the sea inland. Salt has a very beneficial influence in improving grass-land when applied as a topdressing. I have used it with great success along with a topdressing of lime. Cattle eat the grasses more sweetly where they have been topdressed with salt. I have already stated that salt has a remarkable property of strengthening the straw of cereals. Upon a large farm in Forfarshire I used to apply upwards of twenty tons annually to it, although part of the lands was liable to be submerged by the tide. Salt destroys small weeds, especially mosses, in a grass-field. It is essential in growing mangold-wurzel, as that plant contains a large proportion of salt in the roots and the leaves.

SECTION 10.—*Lime.*

All our stiff clay soils, old pasture-land, peat soils, and all soils containing a quantity of vegetable matter, require a regular manuring of lime, and are much benefited by it. It is also of great utility on soils resting on the granitic formation. Some soils may not require lime; these can easily be known by a very simple test given to us by Dr Voelcker, who states: "Put a small quantity of soil in a tumbler, and pour upon it first a little water, and then a good deal of spirits of salts or muriatic acid. If this addition produce a strong effervescence, there is no need of applying lime to the land; if no effervescence is produced, in all probability liming or marling will be useful."

The quantity of lime required per acre depends very much on the kind of soil, and upon the kind of crops which is to follow it. Wet soils take a larger quantity than those that are dry or have been drained. In reclaiming waste lands, it is always beneficial to apply a heavy dose at first, especially if there is much vegetable matter in the soil. Land which is in regular cropping should receive stated quantities at regular intervals, and it is necessary to do this at least once in a rotation.

Lime should always be applied to the surface of the soil, as it has a natural tendency to sink down. Rains wash it into the soil and gradually carry it into the subsoil. If the land is wet in the subsoil, the lime is then dissolved and carried away into the substrata; hence the reason that drained land requires less lime than undrained and wet land.

The quantity of lime applied to the soil varies in different parts of the country. In the county of Durham and north Yorkshire, it is generally calculated that from three to four bushels per acre are sufficient; this is applied once in each rotation—that is, four years—and is put on the fallow land. In the county of Stirling the farmers apply ten bushels once in each rotation—that is, once in every five or six years—and to the fallow land or old grass. In the county of Ayr eight bushels are applied once in every five years to the fallow land or old grass. This refers to medium soils. Very stiff soils and peat receive larger doses.

The effect produced by lime upon our lands is very marked. When applied to pasture-land, the grasses become finer and sweeter. The greater portion of the old grass-land in England would be much improved by large applications of lime to them, and all our hill-pasture would be greatly benefited by a topdressing of lime. On arable lands the application of lime is followed by more productive and a finer quality of crops. But lime requires to be followed up by the liberal application of manure, otherwise its use will be injurious rather than beneficial.

CHAPTER XI.

VALUE OF LAND.

Section 1.—*The present Rents of Farms.*

For a number of years past, farms that have come into the market to let have in most cases brought considerably higher rents than they were let at previously, even after taking into account the money the proprietor had laid out on them to improve them for the better accommodation of the new tenant; and consequent on this the question is very frequently discussed among farmers, *Are farms not too high rented now?* My answer is, farmers whose means and ideas confine them to the old beaten track will certainly find many farms now too high rented for them to live on with comfort; but those whose means are enlarged, and who cultivate their land on enlightened principles, find them generally still rented as to enable them to realise fair profits from their business. The proof of this is frequently brought under our notice in various ways; for example, we often find a farm that has been in the hands of an antiquated tenant—on which he could scarcely manage to make income meet expenditure, and which he left from the terror of the advance of rent which was put on it—when occupied by a new and enterprising tenant who brought money and superior skill to bear on it, turn out in his hands a highly profitable subject. It is generally men of the old school who grumble as to their farms being too high rented, and seldom those of the new one. Those who act on the principles taught by the latter, when they do complain of their farms not paying them, their complaint is not that it is the fault of the farm, but that they are short of capital to make it more profitable. When I hear farmers complain of their farms being too high rented to enable them to make a comfortable living from them, I invariably suspect that there is something awanting in regard to their case—namely, that either they are deficient in the necessary skill to enable them to be profitable farmers, or that they are not in possession of the necessary capital for this. But it is rare to hear a farmer grumble who is possessed of good skill and of fair capital for his subject—simply because he knows how to turn his money to good account in the working of his land and in dealing with his live stock. So long, however, as there are farmers of the old school in the occupancy of land, they will continue to complain of high rents, simply because they are too confirmed in their old prejudices in regard to farming to admit of their easily throwing them aside and taking up new modes of action. The cry about too high rents does not now prevail nearly so much as it did among farmers, the younger, the more intelligent, and the moneyed part of them setting such examples as shut the mouths of those who would still call out; for they are, generally speaking, obliged to confess that there is more truth in the principles of the new school than they were at first willing to believe. Facts in all cases speak for themselves, and a first-rate crop, grown on a farm previously considered unfit for this, is not a thing to be hidden from any one living in its neighbourhood. A man of capital and skill takes a farm in a district in which he has many old-fashioned neighbours; he sets to work, and drains and manures his land on a more extended scale than is adopted by them, and the results of his new modes of dealing with his land are soon visible in the crops he grows, and the larger numbers, as well as the superior character, of the live stock he maintains on his farm. This improved state of things is not to be denied, and the neighbouring farmers begin to have faith in modern agriculture; and now one tries it, and then another, and all who do try are benefited by their attempts—of course in degree according to the extent of the work performed. In this way one or two good farmers in a neighbourhood soon banish grumblers from it, as they are shown in the most plain and practical way that their complaints are groundless, and that the fault is their own if they cannot make their subjects pay as well as the other does; and so they gradually complain less and farm better.

Having made the foregoing explanatory remarks in regard to my views on the subject, I now come to give a direct answer to the question standing at the head of the chapter, and it is this: Taking the qualifications and abilities of many inferior farmers into account, their subjects may be said to be *too high rented for them;* but judging all farms I have examined by the capabilities of the land, I do not know of any one which can be said to be too high rented, as, in the worst paying cases of farming that have ever come under my notice, the fault could not be attributed so much to the land as to the want of ability in the tenants to deal profitably with it.

Section 2.—*Landed Property will increase in Value and Rents accordingly.*

That land must continue to rise in value in this country is, I think, without a doubt, and that for several reasons, to the principal of which I shall only refer—namely, *the limited extent of our island, taken in conjunction with its increase in population and wealth.* This is one of the strongest points in proof; for with the increase in population and wealth there will of course be a corresponding demand for land and its produce, while it is clear that no increase can take place in the extent of our country. Looking at the extent of our island, it is but a small patrimony for such a people as we are even at the present time; and gradually as we become more numerous, it must become, as it were, still more limited for us, and every available foot of soil must become more and more precious. Altogether, our island is not much larger than one of the many valleys in America. That of the Ottawa, in Canada, for example, embraces about eighty thousand square miles, while England and Scotland together contain only about ninety thousand square miles. Even in a new and thinly-peopled country such as Canada, where there is a vast extent of available territory yet unexplored, land is rapidly rising in value; as in most settled parts that which only a few years ago could have been got for a few shillings per acre now costs as many pounds, and in not a few cases land has even risen to as high a price as it is in this country. Now, looking at these facts in connection with the industry of a comparatively poor people like those who inhabit Canada, and who have a boundless territory of excellent land in a good climate to lay hold on for use as it may be found necessary, and applying them to our own position as one of the most industrious and wealthy people in the world, having only a limited extent of land to use, some of it not favourably situated in regard to climate, and all long ago taken up for use in one way or another, what conclusion can we come to other than that the land must continue to rise in value? This is a matter demanding the most serious consideration of all who are interested in the welfare of the landed property of this country; for unless decided steps are taken, not only to improve our system of agriculture, whereby a much greater amount of produce may be obtained from our limited surface, but also to bring into use a greater breadth of arable lands for improvement from those which are still lying waste and comparatively unproductive, we must become more and more dependent on foreign supplies, which is not desirable. Looking at the steady increase of our population, independent of the heavy drain upon it by emigration to other countries, and keeping in view the very great trade and business—also on the increase—carried on in this country, and the general accumulation of wealth in consequence, it may be safely stated that, with our small and limited extent of land, its value must rise in a proportionable degree. Indeed it is my own opinion, after a careful consideration as to the bearing which the limited extent of the country has upon the value of its land, that ere long estates will be worth more than double the money they can now be purchased at.

I am aware that there is a large class of society, among which are many farmers, who hold the opinion that whatever prices wealthy people may choose to give for land, a much higher rent than is now paid for it cannot be given by those who cultivate it. This is a mistaken opinion, however, and refuted by our everyday experience; for we see almost every farm which falls to be let anew brings its proprietor a much higher rent than it did before; and this must, in the common course of things, continue to go on from time to time as farms fall to be relet. When a farm comes into the market to be relet, if it is at all a good one, there are many applications for it, while of course only one party can get it; and from this circumstance much higher rents are often obtained for farms than their proprietors, in their most sanguine views, expected to realise. This indicates, then, that there is a steady and increasing demand for farms, even at higher rents, and that, generally speaking, there is a wealthier class of men looking out for them than occupied them formerly; for in most cases we find the new tenants of farms more skilful and wealthy than those who left them, and therefore better able to cultivate them profitably than the old tenants were, and consequently are better enabled to give the advanced rents than the old tenants were to give the former rents. If, then, this is the prevailing state of things in regard to the rents of farms in the mean time—and every one at all acquainted with the subject knows that it is—it is but reasonable to conclude that in the future also, as farms fall out of lease, a similar proportionate increase of rent will be obtained. We have no reason to hold any other view in regard to the future of farming, than that rents of land must necessarily increase with the progress of our wealth and population. Were these to remain stationary, then, but not till then, it would be reasonable to expect the value of land to remain stationary also. But we have no reason to suppose that such a state of things is likely to obtain with us, at least for many years to come. In the face of this, then, it may be asked, How are farmers to realise profits from their business, if rents are to go on increasing without any limit as farms fall out of lease? The answer is clear. The resources of the land are not fully brought out, and can be made much more productive. Its productive capabilities are as yet lying dormant under our feet, while we go about scratching it on the surface, supposing that all its fertility lies there. We are now, however, beginning to know a little more of the constitution of the soil than we did, or than our fathers knew, and we also begin to understand how our land can be made more fertile; and if we in one generation have made some advance on the knowledge which our forefathers brought to bear on the land, what is to be expected in future generations? Our forefathers, with their knowledge and system of agriculture, made out to pay their rents, and in their day entertained the opinion that the land was high enough rented. We in our day, with our better system of agriculture, pay much higher rents than they did, and we admit that even still higher rents may be paid under a further improved system. We think and act in regard to land according to the condition in which we find it, and improve it according to the best of our knowledge, giving higher and higher rents for it. The next generation will also deal with it as they find it, and will make improvements on our modes, and from these be able to raise more produce to pay higher rents in proportion; and so on, one generation improving upon the modes of the other, till without doubt, some time hence, one acre will produce more crop than we can make two or even three produce now. Then, I have no doubt, much of our hill-lands, which are at present comparatively of little value, will be so dealt with as to produce more valuable crops than our best low-lying and cultivated lands yield at present. This to many may seem utopian; but for my own part I have great confidence in what can be achieved by the intellect of man, with science and wealth at command. What seemed impossible less than a hundred years ago, is now performed every day, and thought nothing of; and what now seems impossible to many, will be found a thing of common occurrence less than a hundred years hence.

CHAPTER XII.

COLLECTION OF RENTS.

Each estate has generally its own fixed time for the payment of the rents. In England it is usual for a tenant to pay his first moiety six months after his entry, and at the end of his first year's tenancy he pays a second moiety: this is where a tenant takes possession of a farm at Lady-Day. On some estates in Scotland the tenant takes possession of the arable land at the November term, and to the grass-land and buildings in six months afterwards—namely, at the May term: in this case the farmer pays his first half-year's rent at the May term, and the remainder in the November following. Again, on a great many estates in Scotland we find that where the tenants enter as already stated, they do not pay their first half-year's rent till the November following, when they have had the farm in possession one year, and have had the advantage of reaping their first crop from it. Each system has its advantages. Where the first half-year's rent is due six months after entry, it requires a tenant to have capital at command to meet it; on the other hand, where the first half-year's rent is not due till the tenant has had a crop reaped and time to thrash it, he does not require to have money to meet the rent when he takes the farm, as he can generally meet it from the proceeds of his harvest. There is no doubt that there is greater competition for farms which are let on the condition that the first half-year's rent is not due till the full year is out, because, as I have already stated, a farmer can take such a farm with less capital than he could where the first half-year's rent is due at the end of the first six months.

When the rents are paid, receipts should always be given. It is a practice on many estates not to give receipts to the tenants, and I have often known mistakes and misunderstandings caused by this very unbusiness-like practice. The following is a form of receipt which I have used :—

Received, *the*..................*day of*............................18..........,
of Mr.. *the Sum of*
....
on account of Rent due at.. *last*
to..
£...........................

The following is also a copy of rent-roll :—

RENT-ROLL.

Name of Tenant.	Description of Occupation.	Annual Rent.			Arrears from last Account.			Rent now due.			Amount received.			Arrears to next Account.			Remarks.
		£	s.	d.	£	s.	d	£	s.	d.	£	s.	d.	£	s.	d.	

The receiving of the rents of a landed estate is a simple matter; but in all cases, and more especially on large properties, some regular method should be adopted in this as in all other things. On many estates, besides the farm-rents, there are the rents of cottages, mines, tithe-compositions, &c. It is of great consequence to have fixed days for receiving the rents; and yet some judgment should be exercised in this, as the rent should be called for at such a time as will enable the farmer to pay without having recourse to selling his produce at a disadvantage. The time to be fixed for any particular estate must depend upon local circumstances; the markets and fairs in the district should be taken into consideration, so as to give the tenants every advantage of selling their produce before the rent-day.

There are several points of law relating to rents which are useful to know.

A farmer or other tenant is not liable to pay rent for any land or premises until he has received possession of the same.

Rent cannot be distrained for until the landlord or his agent demands it on the tenant's premises, and this cannot be legally done until after midnight of the day on which the rent is due according to the agreement.

If the landlord owes money to a tenant, such money cannot be made a set-off against the rent. The rent must first be paid, and then the tenant may demand his due; and even where a landlord owes a tenant for an account, and the tenant refuses to pay his rent until his account is paid, this does not prevent the landlord from distraining, unless it is expressly stated in the agreement. But the tenant's claims should be set against the rent, as I have known cases with small tenants where they could not pay the rent until the money due to them by the landlord had been paid.

"In cases of bankruptcy the landlord may lawfully distrain, though the tenant become bankrupt immediately afterwards. And he may distrain after the bankruptcy if the tenant's goods remain on the premises; and this though the bankruptcy officer be in actual possession of the goods. But a landlord has no lien, in case of bankruptcy, after the goods are removed from the premises; therefore, if he neglect to distrain, and the goods are sold by the assignees, and removed from the premises, he must come in and share with the rest of the creditors." *

As a rule, it is generally decided that all goods found upon the premises can be distrained for rent, whether they may belong to a stranger or not.

The following is a summary of the Hypothec Amendment Act, reg-

* 'Every Man his own Lawyer.'

ulating the relationship between landlord and tenant in Scotland, as regards the power of distraint:—

The Act (1) applies only to Scotland; and (2) only to farms or land with the buildings thereon occupied for farming purposes, and not dwelling-houses, shops, and other subjects, though the same may be in rural districts.

(3) Whensoever any agricultural produce has been *bona fide* purchased for its fair marketable value from the tenant of any farm, and actually delivered to the purchaser, and removed, the price having been paid, or whensoever agricultural produce has been purchased at public auction, after seven days' written notice of the intention to sell by public auction given to the landlord or person entitled to the rent of such farm or land, then all right of hypothec over such agricultural produce shall cease and determine. This does not, however, apply to any agricultural produce which the tenant is not entitled legally or by the terms of his lease to sell or carry off the land.

(4) Hypothec not to be available beyond three months after rent is payable.

(5) Stock of third party taken on a farm to graze to be liable only to the amount of consideration payable for the grazing.

(6) When agricultural produce or stock is sequestrated, it is incompetent to sequestrate furniture, implements, imported manures, &c.

(7) Register of sequestration for rent is to be kept.

It is always advisable for an agent to be careful in giving credit to a tenant for rent due. In many cases it may be with very great advantage to the tenant to allow the rent to lie over for a few weeks, as on the rent-day he might be unable to meet the demand, but in the course of a few weeks he may be able to pay it without any disadvantage. An agent requires to use great discretion in matters of this kind, being careful not to oppress any tenant too hastily, or to allow his arrears to accumulate. If a tenant has been unfortunate, and is a deserving man, the agent should make the case known to the landlord, who will probably be willing to assist industrious and deserving tenants. In cases of the kind, however, it is always judicious for an agent to make himself acquainted with, and to keep a sharp inspection over, the stock and crop on the tenant's farm, and to see that it is kept up to its full value.

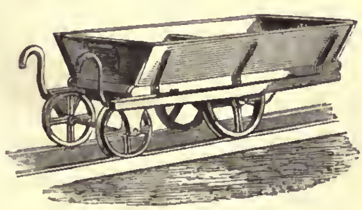
CHAPTER XIII.

PORTABLE RAILWAYS FOR FARMS AND ESTATE IMPROVEMENTS.

As the steam-plough promises to supersede the common plough, there is great reason to think that ere long an application of the railway system will be got to work successfully in the carriage on farms and general works on landed property; and more especially, I think that a system of farm-railways will be of great benefit where the land is cultivated by steam.

Mr Grant of Wester Hill, Linton, Staplehurst, Kent, has brought out a system of portable farm-railway which seems to answer the purpose remarkably well. We have been using it on this estate for some years, and feel much satisfied with it. It is a good substitute for wheelbarrows in making roads, quarrying, removing soil, and brickmaking; and the expense is considerably less than where the work is done by means of the wheelbarrow. From what I have seen of it, I am of opinion that it can be worked to advantage in farming operations, as in the case of removing manure to a field, &c. It is the common practice to wait for frosty weather to remove farmyard manure to the fields, which does not always come exactly as each farmer wants it. Consequently the portable railway can be laid out, and set to work in any sort of weather without injury to the soil; and the removal of grain crops and turnips can be carried on when the soil would be too wet for horses and carts.

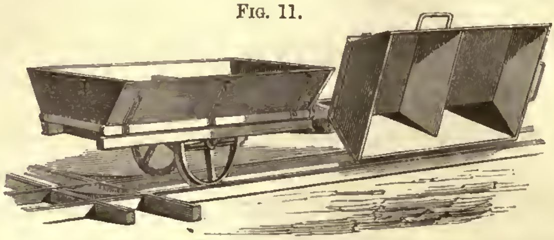
FIG. 10.



The rails are constructed of wood and iron, having a large bearing surface; the chief portion of the rail is wood, being capped with a light iron rail on the top, where the wheels of the waggons run. The preceding sketch, fig. 10, will give an idea of the form of the truck which I have had in use for removing soil, gravel, &c. The truck tips to the side, clear of the rails. The rails will lie on any garden walk, as they only occupy a breadth of sixteen inches. When the trucks are full of soil or gravel, they carry from six to seven cwt.

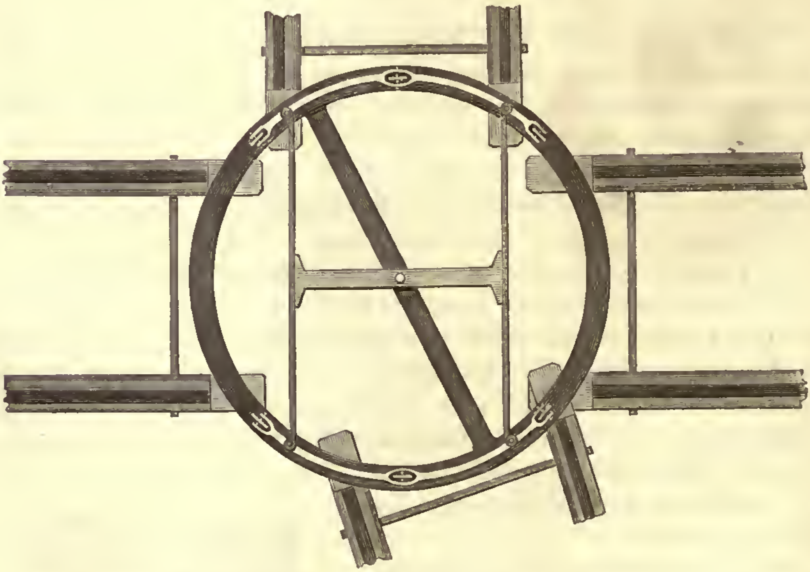
When trucks are required for the removal of manure to fields, they are used of the form of the sketch, fig. 11. These trucks are in pairs,

Fig. 11.



being coupled together very firmly; and they can be turned in pairs on the turn-table, fig. 12.

Fig. 12.



The sketch, fig. 12, shows the principle of Mr Grant's turn-table as used for his portable farm-railway. It is made much in the same way as the turn-table used for locomotive engines. It is very simple, and easily worked.

This kind of farm-tramway will be found very useful in the removal of manure to the fields and root crops from the fields in wet weather, or when the earth is soft. It is well known that the working of cart or waggon wheels over wet land, or what may be termed "kneading" it, is very injurious to the soil. Mr Grant's tramway is a great means of preventing this. In fig. 13 is shown the way in which the system of tramway can be advantageously applied to the removal of manure to the fields.

FIG. 13.

Major Stapylton has recently applied Mr Grant's system of tramway to the purpose of removing clay from pits to a crushing-mill in his brickmaking establishment at Myton. The trucks are drawn up an inclined plane by an engine which works the other machinery in the brickworks. The trucks are drawn up by a rope which winds round a drum driven by the engine.

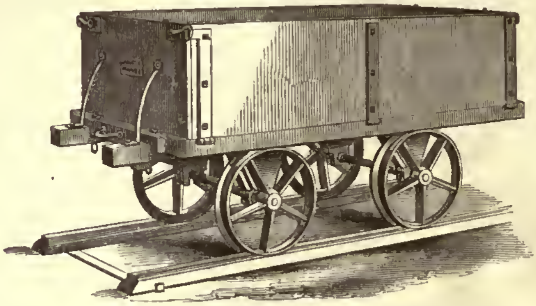
The following are the prices of Mr Grant's apparatus:—

Rails per pair, with tie-rods complete, for the 2 feet 2½ inch gauge, per lineal yard,	£0 3 0
NOTE.—The rails are supplied in lengths of 5½ yards or 1 rod, with a small proportion of short lengths, some of which are adapted for curving.	
Patent turn-tables, each, ...	5 10 0
Patent ballast-truck for the 2 feet 2½ inch gauge, with self-acting tailboard and brake fitted ; holds a cubic yard level, and more when heaped,	10 0 0
Small-sized ditto, holding half a cubic yard level, . . .	8 10 0
Side truck for the 2 feet 2½ inch gauge, to carry a cubic yard level, and more when heaped. It does not tip the load, but is long and narrow,	

and both sides let down so as to admit of its being easily emptied, and it is much lighter and lower (and consequently far more easily loaded) than any truck of equal size having a side tip, . .	£9 0 0
Pair of patent barrow trucks, with side tip, fitted with false lades and screw-brake. These trucks are only adapted for the 11-inch gauge, and on that account are not recommended for general farm work, .	9 0 0

Mr Grant also makes a harvest-truck, fig. 14, the sides of which let down to a horizontal position, and are there held by means of chains, thus forming a wide surface for the conveyance of grain from the fields.

FIG. 14.



This form of truck costs £13. These harvest-trucks carry about half the quantity of an ordinary farm horse-waggon.

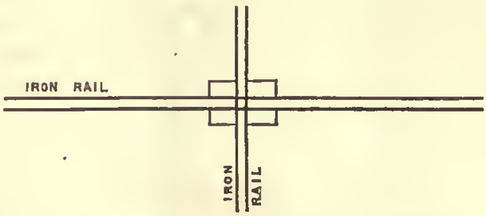
For a large farm it would be necessary to have half a mile in length of the rails, and this, with the necessary trucks required, will cost nearly £180.

I have seen trucks used, with a great saving of time and labour, in conveying turnips and steamed food for cattle in farm-steadings; but in those cases there was no turn-table used at the corners; the rails were laid round the corners in a bend, forming, as it were, a semicircle, and the axle of the front wheels of the truck was made to turn on a pivot fixed to the centre of the axle, and under the body of the truck. When made as described, the wheels accommodate themselves to the rounded rails.

I am of opinion that ere long a system of railroad or tramway will be very generally adopted for the work of large farms. They may be put down permanently, by having the rails to lay down on the common road or over the arable land as may be required, and then to be removed at pleasure to other parts of the farm. This would certainly be very convenient, and an advantage in an economical point of view, in removing manure to the fields, or in the ingathering of the crops in harvest-time. If laid down permanently on a large farm of, say, five hundred acres in extent, it would be sufficient to have two main lines running the whole width of the farm in each way, and crossing each other at the farm-steading, thus, fig. 15.

If the farm-buildings are situated near the centre of the farm, it will be all the more advantageous for a system of tramway. Branch lines might be carried into different parts of the farm in conjunction with the main lines, having either gradual bends or turn-tables at the junctions. The trucks to be used on such lines could either be moved by horse-power, or by a fixed engine at the steading. One powerful engine could command the main lines by means of a rope to pull the waggons, and also the branch lines by having a pulley or drum wheel at the junctions to keep the rope right.

FIG. 15.



There can be no doubt of the advantage of tramways when constructed on cheap principles. They would be found of immense advantage and profit in the removal of timber from the woodland on estates where these are extensive. At the present time Colonel Farquharson has commenced to construct a tramway from the Ballater station, on the Deeside Railway, to his estate of Invercauld, for the removal of the timber from the extensive forests there. I believe the total length of tramway is about twelve miles, and the cost is estimated at £2000 per mile. It is to be made substantially with sleepers and iron rails, and strong enough for the engines of the Deeside Railway Company to run upon it.

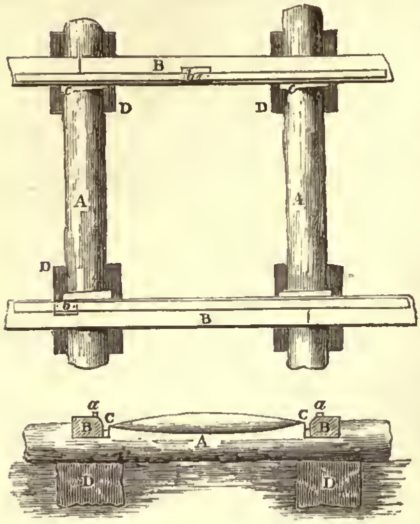
In the construction of a tramway on an estate for the removal of timber, or on a farm for general farm purposes, it would not be necessary to form an expensive roadway. If the trucks are to be drawn by a rope and fixed engine, the rails and sleepers could be laid upon the level surface, or at least after the surface-soil had been removed. Where horses pull the trucks, then it would be necessary to have the centre way between the rails made hard with stones.

On referring to fig. 16, the old system of farm-tramway is shown, suitable for the weight of heavy trucks; and when the timber string-pieces are made of sufficient strength, it is quite capable of bearing engines and heavy trains.

The letters A A show the position of the cross sleepers, B B the string-pieces on which the iron plates *a a* are fastened; *b b* shows the arrangement of the joints between the plates, *c c* the position of the wooden wedges to firm the string-piece to the sleepers, and D D the stone supports.

This description of railway is frequently adopted in Canada and the United States, from motives of economy in the cost of the first construction. Timber being plentiful in those countries, it is used for the purpose of rails, and a small narrow bar of iron is fastened to these wooden rails, as shown at *a a*; this forms a better running surface for the wheels of engines and trucks. The iron bars are generally made two inches wide and about three quarters of an inch in depth, and in lengths of from fifteen to eighteen feet. The top of the iron rail is made somewhat convex. They are fastened to the wooden rail by means of screws through the bar into the timber.

Fig. 16.



The wooden rails are usually made eight inches deep and six inches broad, and of any length. The rails are either supported by stone blocks or wooden sleepers; as a rule, the wooden sleepers are more preferable, especially on embankments, and also from the fact that they cause less shake to the waggon passing over them. The sleepers being slightly elastic, give way to a certain extent, and cause the waggon to run much more smoothly. The sleepers are generally made nine feet long, nine inches broad, and five inches thick; but of course these lengths and sizes must be regulated by the width of the axle of the trucks to run on the line, and also by their size or weight.

The wooden rails are fixed into a notch in the sleepers by means of a wedge, as shown at *c* in the sketch.

The sleepers can be either laid on the natural surface, or into a trench dug out to receive them, and then securely fixed there by beating the soil about it; but generally it is better to fix it with stones on each side, and have the space about it filled in with loose stones. This causes a drainage about the sleeper, and assists in making it last longer.

It is a great matter to have a thorough drainage under the tramway, especially if horses are to be the motive power, as it is necessary to have a dry footpath for them; but in any case it is well to have the soil about the timber work made dry.

In fig. 17 is shown a mode of rails for passing trucks from one line of rails on to another, or what is termed a siding. It would be necessary to have this in some places on a large farm or estate, so as to allow one truck to pass another. A A shows the main line, and B B the siding: *a* is what is termed the fixed switch, and *b* the movable switch. In the position the movable switch is shown, the trucks would run along the main line A; but on its being moved towards the other side, the siding would then be open to allow trucks to run into it.

FIG. 17.

The following is a description of a new traction-engine as made by Mr R. W. Thomson of Edinburgh, and as described in the 'Scotsman' newspaper of August 10, 1868:—

On Saturday afternoon a very remarkable sight was seen in this city. A train of heavily-laden coal-waggons, looking exactly like a luggage-train, was observed coming steadily up the steep incline leading into Edinburgh from Dalkeith. It was one of Mr R. W. Thomson's patent road-steamers, with india-rubber wheel-tires, having four huge loaded waggons in tow. Each waggon weighed, when empty, two and three quarter tons, and carried a load of five and a quarter tons of coals, making the gross weight of the waggons thirty-two tons. The road-steamer weighs eight tons. Thus a total of forty tons was in motion. The road-steamer had drawn the train from Newbattle Collieries, eight miles from Edinburgh, over a very hilly road, with rising gradients of 1 in 16.

The interest excited by this remarkable spectacle was so great that the crowd could not be kept back. A halt was therefore ordered, and application was made at the central police-office for the aid of a few constables to keep the over-curious from pushing each other into the way of the advancing train. A sergeant and six men were at once despatched to the outskirts of the city, where the halt had been called, and progress was immediately resumed. The hill from the Pow Burn up to Minto Street is both long and steep, but the road-steamer drew its train to the top with the most perfect ease. It was very curious to watch the behaviour of the patent india-rubber tires of the road-steamer as they passed over the various descriptions of road-surface. In the outskirts of the city, where the roads are macadamised, there were many places where broken stones had just been spread on the surface. Over these sharp loose stones the indiarubber tires of the road-steamer passed without crushing or in fact disturbing them in the least. The roughest and sharpest bed of broken stones sank gently into the elastic cushion of india-rubber, which rose from the contact with the most jagged fragments of stone without any trace or mark of injury. The perfect command which the conductors of the train had over its movements enabled them to control both its course and speed with the utmost precision. The line of streets through which it passed—viz., Minto Street, Clerk Street, Nicolson Street, South Bridge, North Bridge, Princes Street, Leith Street, and Leith Walk—are always the most crowded streets in the city; but at the time the train passed through these thoroughfares there happened to be an unusually great current of traffic passing in a contrary direction towards the South-side

Gymnasium, where some games were going on, which gave rise to a great stream of omnibuses, cabs, and conveyances of every description, in addition to a great crowd of pedestrians. Notwithstanding all these obstacles, aggravated by the streets being at some points under repair and closed for one-half of their width, no difficulty was experienced in steering clear of every impediment. The crowd of spectators increased with such rapidity, that by the time the train was passing the University thousands were trying to catch a glimpse of the novel sight, and when crossing the High Street the swarms of idlers who give such a busy aspect to that locality rushed in vast numbers to see how the train would descend the steep incline from the High Street to the Bridge. This was done with as much ease and quietness as if there were no hill at all. The extremely curious way in which the whole four waggons follow, snake-like, in the track of the road-steamer, was clearly seen in passing out of North Bridge into Leith Street. First, the road-steamer had to turn to the right, and before the last waggon was round the corner to the right, the road-steamer had already turned sharp to the left to go into Leith Street—thus the train actually assumed the form of the letter S, every waggon going over the same ground as the road-steamer with the most perfect accuracy. The very steep and crooked descent of Leith Street, which has a gradient of probably 1 in 12, was managed with perfect ease, and the train pursued its way down Leith Walk, along Junction Street, and up Bonnington Road to the works of Messrs T. M. Tennant & Company (Limited), where it had to deliver the coals. In passing out of Junction Street into Bonnington Road there is a sharp acute angle, so that the train had actually to double back on itself; however, it rounded the corner without the smallest difficulty. The final manœuvre was one which the conductors of the train did not expect to be able to accomplish without breaking it into two portions. It had to be taken out of the Bonnington Road, which is a narrow street of thirty feet in width, into a lane twenty-five feet wide, which rises with a steep incline to the entrance-gate of Bowershall Works. It was determined to attempt this narrow entrance with the entire train of ninety feet long, and it passed in at the first trial, leaving so much space to spare that it was found, on afterwards measuring the wheel-tracks, a width of fourteen feet would have sufficed, though the breadth of the waggons is seven feet. The train curved in through this narrow entrance, mounting at the same time the steep incline leading up to the works, and drew up in the yard in perfect order.

There can be no doubt this invention of the application of vulcanised india-rubber to the tires of road-steamers forms the greatest step which has ever been made in the use of steam on common roads. It completely removes the two fatal difficulties which have hitherto barred the way to the use of traction-engines—viz., the mutual destruction of the traction-engine and the roads. The india-rubber tires interposing a soft and elastic cushion between the two, effectually protect them both from every jar and jolt—in fact, as much so as if the engine were travelling over a tramway of india-rubber. The road-steamer which drew the four waggons of coal from Newbattle Colliery on Saturday was constructed to draw less than one-half of the weight comprised in the coal-train. It was perhaps hardly fair to test it with more than the double of its legitimate work, but it was deemed best to test it with great severity, and the great success of the trial has surpassed every expectation. It is, we believe, destined for Ceylon, for transporting coffee from the plantations to the railway stations.

A few days ago a preliminary trial was made with the Ceylon road-steamer. With one heavy waggon in tow, it passed through a number of our steep streets, and as nothing seemed to come near its limits of climbing, it was headed towards Cockburn Street, and rolled quietly up that steep and crooked street, some parts of which have gradients about 1 in 8 or 9. The French Government have instructed M. Leon Rascol, *Ingénieur des Ponts et Chaussées,* to examine and report on the working of Mr Thomson's road-steamer. One steamer is in course of construction for transporting coal over a hilly road, nine miles long, in Derbyshire.

It will be necessary to substitute coke instead of coal, the smoke from which is offensive when the road-steamers are passing through towns.

These engines of ten-horse power cost in Edinburgh £680; they weigh eight and a half tons, and can take a load of fifteen tons up a gradient of 1 in 12, and on level ground thirty tons.

CHAPTER XIV.

FENCING.

Good fences are of great importance on an estate, as in exposed districts the greater part of them afford shelter, and in all cases define and protect the boundaries of fields, and consequently make the land more valuable. In many parts of England thorn hedges are planted on high embankments, and allowed to grow till the plants are from ten to fourteen feet high, when they are cut half over and the tops laid along the line of hedge; this is what is termed "slashing." In a very short time the hedges so treated become partly dead, and they are very seldom kept in anything like order. They disfigure an estate very much, and form a nursery for vermin and weeds. In many parts of England the fields are small, and so much surrounded and shaded with high and badly-kept thorn hedges of this kind, that the rays of the sun cannot fall on the cereal and other crops to ripen them; and in hay-time and harvest these hedges prevent the air getting in to dry the sheaves. Were hedges kept trimmed in such a way as to admit of the land being cultivated close to the roots of the plants, the case would be very different; and I merely refer to this to show the necessity there exists for an improved mode of managing such fences.

The ordinary fences on an estate may be set down as consisting of eight kinds, and these are:—

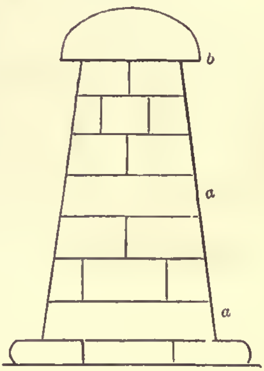
1. Stone walls.
2. Wire fences.
3. Wooden fences.
4. Thorn and other hedges.
5. Turf walls.
6. Fences made from underwood.
7. Gates.
8. Sunk fences.

I shall describe these in the order in which I have put them down.

SECTION 1.—*Stone Walls.*

Where stones are plentiful, nothing can be better for a fence than a good stone wall. It is expensive at first, but ultimately it is the cheapest of all fencing. If properly put together, it affords more direct shelter than any other kind of fence. It takes up a small space of ground, and does not afford any refuge for vermin, or encourage the growth of weeds, and costs the least in keeping it in repair. Stone walls are of two kinds, the one being built with lime and stones, the same as plain rubble-work; and the other being built of stones alone, without mortar, or what are usually called dry-stone dykes. I need not give any description here of the first-mentioned, but will describe the mode in which I have usually built the dry-stone walls, as they are the kind usually erected for farm or plantation fences, and are the cheapest.

FIG. 18.



In fig. 18 is given an end view of a dry-stone wall, five feet high over all. The foundation should be laid with large flat stones to the breadth over all of thirty-two inches, and made properly level. On these foundation-stones the building should be commenced, making it twenty-six inches broad, thus leaving a scarcement of the foundation equal to three inches on each side. The wall should be built in regular layers to the necessary height—say fifty inches, exclusive of cope—gradually drawing it in in breadth to fifteen inches at the top just under the copestone. There should be at least two layers of "through-band stones" to bind the whole together, as shown at *a a* on the sketch. The first layer of through-band stones should be laid one at every four feet in length at least, and about eighteen or twenty inches from the ground. The next layer should be put in at similar distances, but alternately with the others, at a height of three feet six inches from the surface. After the wall is built to the point *b* on the sketch, it should here receive a layer of mortar upon which to bed the copestones. This coping with lime secures the whole wall, and binds it firmly together. It is an important point, in building this kind of wall, to have the centre well packed with stones, as, if this is not attended to, it will not stand well. Some kind of stones are much better suited than others for building walls of this kind. On many estates stones cannot be got for the purpose; but, generally speaking, they are to be got on all the geological formations excepting the clay.

The implements required for building a dry-stone wall are not many, these being a frame, hammer, and lines or cords. The frame is used as a guide or gauge for shaping the wall, the hammer for breaking the stones to any required shape, and the cords are for stretching along the line of wall on each side to keep the work straight, and also to regulate the thickness of the wall. The frame is set as shown in fig. 19. For this and some other figures, taken from the 'Book of the Farm,' I am

Fig. 19.

indebted to Mr Stephens. It will be observed that the frame is set to the right in the sketch; and being the side towards which the men are working, it is made the same width at the top and bottom as the wall is intended to be, and the same height under the copestone. Two frames are sometimes used by putting the other where the stakes are shown.

The wall is built in lengths—generally about two roods of seven yards at a time if the ground is hilly, and more if level. As the stones are laid in their courses they should not be laid flat, but should lie highest in the centre and sloping towards the outside each way, and they should be kept firm in this position by the packing in the centre. Besides making the wall more substantial, this method of sloping the stones assists in throwing off water from the wall.

The through-band stones should not be allowed to project, as is often done, as the wall is frequently injured by persons stepping over it by means of the projecting stones.

The copestone should in all cases project over the wall on both sides; this assists in keeping the wall dry, and also in throwing back any sheep which may attempt to get over.

Where two walls cross each other, and thus form four corners, Mr Stephens suggests that, as these cannot be reached by the plough, the walls should be built curved, as in fig. 20, and the enclosed space planted for ornament or shelter; or if the site is naturally wet, or even if not, watering-pools should be formed in such points where the fences cross

Fig. 20.

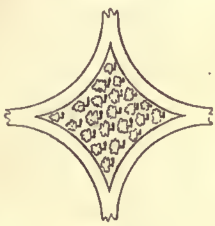
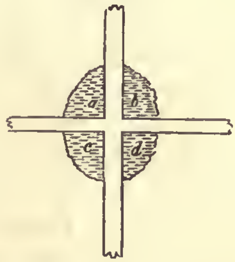


Fig. 21.



each other in subdividing farm lands. One large pool formed in the centre, and the walls carried through it, as shown at *a b c d* in fig. 21, would form a pool for each field.

In regard to the cost of such a fence as described, no fixed sum can be put down as a rule, as much depends on the kind of stone to work with, the extent of quarrying required, and the distance to cart the stones; so that to state anything like a definite sum would only mislead. I may, however, state what they have cost me in different parts of the country. On this estate they have cost me as follows, built five feet high:—

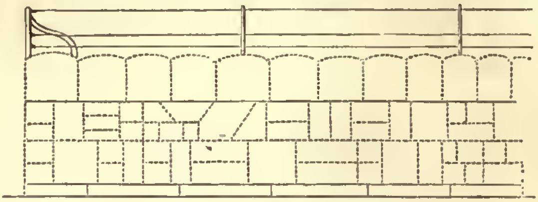
	Per rood of seven yards.		
Quarrying stone,	£0	1	6
Building wall, and lime,	0	4	6
Cartage of stone a quarter of a mile,	0	3	0
Preparing foundation,	0	0	3
Cost of lime,	0	0	3
Total,	£0	9	6

The foregoing shows what it has cost to build a wall five feet high in the way already mentioned. In some cases I have had them built for a less sum, and in others they cost more.

On some districts, where the light mountain sheep are kept, the kind of wall described will not answer the purpose, as moor sheep will often spring over them. Where this has been the case, I have erected a stone wall with a wire fence on the top. Where this is done, the sheep very seldom attempt to get over it, and if they do, the wire fence throws them back. The following is a description of such a fence, fig. 22:—

It is built in the way already described for the other kind of wall, excepting that it does not receive an overhanging copestone. It is built to a height of four feet, and the top stones are closely packed and bedded with lime, arranging them so as to have good large through-band stones

Fig. 22.



every nine feet in length to receive the posts for the wire. The posts used are iron, and are put in one at every nine feet in length of the wall; they are fixed into the stones with lead, and iron straining-posts are inserted at the rate of one to every hundred yards in the fence. The posts when put in stand twenty-four inches above the wall, and are one and a quarter inch broad by a quarter inch thick.

This kind of fence has cost me as follows:—

Quarrying stone,	£0	1	2
Building wall,	0	3	6
Cartage of stone and lime a quarter of a mile,	0	2	6
Preparing foundation,	0	0	3
Cost of lime,	0	0	3
Cost of material for wire fence,	0	3	0
Fixing wire fence,	0	1	6
Total,	£0	12	2

The above shows the cost per rood of seven yards.

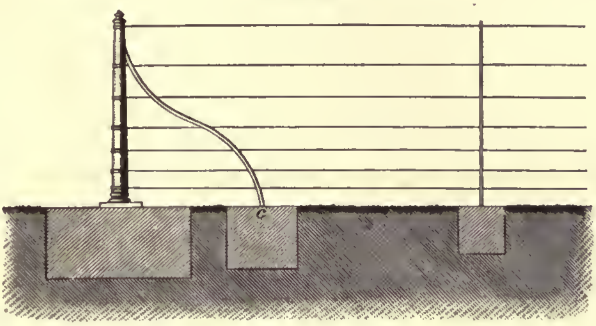
Section 2.—*Wire Fences.*

Wire fences are very useful when no artificial shelter is required, and where a light fence may be wanted not to be much seen or obstruct a view. They make admirable fences for home parks. I have also used them extensively in fencing plantations. One objection to them in some parts of the country is that they are dangerous to those who follow fox-hunting, as accidents have often taken place with them in horse-leaping. The wires are so light that a horse does not see them sufficiently to take a high enough leap to clear the top wires, and the consequence is that sometimes the animal's feet get entangled in the wire, and the rider is thrown. The best plan, however, to avoid such accidents is, to put a wooden rail four inches broad along the top of the posts, where the uppermost wire would otherwise have been placed.

Wire fences are usually erected of two kinds, one of which is all iron, the posts being made of iron; and another having wooden posts on which the wire is fixed. Where good timber is plentiful, it is best to erect wire fences on wooden standards, as, in the case of iron standards, if one of them give way, it deranges a great part of the fence before it can be made good; whereas, if a wooden standard give way, it is merely necessary to draw the staples and put in a new post.

In erecting a wire fence solely with iron, the standards are either fixed into wooden blocks or stones. The wooden blocks do not last long, and therefore should never be used. Fig. 23 is a sketch of one erected and fixed in stones.

Fig. 23.

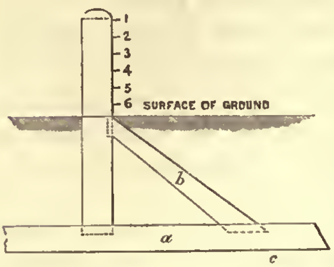


This kind of fence is generally erected with six wires, the top wire being the strongest, and is what is called No. 3 amongst manufacturers of wire. The second and third wires from the top are a little smaller than the top one, and are what is termed No. 4. The three lowest wires are put on smaller still, and are what is usually called No. 6 wire. The posts are made four feet long, one and a quarter inch broad by three-eighths of an inch thick. The total height of fence when finished is usually three feet nine inches. The straining-posts are usually put in one to every hundred yards of fence; but much depends upon the line of fence, as to whether it be level or not. The straining-posts at the end of the fences are much improved in strength by having a stay to assist in resisting the pull of the wires, as shown at *c*. This kind of fence costs from 10d. to 1s. per lineal yard for material, and from 3d. to 4d. for erecting it.

In erecting wire fences with straining and intermediate posts of wood, the straining-posts are usually made as shown in fig. 24.

I have generally used them of larch timber cut to a length of eight feet, and eight inches diameter. The post is fixed into a piece of timber called the "sole," as shown at *a*, the dimensions of which are seven feet long and seven to eight inches on the side of the square. Between the post and sole, and fixed by mortising into each, is a "stay" six feet long, and made from any piece of strong timber from six to eight inches diameter, as shown on sketch at *b*. These straining-posts are fixed firmly in the ground, deep enough to cover the top of the stay. From the bottom of the sole, at *c* on sketch, to the surface of the ground, should not be less than from three feet six inches to four feet; and from that point to the lowest wire,

FIG. 24.



	No. 6		on sketch, is	5	inches.
From	6 to 5		,,	5	,,
,,	5 to 4		,,	6	,,
,,	4 to 3		,,	8	,,
,,	3 to 2		,,	10	,,
,,	2 to 1		,,	11	,,

and from No. 1 to the top of the post should not be less than three inches; thus making a fence, when complete, three feet nine inches high.

The intermediate posts should not be put in at less than five feet apart. I have often observed them erected at from seven to eight feet apart, but this never makes so secure a fence as when they are put in closer. These intermediate posts are cut six feet long, and should not be less than three and a half inches diameter at the small end if round, or four inches by two inches if cut from broad timber. The galvanised cable wire is the best for general purposes, and is, withal, cheap in its first cost. It is simple to erect, is strong and durable, and neat in its appearance, and being of an elastic nature, it is rarely injured by cattle or horses.

FIG. 25.

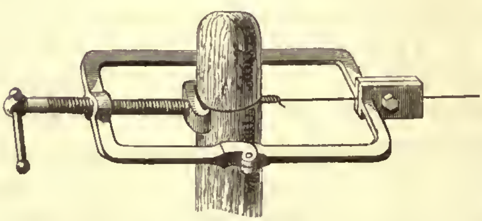


FIG. 26.

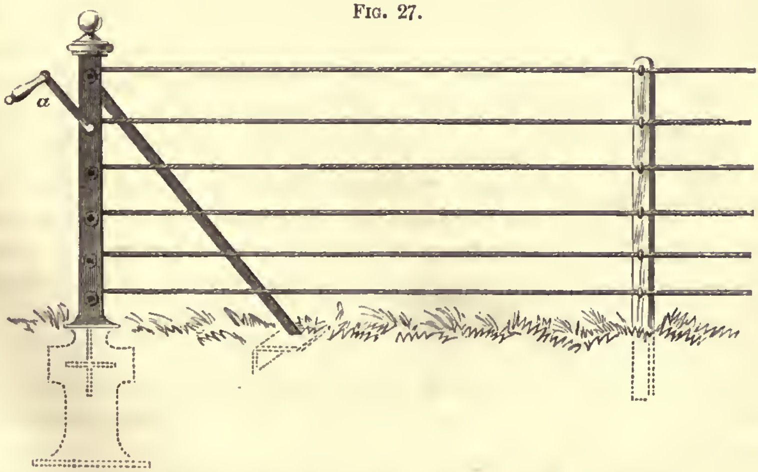
When wooden straining-posts are used, a straining-screw is required; and where the common wire is used, a wire-straightening machine is also required. Fig. 25 is the sketch of a screw, and fig. 26 is a sketch of a wire-straightening machine, which I have had in use for some time. I purchased them from the makers, Messrs A. & J. Main of Glasgow. The price of a complete set of fencing tools—consisting of the foregoing, a pair of clambs and pincers—is £2, 5s.

The cost of a fence of this description may be put down as follows, when erected under ordinary circumstances. This is exclusive of the value of the timber.

Cost of wire and staples per yard, six deep, .	7½d.
Erecting fence, ...	1½d.
Total, ...	9d.

Even where timber is plentiful, however, I have found it advantageous, in erecting wire fences on wooden intermediate posts, to use iron straining-posts instead of wooden ones, as the straining-posts are the mainstay of the whole length of the fence; and the longer they stand, the fence will keep in order in proportion. Wooden straining-posts are apt to give way, while iron posts are less liable to do so; and iron posts strain a much longer length of wire than the others. Good iron straining-pillars will strain four times the length that a wooden one will do. Taking, therefore, the value of the timber used, and the real expense of erecting four posts instead of one, the iron pillar comes to be the cheapest, and the wire can be tightened at any time. Fig. 27 shows a sketch of a wire fence erected with an iron straining-post and wooden

FIG. 27.



standard. At *a* is shown the handle or crank for tightening the wire; this is taken out when not in use, and is used for tightening them at any time. Fig. 28 is a sketch of the straining-pillar. The winding apparatus is shown at *a* on the sketch. The crank round which the wire is worked is shown at *b*. The shaft and base are made in one solid casting. The base is of such a form as makes the pillar easily made firm in the ground. They are powerful strainers, and are very efficient for the purpose.

FIG. 28.

There is another straining-pillar just come into use, which is a very powerful machine for straining a great length of wire, and also strains on two sides at once. It is called Sam's double-action straining-pillar, and is manufactured by Messrs Benjamin Reid & Co. of Bon Accord Works, Aberdeen. It has been extensively used in the erection of long lengths of wire fencing in the north of Scotland, in the formation of high fences for deer, and fences required for new plantations.

The representation of the pillar, fig. 29, shows the wires as being strained from both sides. It is made wholly of iron, and will strain from five hundred to one thousand yards on each side, according as the line may be straight or otherwise.

The principle of the double action is shown by the two following sketches, figs. 30 and 31.

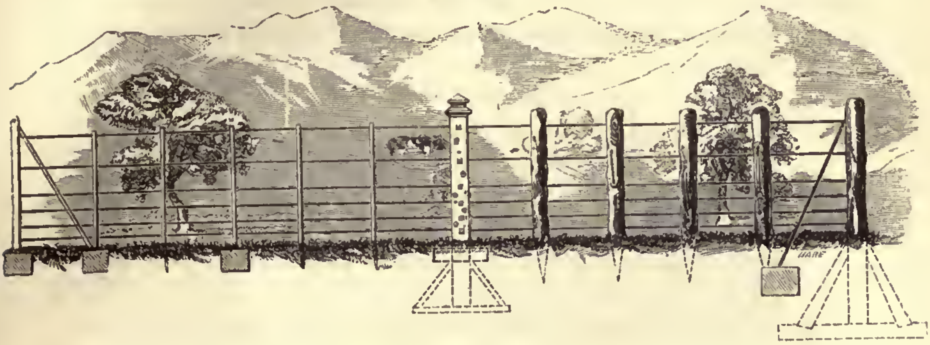
One spindle answers for the two rollers, and yet the rollers work independently of each other. In proceeding to work with the pillar, the operator passes the ends of the wire through the holes in the rollers, and then winds it up with a key as shown in fig. 30, and thus tightens the wire to any degree of tenacity required; and when it is thus tightened, a pin is passed through a hole in the side frame, and also one into a hole in the flange of the roller, which is thus held secure.

The stays of this pillar are small in comparison to its size; but large stays are not required, as the wires, pulling from both sides, keep it in position.

The price of a pillar of the kind described, and suitable for an ordinary wire fence with six wires, and standing three feet nine inches high, will be 19s. 6d.

Another form of iron fencing which is coming more into use, is that of the wrought-iron continuous fencing. Although an expensive fence to begin with, it is peculiarly adapted for being easily removed when required. It is very durable, and although it may be removed from place to place, it does not cause any breaking of the surface of the soil. In fig. 32 is given a sketch of continuous bar fencing as manufactured by

FIG. 29.



Messrs A. & J. Main of Glasgow. It makes a first-class fence for deer.

FIG. 30.

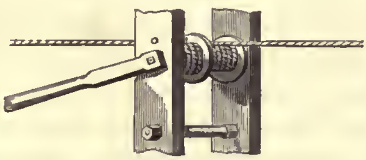
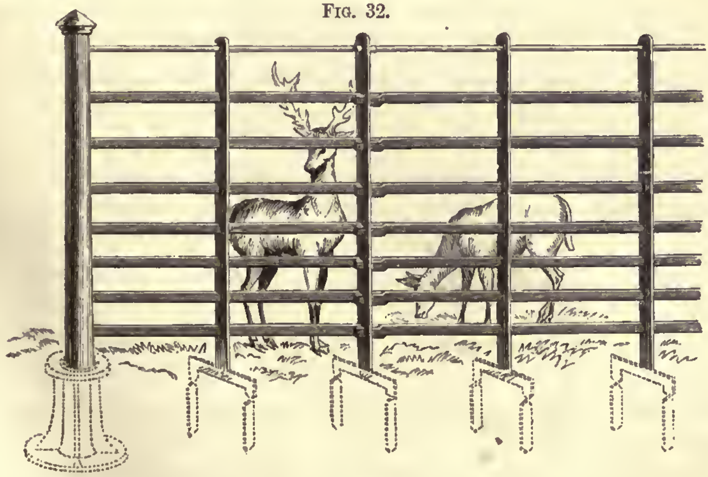


FIG. 31.

Such a fence as shown, of a size for deer, six feet high, with eight bars, one inch by a quarter inch, and the standards placed about four feet

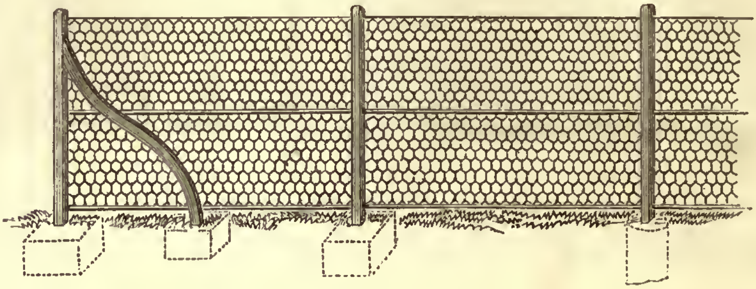
FIG. 32.



apart, and one and a half inch by three-eighths of an inch, will cost about 3s. 10d. per yard. Of course such fences can be got any height required.

The different descriptions of wire fencing given are suitable for sheep, cattle, and horses, but are not close enough for rabbits. For the protection of some young plantations and our home nursery here, we have erected a considerable length of wire fencing to prevent rabbits from getting through. In fig. 33 is given a view of such as we have used on

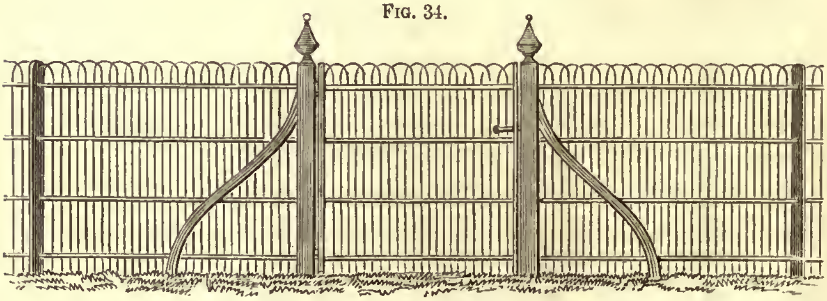
Fig. 33.



this estate. It simply consists of three wires stretched in the ordinary way, to which wire netting is laced with small wire. The prices of such vary with the height and size of mesh.

Where a more ornamental fence is wanted for a garden, or for shrubberies near a mansion, something more neat is requisite, such as shown in fig. 34.

Fig. 34.



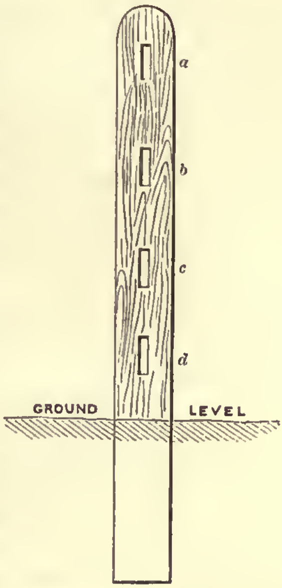
Section 3.—*Wooden Fences.*

Wooden fences are generally of two descriptions—horizontal and upright.

The horizontal fence is sometimes made with mortises in the posts to receive the bars, or the bars are nailed on the posts. In erecting a four-barred paling with mortised posts, they are cut six feet long, and sawn to six inches by three inches on the sides. Fig. 35 shows the character of the mortised posts.

From the top of the post to the upper edge of mortise *a* is five inches, the space between *a* and *b* eight inches, between *b* and *c* seven inches, between *c* and *d* six inches, and from *d*, the lowest mortise-hole, to bottom of the post is twenty-six inches. Six inches are usually allowed between the lowest mortise-hole and the ground, thus leaving twenty inches to be inserted in the ground. The rails for this kind of fence are made ten feet long, five inches broad, by one and a half inch thick.

Fig. 35.



It is of the greatest importance to have the posts firmly fixed, and this is done by digging pits for their reception, and having them firmly blocked with stones and earth.

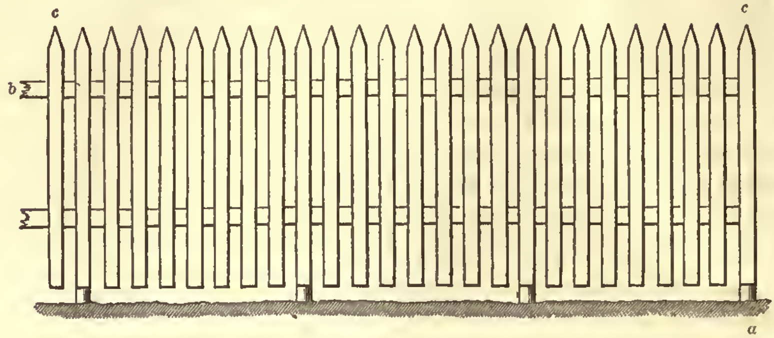
Another kind of horizontal fence is made with posts about the same size as the mortised ones, or they may be of round timber, and the rails the same dimensions, only that, instead of the posts being mortised, the rails are nailed on them. This makes a good fence when properly erected.

Upright wooden fences erected for estate purposes are of several descriptions, some being made of timber sawn to dimensions, and others being erected with the thinnings from young plantations in the rough natural state, without being dressed or sawn in any way.

A good upright fence is made with round larch timber, the posts being cut six feet long, and sawn to a size of three inches square; the rails being ten feet long, three and a half inches broad, by one inch thick; and the uprights being four feet long, two and a half inches broad, by three quarters of an inch thick. The posts are put in five feet apart. Fig. 36 gives a sketch of such a fence as described. *a* shows the post fixed in its place; *b b* the rails nailed to the post, the uppermost one being about one inch from the top of the post, and the lower one being about four inches above the soil; *c c* the uprights in their place. The uprights are usually put in about two inches apart. At that width it would be rabbit-proof; but if not wanted for that purpose, they could be put in much wider. And of course a fence of this kind could be made of any height; and when properly painted or tarred it lasts a long time.

The cost of erecting an upright fence such as I have described may be set down as follows, presuming that the timber has to be bought—

FIG. 36.



the calculation being made for a space of ten feet, or the full length of the rails:—

Two and a half posts, six feet long, at 6d., .	£0	1	3
Two rails, ten feet long, at 5d., ...	0	0	10
Eighteen uprights, at 1¾d. each, ...	0	2	7½
Eighty nails, at 6d., ...	0	0	6
Men's time erecting, ...	0	1	0
Total, ...	£0	6	2½

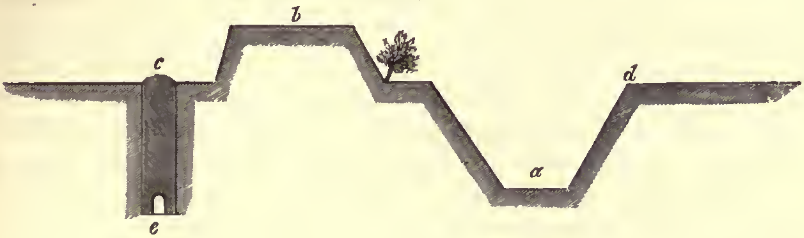
This is an expensive kind of fence, and is not generally used for estate purposes. It is only used for cottage gardens, &c. A similar kind of fence is made with young larch thinnings; the root end of the stronger trees are split up for posts—rails are also made of the same material—and the smaller trees and top ends are split up for uprights. This makes a good fence, and can be erected much cheaper than the one formerly described, but does not last so long.

Another description of upright wooden fence is in much use in some parts of the country. It is what is termed the *stob fence* in Scotland, and Scotch fencing in England. It consists of a row of small trees or posts driven into the ground as close as they can be put; a rail or spar is put along the top of the posts, and a nail driven through the rail into each of the posts. This is a very expensive kind of fence in many respects. The amount of timber used in its erection is considerable; it takes a great many nails; and from the posts being inserted in the soil, it does not last long.

SECTION 4.—*Thorn Hedges.*

Hedges for the general fencing of fields in this country usually consist of thorn-plants alone, but I have found it much better to plant a mixture of beech along with the thorn. Along the sides of roads, and sometimes along the boundary of a plantation, where we often find a greater run of water than can be contained in an ordinary pipe-drain, it is necessary to have an open ditch in front of the hedge, and the hedge itself planted upon a raised embankment, as shown in fig. 37.

FIG. 37.



A ditch or open drain, *a*, is opened three feet wide at top, from twenty to thirty inches deep, as the case may be, and about twelve inches broad at the bottom. The best portion of the soil from the ditch is thrown up, so as to form the embankment *b*. This embankment is raised to a height of eighteen inches, which gives shelter to the young plants for some time. The bank being made three feet wide, a drain is run along the opposite side or back of the fence, as at *c*, to catch the water from that side. This drain should be closed in, and receive a pipe at the bottom, as at *e*, if the land on that side is used for agricultural purposes; but in the case of a plantation, an open drain will answer the purpose better. With a drain on each side of the hedge, the plants have a dry bed, which is essential, because thorn or beech will not thrive well in a wet soil. If the side at *d* is exposed, a wooden paling or wire fence should be erected to protect the hedge against the inroads of cattle or sheep. This wooden or wire fence will require to stand till the hedge is in a state to act as a fence, and this is generally from seven to nine years.

Having had all these operations done as described, proceed next to plant the thorn and beech plants on the side, as shown. The thorn-plants, before being inserted, should be cut over to within about four or five inches from top of the roots; but the beech-plants should not be cut in any form. The plants are next inserted into a trench opened for their reception, putting the plants in the trench about nine inches apart, and planting two thorns for one beech. Good soil should be put next the roots of the plants. I know of nothing better than road cleanings or scrapings. The roots should be covered up carefully, and the plants firmly fixed in their places. The cost of making such a fence as described will stand as follows:—

	Per yard.
Labour, ...	2d.
Cost of plants, ...	1d.
Total, ...	3d.

This does not include the cost of the inside drain, as it is calculated that such a drain, if required at all, should be done for the benefit of the plantation or field in which it is made. The mode of planting hedges already described is suitable for, and should only be done, where the land is a stiff wet clay, or where the soil is naturally wet and no means have been taken to drain it; and it is also suitable for the sides of roads and plantations, where very often we find a stronger current of water than can be enclosed in a pipe-drain. But where the soil is naturally dry, or where it has been made so by thorough drainage, the hedge should be planted on the level surface, as of course, the land being dry, there is no need of an open ditch or drain, or of an embankment. In all cases it is better to plant the hedge on the level surface, where the state of the soil will admit of such being done.

In planting a hedge on the level surface, the ground should be trenched along the line where the plants are to be put, at least two feet deep and four feet wide; and in trenching it, all stones of any considerable size, and all roots of weeds, should be carefully taken out, so as to make the soil clean. After this is done, the line of fence should be levelled, of course taking the inequalities of the ground into consideration. If a line is stretched along the line of fence, it will show at once any small hollows or heights, as the line will stretch above the hollows and press into the heights. While the line is in this position, the soil immediately beneath it, and to a few inches on each side, should be firmly pressed down by the feet of the operators, by moving along the line sidewise, when the site for the plants should be levelled with the spade, taking down the heights to fill up the hollows, and filling in any holes made by the feet in pressing; and after the levelling, it should be beat with the back of the spade, making it smooth and level, about six inches on each side of the line. The next operation is to open out a trench for the plants on the one side of the line and along its whole length, and deep enough to receive the roots of the plants, which is generally about eight inches. The plants having been prepared as formerly described, are inserted into this open trench, about nine inches apart, putting in two thorns to one beech. After filling in the earth about the roots, have the whole made level and firm.

The advantage of planting on the level surface, over the mode of planting with an open drain and embankment, is twofold: 1st, The plants grow faster, and make a fence sooner on the level than on the embankment; 2d, There is a smaller space of ground occupied with the hedge on the surface than in the other case.

On the estate of Wass I have in several instances put a drain-pipe into the open ditches, and filled them up to the surface; the gain of land by this mode has been considerable. And many of our old hedges have been very much improved by having some fresh soil put about their roots, and by having the roots covered with soil where bare, as they do not thrive well if the roots are exposed to the air.

The cost of planting hedges on the surface will stand as follows, under ordinary circumstances:—

	Per yard.
Labour, ...	1¾d.
Cost of plants, ...	1d.

Besides the foregoing description of planting young hedges, the following points ought to be attended to in dealing with them:—

1st, In trenching the site for the hedge, see that the soil along the whole line is equally good; if not, some portion of it will grow faster than others, and thus make the hedge unequal. When it is found necessary to improve any portion of the soil along the line of hedge, good soil should be carted to it. Good loam or road-scrapings will do well, care being taken that, where fresh soil is added, it should be well mixed with the original soil in the trench.

2d, Rather cart good soil to improve the bed for the plants than put in any manure. I have found that both thorn and beech plants will grow better with the former than with the latter.

3d, Where the soil is naturally strong and retentive, and where it contains a large amount of vegetable matter, it is a good plan to mix a moderate quantity of lime with it. Lime will make a stiff soil more porous, and assist in decomposing the vegetable matter in it, and thus be the means of making the plants grow quicker than they would without it.

4th, Plant the young hedges in the month of November, the beginning of December, or in the month of February and beginning of March.

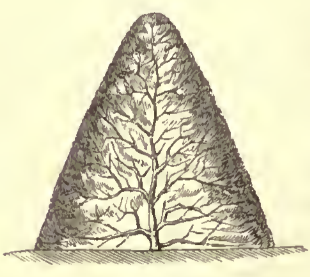
We will suppose that a young hedge has been planted in the way described; and we now come to consider the way in which it should be treated until it becomes a fence. The plants should be allowed to grow for two years after being planted before they are switched or cut in any way. The beech-plants do not stand cutting well during the first year; and the thorn-plants at the end of two years will have attained a much stronger stem than they would have if they had been cut at the end of the first year. During these two years the surface of the soil next the plants should be kept free from weeds; and to do this thoroughly, the soil will require to be slightly dug or deeply hoed twice in each year to about a foot in width on each side of the plants. After allowing it to grow for two years, it should be cut or switched over, leaving it about one foot high. Fig. 38 is the form of switching-bill I have used, and, I may state, is the best implement for the purpose, and is made by Sanderson of Dunse.

FIG. 38.

The hedges should afterwards be cut or switched up once in each year, leaving at each cutting about four or five inches of the last season's growth in height, and cutting it in the sides so as to leave about one and a half inch of the last growth; and after the hedge has attained a height of about four feet, it will then be high enough for an ordinary field or plantation fence, after which the hedge should be kept to about these dimensions as near as possible.

There are three forms of hedges, each suiting different purposes. Fig. 39 shows the end view of a form of hedge adapted for general farm and plantation purposes. This is what is termed the "wedge" form, and if kept regularly switched, it is the best adapted for farm fences, and is easily kept in order. If a hedge of this form is switched every year, a good hedger can, with one of Sanderson's knives, clear all the twigs with one upward stroke from the bottom of the hedge to the top, the length of the blade. On a great many estates it is not thought necessary to switch the hedges every year, but it is mistaken policy not to do so. The cost of keeping a well-formed hedge in order is very small per annum; a good switcher will cut them at the rate of 2d. per chain of twenty-two yards.

FIG. 39.



Another form of hedge used in some districts is shown in fig. 40. It will be observed, from the rounded form of the hedge shown in the sketch, that it must be more expensive to switch than the wedge-formed one, as in this case it requires several strokes to cut all the twigs from bottom to top. This form is not well adapted for high-lying districts where there are heavy falls of snow, as the snow lies on the top of the hedge and is apt to break it down. This fence is a stronger one than the other, and is serviceable where heavy bullocks are pastured; but, generally speaking, the wedge-shaped one is to be preferred.

Hedges are sometimes grown and formed in a perpendicular form, as shown in fig. 41. It takes up little room, and does well to give shelter

FIG. 40.

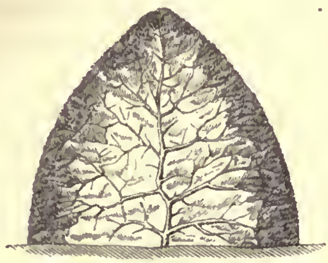


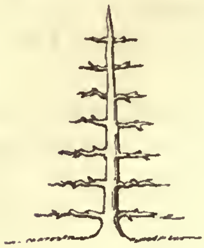
FIG. 41.

in a garden or pleasure-ground, but is not adapted for subdividing fields.

I next come to make a few remarks on the renewing and improving of old hedges. There is a very great extent of old hedges throughout England growing in a very bad and neglected state. They are allowed to grow as they will for a number of years together, and when allowed to get to a height of from ten to fourteen feet they are cut in a way termed "slashing"—that is to say, each stem is taken and cut half over about six inches or a foot above the ground, as it may be wanted; this is bent over and laid along the line of fence—and so on, each one being cut over and laid above and alongside of others in line of the fence. These are next bound together with stakes driven in about eighteen inches apart, and bound together at the tops with long hazel rods, or what are termed "yeathers." This is a thoroughly bad way of treating hedges, and should never be done under any circumstances. Hedges thus treated never make a secure fence afterwards without being constantly "staked and yeathered." The best way to renew old hedges which have been neglected, or which have become overgrown, as many are allowed to do so even when switched every year, is to cut the branches close in to the stems of the plant, as shown in fig. 42. Each cut made, on the plants forming, and to the desired height, the hedge will throw out a number of shoots, and in a few years will have thoroughly renewed itself.

When any gaps exist in the fence, they should be filled up with good strong beech-plants; these will be found much better for the purpose than thorn-plants, as the beech bears confinement, and being overhung or crushed, much better than thorn-plants. It is a frequent method in many parts of England to fill up the gaps, and any holes in the bottom, with dead thorns, but it is very injudicious to do so, as the dead branches kill the living thorn on either side, and in a few years is the cause of making the gaps much larger; and in a short time, what with splashing and filling up gaps with dead thorns, the entire fence becomes a mass of merely half-dead twigs.

FIG. 42.



Where the hedges are kept up by the farmers on an estate, they are not generally kept very satisfactorily. The usual system with farmers in Yorkshire is to give them a "dressing" once in every rotation—that is to say, once in four years—when they are in such a rough and bad state that the farmers cannot see it to be their interest to put them into good order.

The best system for a proprietor to adopt is to have skilled hedgers on his estate, and keep the fences in order under the management of the agent, and charge the tenant with all or a proportion of the expenses. This system, I am aware, has given great satisfaction on many estates. Bad fences give an estate a poor appearance; while good and well-kept fences give a property a richer appearance, and make farms let better than they would otherwise do. The expense of keeping up fences, when they are once put into good order, does not amount to much. I know a few estates where the proprietors keep all the fences in order, and the average expense on these comes to 1s. 10d. per acre per annum.

The plan to be adopted by the proprietor should be as follows:—

1st, The forester should have the management of the fences.

2d, Under the forester a staff of men, who have been trained to hedging and fencing generally, should be employed to keep the fences in order.

3d, Wherever it is practicable to do so, let the work to these persons by contract.

4th, For the keeping up of fences subdividing the farmer's own fields, he should be charged the half of the amount of the expense.

5th, For fences forming boundaries between two farms, the fourth of the expense should be charged to each tenant, the proprietor always paying the one-half.

6th, The expense of enclosing all woods and plantations on the estate should be borne by the landlord.

By adopting this mode of keeping the fences in order, the result would be satisfactory both to proprietor and tenant. It would benefit the proprietor, inasmuch as well-kept fences always increase the value of land; and the benefit to the tenant would come to him in having his fences and gates always in good order. His crops would always be secure from the inroads of cattle and other animals, and there would be no shelter for rabbits in the sides of the fences; and besides, the nurseries for rearing weeds would be done away with.

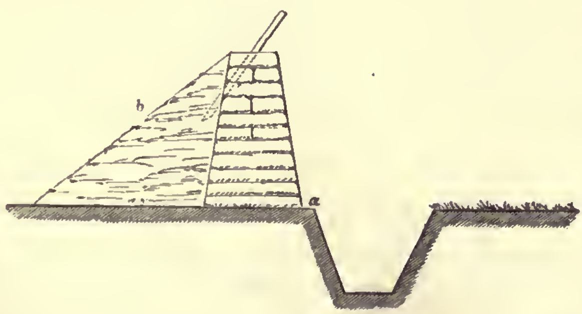
The benefit of well-kept fences is of more importance to farmers than many of them think; but so many of them go on in the old way that their grandfather and great-grandfather did, that they think they ought to go in the same way too.

SECTION 5.—*Turf Fences.*

Turf fences are used on high-lying and exposed districts, where perhaps timber is not plentiful, and stones are not to be had for erecting walls. There are two kinds of turf fences usually erected—one suitable for a plantation fence is shown in fig. 43.

This kind of turf wall is suitable for enclosing a plantation, as it only acts as a fence on one side. The turf along the site and close to the

FIG. 43.



fence is used in its erecting. The work is usually commenced by cutting the turfs about fourteen inches broad and two feet long. These are laid along the line of fence, having each turf laid lengthwise across the line. One man or set of men first proceed as described; another man opens out a ditch immediately in front of the fence, and the soil from the ditch is thrown behind the turf, as shown on the sketch at *b*. These turf walls are usually made forty inches high, and sloped to fifteen inches broad at top. As the building of the wall proceeds, the excavation of the ditch goes on at the same time, and the soil from the ditch is gradually put behind the turfs as they are built. In laying the turfs in their places, the natural or grass surface is put lowest, excepting the last row on the top, which is laid in its natural position.

The ditch outside is made forty-eight inches broad at top, and eighteen inches deep, sloping the sides down, leaving the bottom one foot wide. At the point *a* on the sketch a ledge of five or six inches is left between the ditch and the foundation of the wall, to prevent the wall giving way.

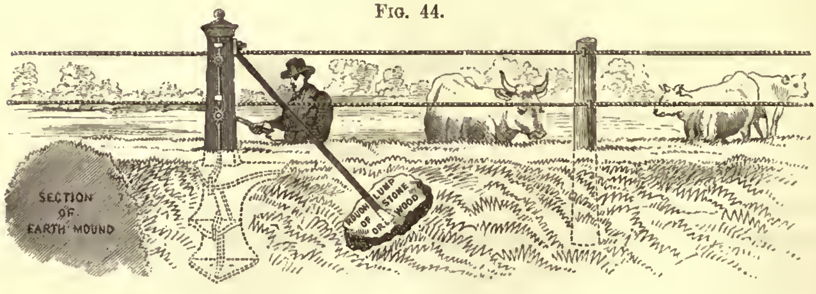
After the wall is finished, a two-barred paling, or, what is better, a wire fence, should be erected on the top, to prevent sheep springing over. The posts for a two-barred paling may be made three and a half feet long, and sawn to the dimensions of three and a half inches broad by two and a half inches thick. One-half the length of the post should be driven into the wall, and in a sloping direction, and five feet apart from each other. The rails are nailed to them—one along the top of the post, and the other four inches from the top of the wall.

This kind of fence, when completed with ditch, turf wall, and wooden paling, or wire instead of rails, will stand six feet six inches high.

Another kind of turf fence is to build turf up four feet high, one upon another, so as to make a fence on both sides. This is not a convenient fence, and therefore need not be described here.

But a turf fence may be made a very substantial one by raising a turf or sod wall to a height of about three feet, and then fix a low wire fence on the top, by driving in posts into the centre of the wall, cutting them first four feet long, so as to admit of two feet being driven into the wall, and two feet to stand above it, on which to fix two or more wires or rails, as may be thought necessary. Fig. 44 gives an idea of such a

Fig. 44.



fence, and at the same time shows the patent winding-pillar as manufactured by Messrs Morton and Company of Liverpool.

Section 6.—*Fences made from Underwood.*

On some estates where there is a large quantity of hazel and other copsewood, it is often the practice to convert a portion of it into fences. The chief mode of doing so is to have it made in the form of basket-work. In proceeding to make this kind of fence, stakes about the size of broom-handles are taken from the strongest part of the underwood, and are driven into the soil in the line of fence about fifteen inches apart, and to such a depth as will make them stand up firmly. If the stakes are cut five feet six inches long, this will admit of eighteen inches being driven into the earth, leaving four feet for the height of the fence. Having secured the stakes in a line, the process is to take the longest and most elastic shoots of the underwood and work them along the line of the stakes, putting it behind the first stake and in front of next, behind the third and in front of the fourth, and so on alternately. This "yeather," as it is called, is pushed down to the bottom of the stakes; and the next yeather is put on in the same way, with the exception that it is put in front of the first stake, behind the second, and so on, putting each yeather in an alternate position, one after the other, until the desired height is obtained; and the small end of every fourth yeather is twisted round the outside to keep it fast.

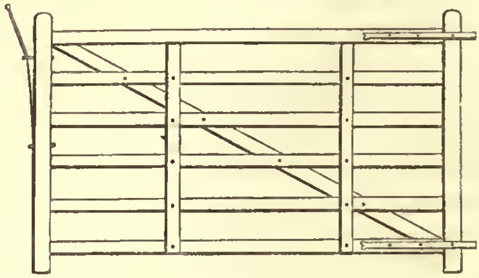
I have used this kind of fence in enclosing specimen trees planted along the side of drives in plantations. It is ornamental, gives a large amount of shelter, and is rabbit-proof. It will last from four to five years, but if coated over with tar, will last from six to seven years. A fence of this description, and made four feet high, costs 3½d. per yard; this does not include the value of the copse, which varies much in different districts.

Section 7.—*Gates.*

Gates for farms and plantation fences are made either of iron or wood. Wooden gates are more generally in use for general estate purposes; they are much lighter than those made of iron, and therefore more likely to keep in order for a greater length of time than the latter. The great point in making gates is to have strength combined with as little weight as possible. The following sketch, fig. 45, gives a view of the kind of gate which I have put up on this estate for some years.

The wood used for these gates is good foreign timber. The heads are four feet six inches long, and three inches thick by three inches broad. The heels are the same length, three inches thick and four inches broad. The bars are sawn to a thickness of three inches broad and one and a quarter inch thick. The rails are all mortised into the head and heel. The top rail is made three inches thick and three inches broad, and

Fig. 45.

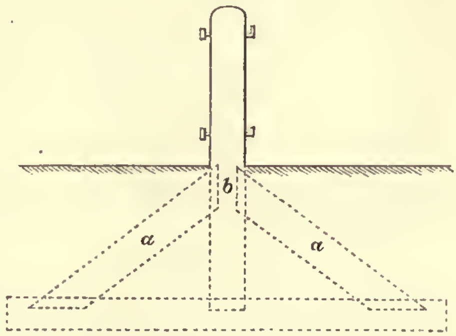


rounded at the top. We put six bars in; it makes a much stronger and a more compact gate than a five-barred one. A diagonal bar runs from the front end under the top bar to the foot of the heel, and is mortised into the top bar at the one end and into the heel at the other. Two upright rails are put on, as shown on the sketch; they are made three inches broad and one and a quarter inch thick, and are mortised into the top rail and nailed to all the lower ones.

This kind of gate is supplied to us, made of sound foreign timber, at 8s. each; this includes the value of the timber, but no painting. I have never found larch timber do well for gates; it is very apt to split and twist from the heat of the sun. It is advisable, also, to paint all the gates on an estate. Many proprietors paint with white alone; this looks well for a time, but very soon gets a dirty look. A slate or blue colour looks well, and lasts much longer than white. When appearance is not of much consequence, tar is about the cheapest material for protecting the timber with, and is a very good preservative. A very useful "paint" for gates, fences, and other woodwork of that kind, is composed of one gallon gas-tar, one pint turpentine, two ounces vitriol; mix the ingredients and apply in the usual manner.

Posts for field-gates should be made from oak timber or good sound larch. In the north of Scotland I have seen old natural Scots pine last for twenty years as posts. If the posts are not firmly fixed, the whole gate gets out of order. They should be fixed so as to withstand a good thrust from a passing cart. I find that by adopting the following method of fixing them they seldom get out of order. I fix *stays* to the posts, as shown at *a a* in fig. 46, and the same from the point *b*, and from opposite *b*. This gives a great deal more trouble in fixing them, but the extra trouble and expense are worth while for gates fixed on farm-roads or principal entrances, where there is a considerable amount of traffic. No moderate thrust will move the post in any way. The post is made eight feet long, and eight inches on the side of the square. The sole or bottom part is about seven feet long, and six inches on the side of the square—the stays being made of any rough strong piece of timber. The post is mortised into the sole as shown, and the stays are also mortised into the sole at one end, and into the post at the other.

Fig. 46.



The gate-hinges should be strong, but not too heavy; those I generally use weigh six lb. each, and are made according to fig. 47. I use these at both top and bottom. It is usual to use only a very short hinge at the bottom; but it is preferable to have it as long as the top hinge, as a long one binds the gate better together.

Fig. 47.

It is a good plan with many gates, and more especially where they are heavy, to have the lower hinge made so as to work into a socket, which is let into a stone firmly fixed in the ground close under the post. This method takes a great weight off the post, and works admirably.

In all cases the gate should be hung so that when it is opened it will shut itself again, and this is contrived by having what is termed a "knee" upon the lower hinge, which, when the gate is opened, throws the lower part of it further from the post than the top part; or the same thing takes place when the lower crook is kept further out from the post than the higher one. I always make farm-gates shut against the post. I find them less liable to get out of order in this way than when hung between the posts.

The springs or catches of the gates are made according to the following shape, fig. 48.

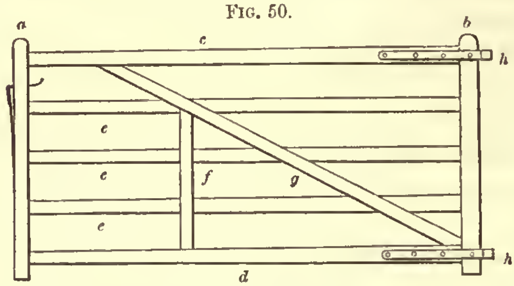
A side view of the same is given in fig. 49. The upper part at *b* is made round and the lower part flat: from the point *c* to *a* it is straight, and fixed to the head of the gate with a bolt and nut; above that point it is bent over from the gate so as to give a spring, and this is kept in its proper place, and from springing too far from the head of the gate, by a catch. This catch is shown in its place in fig. 45. It weighs three lb. and costs about 1s. 3d.

FIG. 48.

FIG. 49.

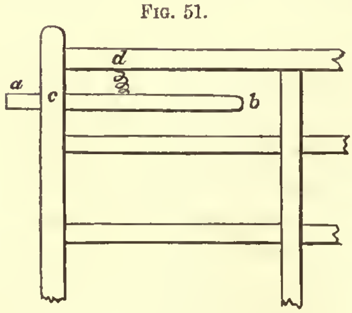
Another form of gate and catch is shown in fig. 50, a form which was used in the fencing of the extensive plantations on the Earl of Seafield's estates in Strathspey. The dimensions of this kind of gate are: The head *a*, five feet high, three inches broad by two inches thick. The heel *b*, five feet high, four and a half inches broad by two and a half inches thick. The upper and lower bars *c* and *d* are made nine feet long, three inches broad, and two and a half inches thick. The bars *e e e* are four and a half inches broad and one and a half inches thick. The piece *g* is the same size as the upper bar, and *f* the same as *e e e*. The hinges, already described, are shown in their places at *h h*.

FIG. 50.



Another form of gate-catches in great use amongst farmers in the north of England is made with wood, and is shown in fig. 51. It is a very simple contrivance, and very much to the purpose. It is usually made from a piece of good oak or ash timber, and about thirty-three inches long from *a* to *b*, the end at *a* being three inches broad and two inches thick, and from that point tapering back to *b* to about half the thickness. A mortise is made through the head of the gate, as shown at *c*, through which the wooden catch is put; and the mortise must be of such dimensions as will admit of the catch working freely in it. The catch is then hung with a small iron chain, as shown at *d*. This admits of it swinging to and fro; and from the end at *a* being the heaviest, the

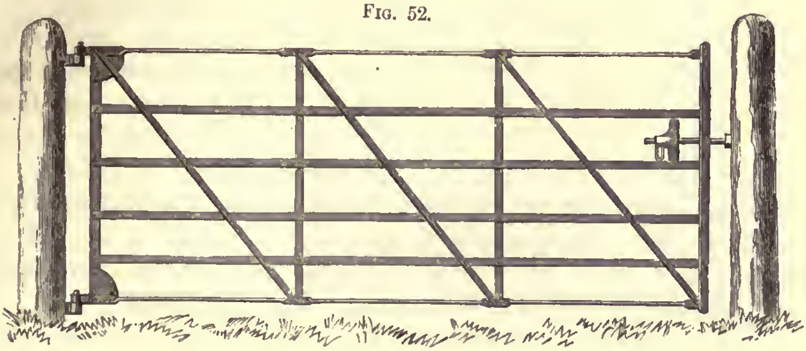
FIG. 51.



catch always swings to that side. A block of wood is firmly nailed on to the gate-post, on which is a notch for the catch to slip into when the gate shuts.

Iron gates are much in use on some estates. I have erected a few on and about the pleasure-grounds of estates. They have the advantage of being lighter in appearance where a wire fence is put up, and obstruct the view as little as possible. Fig. 52 is a sketch of an iron gate made by

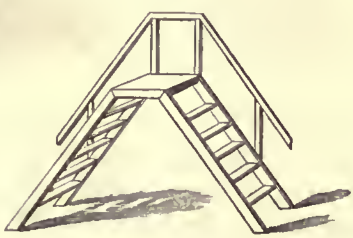
Fig. 52.



Messrs A. & J. Main & Co. of Glasgow. Although it has a light appearance, it is strong. They are made nine feet wide and four feet high. They are supplied with iron mountings for stone or wood posts at £1, 1s. each.

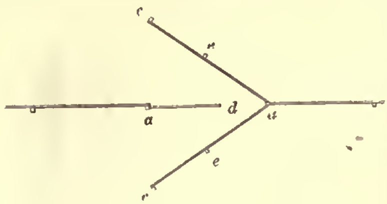
There are often footpaths crossing the line of fences on estates. Where it is not desirable to have gates, and where, if gates were placed, they would be apt to be left open, and thus allow stock to get from one field to another, and most probably cause damage to crops, means should be taken to have a way for foot-travellers without allowing them to injure the fence. I have often seen wire fences much injured in this way. The frequent heavy weight of people stepping over wire fences causes them to slacken very much in time, and the same applies to other fences. We often see large gaps made in hedges from this cause, where footpaths are allowed, which could easily be avoided by having small steps over the fence, or a turnstile fixed in. The form of steps I have used are according to the form in fig. 53. These may be made of wood, and cost from 4s. 6d. to 5s. each, not including the value of the timber. Iron steps are made by many manufacturing firms, which have a lighter appearance and look lighter than wood, and are sup-

Fig. 53.



plied for 21s. each. Turnstiles or wickets are made of wood or iron, and are made in different forms. The form I have usually adopted for common fences is as shown in fig. 54, and is the same as described in the 'Forester' at page 123, where it is stated: "The opening in the fence, from *a* to *a*, may be about four feet wide; the angular part of the wicket, *a c c*, may be about three feet wide between *e* and *e*, and may be made up with any convenient sort of wood according to taste; observing to have a post upon each of the extremities, and one at *c* upon each side, in order that the wicket *a d* may hit upon one as it folds to either side in the act of opening or shutting."

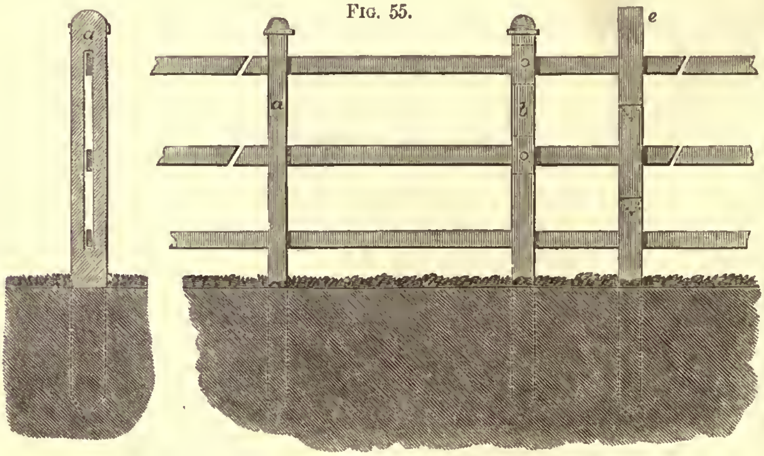
FIG. 54.



I have also used another form of stile, which I first observed on Major Stapylton's estate of Myton Hall, having been erected by Mr Calder, the energetic agent there. Fig. 55 shows the position of it when closed, and fig. 56 the position of it when open.

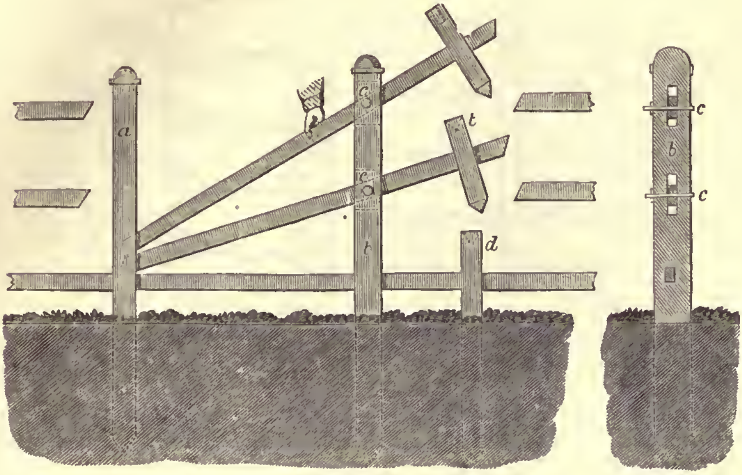
It will be seen, from the transverse section of the left-hand post, that it is mortised nearly from the position of the upper rail to that of

FIG. 55.



the lower rail: this is to allow of the rails working freely in the mortise. *a a a* shows the same post described in its different positions; *b b b* shows the right-hand post. It also is mortised in the same way, and the rails are hinged on to it with iron bolts, as shown at *c c c c*. The lower rail is made a fixture. The post *e* is made in different parts, the lower part being fixed into the ground in the usual way, and made long enough to stand midway between the lower and middle rail. The other two portions of the post *c* are mortised to admit of the rails passing through

FIG. 56.



them. The centre part of the post shown at *t*, being that attached to the centre rail, is pointed so as to fit into the top of the lower part *d*. The upper part is also pointed to fix into the middle part at *t*. The parts *t* and *g* are weighted with lead run into a hole at the top, the weight of which causes the rails to fall down and rest in their places, as shown in fig. 55; and when the hand is pressed upon the fence, it falls down, as shown in fig. 56; and on the hand being taken away, the rails resume their place. Such a stile or pass can be erected in places where it is not desirable to show any other kind of stile.

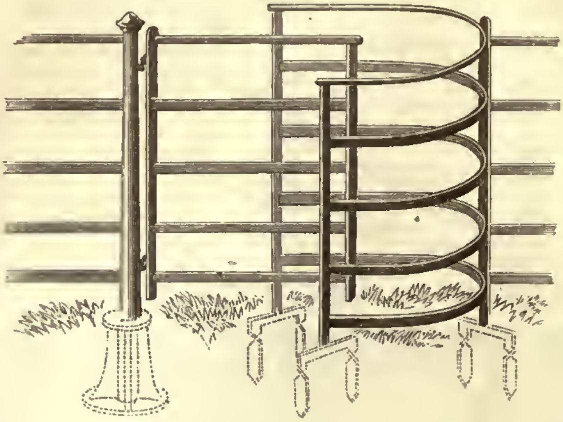
I find this kind of wicket described to be very useful in a line of fence where a footpath crosses. They are simple, and can be easily made by any country carpenter. They are always shut, and at the same time open to any one passing.

Fig. 57 is a form of iron wicket or turnstile made by Messrs Main & Co. of Glasgow, and is really very much to the purpose, as we have proved. Such a one as shown, with iron pillar complete, and three feet four inches high, costs 36s. 6d.

In many cases a small iron or wooden gate might answer the purpose better, such as in fig. 58. The chief objection to small gates is that they are apt to be left open, and then cattle trespass. We have already given a description of wooden steps for erecting over a fence. Many are also to be got of iron, such as in fig. 59. Such iron steps are portable, and can be shifted when wanted. They cost from 26s. upwards.

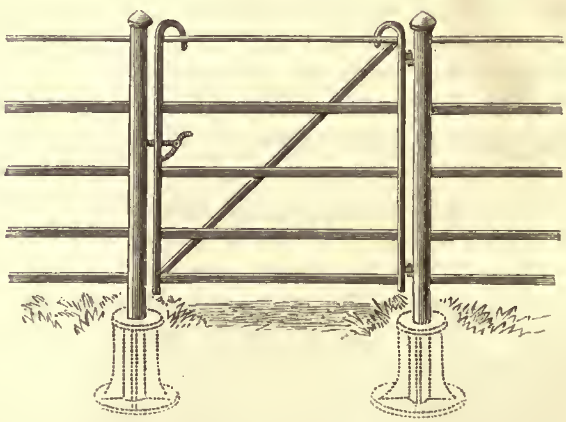
Where tar is used to preserve fences from decay, there is a very simple and useful contrivance for wheeling the tar along the line of fence in

Fig. 57.



the form of an iron barrow, as shown in fig. 60. The one I have had in

Fig. 58.



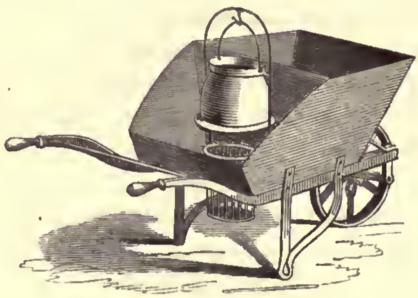
use is manufactured by Messrs A. & J. Main of Glasgow. It is made entirely of wrought iron, and is fitted with fireplace, pot, and compartment for holding fuel. The price is £2, 17s. 6d.

Section 8.—*Sunk Fences.*

A sunk fence, as its name implies, is meant to be erected in such a position as it will be out of observation at a distance. It is a fence which was at one time very much in use, but within late years it has been seldom erected. This is to be accounted for by the introduction

FIG. 59.

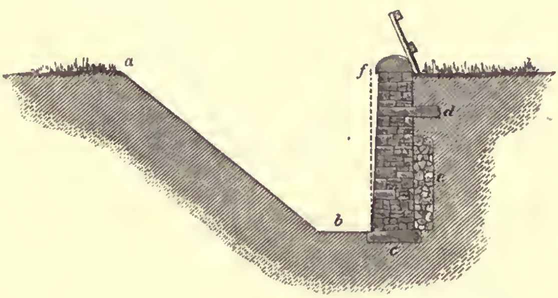
FIG. 60.



of wire for fencing purposes, which is not much seen, and is very durable. Sunk fences are expensive, especially upon a level surface, as the excavation of the soil comes to be a heavy item in the expense.

Fig. 61 is a view of an end section of sunk fence on a level surface. The cutting of the excavation is commenced on the surface, about ten

FIG. 61.



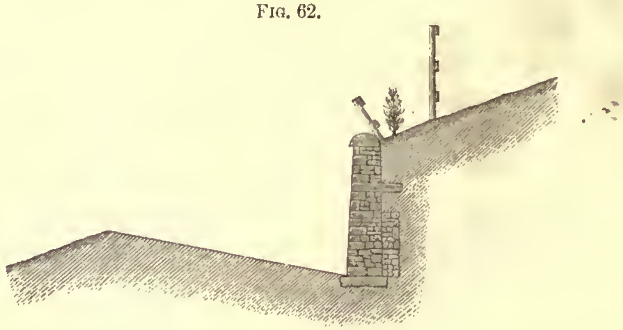
feet wide, as from *a* on the sketch to the point behind the wall touching the earth; this admits of an opening of about eighteen inches for the wall at the top, and eight feet and a half between the front of the wall and the opposite surface at *a*. The opening should be made six feet deep; this will admit of half a foot for the foundation of the wall, and five feet six inches for its height. A level space should be left at the bottom, of two feet between the front of the wall and the bottom of the slope, as shown at *b*.

The foundation of the wall should be laid with large flat stones, as at *c*. The wall should be eighteen inches broad at the bottom, and fourteen at the top, under the copestone. The copestones should hang over the first somewhat as shown at *f*.

The part shown at *e*, immediately behind the wall, should be filled in with small stones to act as a drainage to the wall, and holes should be left at regular distances through the wall to admit of any water getting through from the part behind to the ditch in front. A large stone should be put in at *d* to cover the breadth of the wall and enter into the earth a few inches; this assists materially in keeping the fence strong and firm. If there is a field in which stock graze to the right of the wall, as shown, then a low paling will have to be erected on the top to prevent the stock getting over; but if there is a plantation on that side, then it should answer without a paling. The paling should be made to hang slightly over the wall, as shown, in order to prevent sheep springing over from the ditch side.

Sunk fences are admirably adapted for the sides of slopes, or on any unequal surface. These are made in much the same way as described already, as shown in fig. 62.

Fig. 62.



The building of the wall should be done in the same way as the other sunk fence. On high-lying sites, and where they are not much seen, these fences might be built without mortar; but when in any home-park, they should be erected with mortar; and in any case the copestones should be put on with lime. When the wall is built without lime, or what is termed dry-stone, the drain behind need not be put in.

In exposed positions a hedge is sometimes planted immediately behind the top of the wall, at a distance of about fifteen inches from the stones; and to protect it on both sides from cattle until it is strong enough to act as a fence by itself, a paling should be erected on each side, as shown.

In high-lying districts these kind of fences are very serviceable; they can only, of course, be made useful where the line of fence runs at right angles with the slope of the ground, and the shelter given by the wall and hedge is considerable.

I have had such fences erected as described, in the first case, at a cost of 5s. per running yard; and of the latter kind, on a hill slope, for 3s. per yard. This, however, is no criterion of what they may cost in other districts, as this depends upon the character of the soil to excavate, and the distance the stones have to be carted.

CHAPTER XV.

DRAINING.

In considering this part of estate management, I shall take it under the following sections:—

1. The condition of land requiring draining, and its benefits.
2. The draining of arable and meadow lands.
3. The draining of hill-pastures for sheep.
4. The draining of woods and plantations.
5. The draining of bogs.
6. How to conduct drainage operations on an estate.
7. Other improvements which must follow drainage to make it effectual.

Section 1.—*The Condition of Land requiring Draining.*

In moderate quantities, water is necessary for the health of plants; but when we find it in excess in the soil, or in a stagnant state, it becomes highly injurious. There are, no doubt, plants which require a larger amount of water than others, and there are a few plants which thrive well in stagnant water; yet the cereals, roots, and forage-plants which we cultivate will not come to perfection in land saturated with water, nor yet will the finer grasses thrive unless the land is dry. All the plants which we cultivate in our fields require a certain amount of heat in the soil for their healthy development; but an over-abundance of water in the soil, and more especially water in a stagnant state, reduces the heat required, and makes the soil too cold for the plants to live and thrive. Land which is saturated with water, and therefore too cold and wet to grow the finer plants, can generally be known on the surface by the kinds of plants growing naturally on it. When we examine a meadow or pasture-field, if there be any stagnant water in the subsoil, it will generally be indicated on the surface by certain plants growing there which luxuriate in a damp site. The following are a few of the plants which will generally be found on wet soils or grass-land: *Juncus effusus*, *Juncus acutiflorus*, commonly known as rushes. The tufted hair-grass (*Aira cæspitosa*) and the glow-worm grass (*Luzula*) are indications of a wet subsoil.

Grain, turnips, and grasses, when sown on a wet soil, acquire a stunted habit, and have a sickly and unhealthy appearance. Many farmers think that, so long as there is no water lying on the surface-soil in summer, there is no need of drainage. They think there is no harm done by water lying on the soil during winter; this is, however, a great mistake. It is exceedingly injurious to allow water to remain stagnant on the surface even during the winter season, as it keeps the soil in a damp sour state, so that when summer comes, a season intended by nature to warm the land for the benefit of the crops, it takes the heat of the sun's rays a long time to evaporate the water from the surface of the soil, and thus the best portion of the growing season is over before the roots of the plants can receive any heat from the sun. Another great disadvantage in wet soils is that, if the heat of the sun is allowed to evaporate the water from the land, the soil always remains in a baked hard state, and more especially does this take place in clay soils. On the other hand, where land has been drained, the water passes freely through both the soil and subsoil, leaving in the soil, as it passes through, the elements which it contains for the benefit of the plants. As soon as warm dry weather sets in, the rays of the sun act at once upon the soil, and it remains free, open, and warm during the growing season.

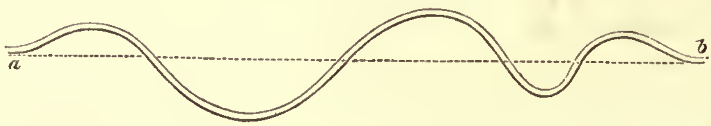
A great many of our clay soils which remain in a wet and undrained state, and which at all seasons are stiff, and in the summer season are as if they had been baked, can be vastly improved by judicious drainage. When the water is removed by drainage from clay soils, they gradually become more porous, and thus the air gets in and makes them free, open, and friable. Any soil is always the richer for having the air penetrating into it; and where drains are made in the subsoil at a proper distance from the surface, water naturally makes its way to these drains, and as the water seeks through the soil, it makes way for air, which follows it through as far as the water goes; and at the same time these drains carry off, by means of the water, any bad ingredient in the soil which might be injurious to the plants.

Wet soils never receive the same benefit from manures put upon them as those which are properly drained, because where water is stagnant manure does not decompose readily, nor does it exist in such a healthy state to become food for plants as it does where land is drained. Where there is air, manure decomposes faster, and is in better condition; hence on drained lands manure becomes more fertilising.

SECTION 2.—*The Draining of Meadow and Arable Lands.*

The first great point in commencing drainage operations is to procure a good outfall, which of course depends on local circumstances. The main drains should have sufficient fall, as on this depends the proper working of the whole system. The main drains are generally discharged into open ditches, streams, or rivers; and attention should be paid to see that the mouths of the mains are kept at such a distance above the highest water-mark of the ditch, stream, or river, as the case may be, as will prevent the drains being flooded by back-water. The openings of the main drains should also have a grating of iron in front, to prevent rats or any vermin or dirt getting in to choke the drain. I have usually put in an iron pipe, with grating in front, as the first pipe in the drain; it is better to have this than to have a common clay pipe projecting at the mouth, which is liable to be broken at any time. If the main drains are emptied into streams which are crooked, it is often the case that the water in the stream runs sluggish from its crooked state, and thus keeps back the water in the drains. Where such exist in a crooked state, as shown in fig. 63, and where the

FIG. 63.



nature of the ground will admit of its being done, the stream should be straightened, as shown by the dotted line *a b*. I have observed on many estates a stream such as is shown, which acted as a "mother" drain to several thousands of acres, and which, if properly straightened, would have benefited the general drainage very much. In straightening a stream of this kind, the earth taken from the new cut should be emptied into the old watercourse.

The expense of straightening such streams is not so much as is generally supposed—at least the expense is not much when the benefits resulting from such an improvement are taken into consideration. I have had them done at the rate of 3d. per cubic yard of soil removed, the soil being removed from the new bed and put into the old bed at an average distance of twenty yards. Of course the cost per mile or half-mile can easily be ascertained by the length, breadth, and depth of the cutting, and calculated accordingly.

The main drains should be run along the lowest level of the field, provided the outfall will admit of this. If the lowest level should be near to a hedge, the main drain should be kept back from the hedge at least four or five yards, as, if put too close, the roots of the hedge-plants, or any trees which may be in the hedgerow, will gradually grow into and choke the drain-pipes.

Small drains should be run into the main ones at regular distances, if the nature of the surface will admit of this; and if not, they must be put where they can be conveniently got, keeping their thorough efficiency in view.

The depth of the drains, and the distance apart from each other, must be guided by the nature and character of the soil and subsoil, but chiefly as regards the subsoil. No rule can be laid down to suit all cases. It is certainly an error in having the pipes laid too deep in some soils, especially in stiff clay soils; and errors are more frequently made in having the drains too shallow. There is generally a hard portion or layer of the soil—what is termed the "pan"—which must be penetrated to insure thorough drainage. This pan lies at different depths in different soils and localities, and therefore must be a guide in determining the depth of the drain. In all cases the main drains should be cut from four to six inches deeper than the small ones, and more especially at the lower end, where there is most water. Unless the main drain is a few inches deeper than the minor drains, the accumulated water in the main will prevent a free flow from the small one. Where there is a rapid fall along the line of the main drain, there is not much necessity for its being deeper than the smaller ones.

I am now draining a large field on this estate where the soil is a clay loam and the subsoil a clay. At a depth of two feet eight inches from the surface there is a stratum of dark-blue shale, very hard. I am draining this field by cutting the main drain three feet four inches deep, and running small drains parallel to each other at a distance of fifteen feet apart, and these are cut three feet deep. At this depth we get through the shale, and I find that the drains are working admirably. A field adjoining the one mentioned, of a similar nature of soil and subsoil, was drained in a like manner two years ago, and the improvement has been very great.

The distance apart of the drains must be guided by the same circumstances as the depth. If the soil and subsoil is at all porous, a greater distance may be put between the drains; but in stiff and retentive soils it is an error to have them too far apart. I should say that four yards apart may be considered as the least distance between drains in stiff soils, that seven yards should be the greatest distance apart in the same kind of land.

The kind of pipe best adapted for general drainage operations is, in my pinion, as shown in fig. 64. Different kinds are used, as shown in fig. 65,

Fig. 64.

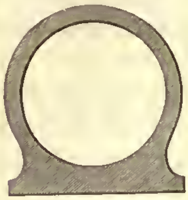


Fig. 65.

and especially an egg-shaped kind, which stands higher, and is narrower at the bottom than fig. 64. Stability is of great importance in a drain-pipe, and this can only be attained by having a broad bottom, as in fig. 64. Pipes with collars are also very safe to use. The collars prevent earth getting into the pipes at the joints. The implements used in cutting ordinary drains in England are shown in fig. 66.

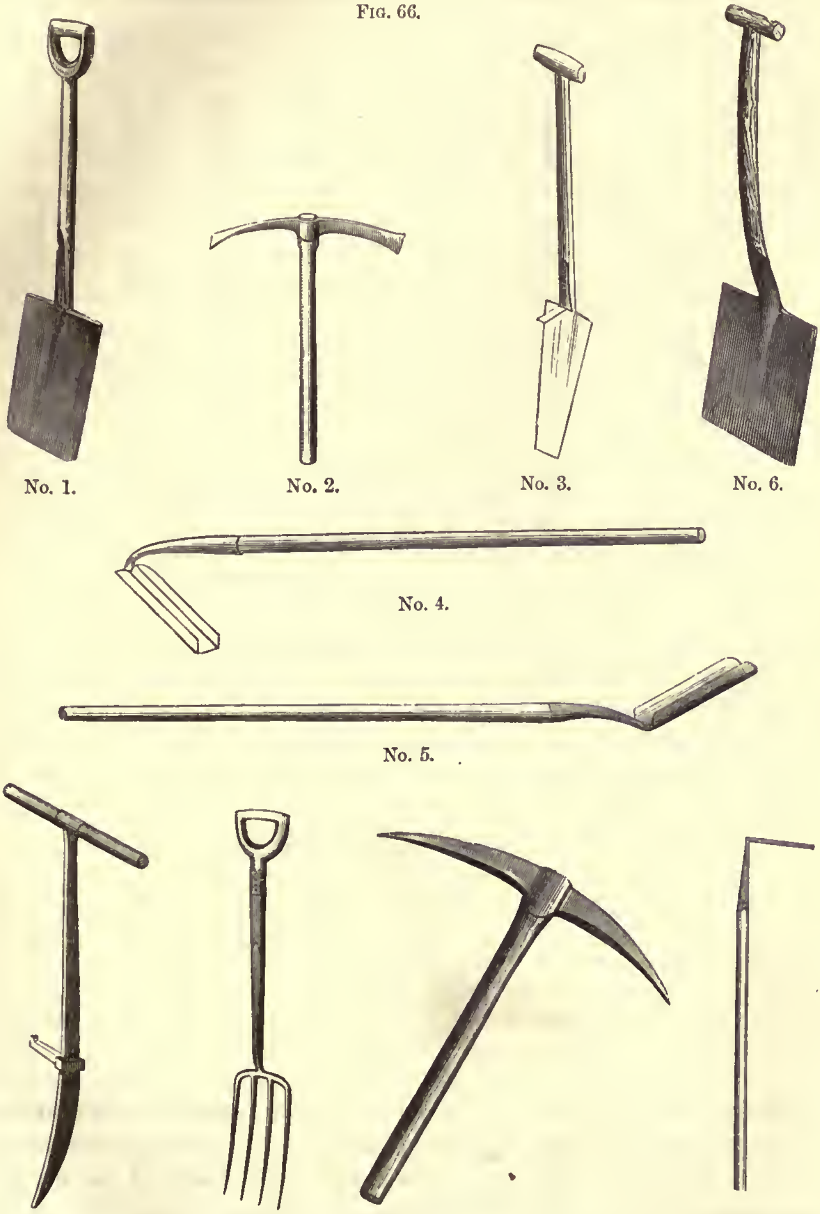
Cost of Draining Implements.

No.				
1.	Common spade, usually costing . .	£0	5	6
2.	Mattock, ...	0	5	6
3.	Narrow draining-spade or spit, . .	0	7	0
4.	Drawing-scoop for cleaning bottom of drain previous to pipe being laid, ...	0	4	0
5.	Pushing-scoop for same purpose, . .	0	4	0
6.	Shovel for filling in drains, . . .	0	3	6
7.	Foot-pick for removing stones and hard soil,	0	7	6
8.	Fork for lifting lumps of clay and filling in drains, ...	0	3	6
9.	Pick, ...	0	5	0
10.	Tile-hook for laying pipes in the drains, .	0	1	6

Besides the list of implements given, another small one is used. This is called the "tile-pick." It is made in the form of a small pick, having one end pointed, and the other broad like a mattock. This is used for making holes in the sides of drain-pipes, so as to admit of one pipe entering into the side of another, as in the case of a small-drain pipe being made to join into a main-drain pipe.

The table on p. 184 shows the probable cost of draining land of different qualities of soil and at different distances apart. The quality of the soil affects the cost of drainage in a great degree, as some soils are more easily dug than others; and the stiff or open nature of the soil and subsoil, as the case may be, requires a greater or less depth of drains. Very stiff soil is of course difficult to remove, and consequently a greater expense is incurred. The greater the depth of drains made, the heavier will be the expense incurred, although in some instances the quality of the soil may alter this—as, for instance, on referring to the

Fig. 66.



No. 1. No. 2. No. 3. No. 6.

No. 4.

No. 5.

No. 7. No. 8. No. 9. No. 10.

table, it will be found that, in a friable clay, drains made two feet nine inches deep cost 4½d. per rod, cutting and filling, while drains made in a loam soil three inches deeper will cost the same; but, generally speaking, the greater the depth of the drain, the more expensive it will be.

TABLE showing the NUMBER of PIPES required to drain an ACRE, and the COST.

DESCRIPTION OF SOILS.	Distance of Drains apart.	Depth of Drains.		Number of Rods of Drains per Acre.	Cost of Cutting and Filling per Rod.		Cost of Cutting and Filling per Acre.			Number of Drain-Pipes of 12 inches long required per Acre.	Cost of Drain-Tiles per Acre, at 30s. per Thousand.			Total Cost per Acre.		
Heavy Soils—	Feet.	Ft.	In.		s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
Compact tenacioua gravelly clay, . . .	15	2	6	176	0	5	3	13	4	2905	4	7	2	8	0	6
Stiff adhesive clay, . .	16½	2	6	160	0	4¾	3	3	4	2640	3	19	2	7	2	6
Friable clay, ...	18	2	9	147	0	4½	2	15	1½	2420	3	12	7	6	7	8
Free aoft clay, . . .	21	2	9	126	0	4	2	2	0	2076	3	2	3	5	4	3
Medium Soils—																
Clayey loam, . . .	22	3	0	120	0	5	2	10	0	1980	2	19	5	5	9	5
Marly loam, . . .	24	3	0	110	0	4½	2	1	3	1814	2	14	5½	4	15	8
Gravelly loam, . . .	27	3	0	98	0	7	2	17	2	1613	2	8	4½	5	5	6½
Friable loam, . . .	30	3	3	88	0	6	2	4	0	1452	2	3	6½	4	7	6½
Light Soils—																
Light gravelly loam .	33	3	6	80	0	8½	2	16	8	1320	1	19	7	4	16	3
Light marly loam, . .	36	3	9	74	0	8	2	9	4	1209	1	16	3	4	5	7
Sandy loam, . . .	39	4	0	68	0	7½	1	19	8	1117	1	13	6	3	3	2
Soft light loam, . . .	42	4	0	63	0	7	1	16	9	1037	1	11	1½	3	7	10½
Sandy soil, ...	45	4	0	59	0	7	1	14	5	974	1	9	2½	3	3	7½
Light gravelly sand, .	49½	4	3	54	0	10	2	5	0	830	1	7	4½	3	12	10
Deep do. do. .	55	4	3	48	0	9	1	16	0	792	1	3	9	2	19	9
Coarse do. do. .	60	4	6	44	1	0	2	4	0	726	1	1	0	3	5	9
Looae do. do. .	66	4	6	40	0	10	1	13	4	660	0	19	9½	2	13	1½

I generally calculate the expense of draining land per acre by first taking the cost of opening out and filling in the drains per rood of seven yards, adding to that the cost of the pipes for the same length, and then finding out the number of roods in an acre; this, of course, varies with the width of the drains. Thus we find that there are in an acre, when the drains are cut

4	yards apart,	170	roods,	of 7 yards each.
5	,,	137	,,	,,
6	,,	114	,,	,,
7	,,	97	,,	,,
8	,,	86	,,	,,
9	,,	74	,,	,,
10	,,	70	,,	,,
11	,,	63	,,	,,
12	,,	57	,,	,,

The statements given of the drainage of land throughout the country vary very much, and this must be expected when we consider the many different qualities of soils, the distance apart and depth of the drains, and the convenience for the purchase and cartage of the pipes, all of which influence in a more or less degree the cost of the drainage, so that no sum can be put down as being the definite cost of drainage.

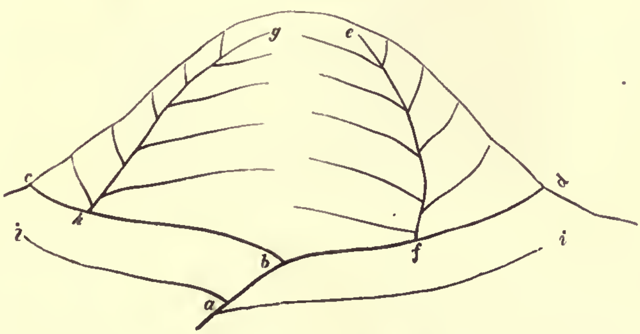
SECTION 3.—*The Draining of Hill-Pastures for Sheep.*

The usual system of draining hill-pastures is by means of open cuts, which I shall describe in this section; but where covered drains can be put in at a moderate cost, it is always best to have them in preference to the open cuts, and this for three chief reasons: 1. The surface is better drained by them; 2. They are more permanent, and are more secure from filling in, or being choked or damaged; 3. The pasturage is not broken, nor is any of it lost.

Where covered drains are used, they should be made similar to those described in the first section of this chapter; but as open drains are usually employed for drying hill-pasture, I shall here describe the mode of doing so.

Open drains on hilly grounds are generally made in what is termed the "herring-bone" form. Fig. 67 will give an idea of the position they occupy.

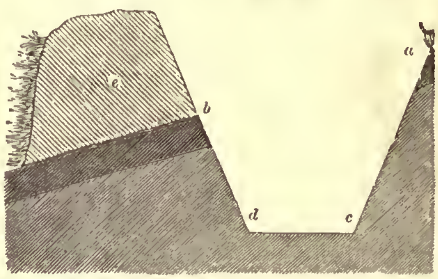
FIG. 67.



The main drains *g h* and *e f* are cut nearly straight over the hill, and the side drains are run across the hill into these mains; but they should not be cut at right angles to the main drains, but at an angle of about forty-five degrees to the main, and parallel to each other. The small drains should be run into the mains alternately—that is to say, the mouths of the small ones should not be run into the main opposite each other, but at a few feet apart, as, if they are cut so that there should be a strong current of water flowing from each, the two currents meeting would cut up and destroy the main drain. The main drains should be cut thirty inches wide at top, and sloping down on each side to nine inches, or about the breadth of a common spade, at the bottom. The necessary depth so much depends upon the nature of the soil and subsoil, that no given depth can be set down. To make them deep enough to dry the surface thoroughly might require a greater depth than would be judicious for the safety of the sheep, and more especially of lambs. From fifteen to eighteen inches is a very fair medium depth for the ordinary soils of hill-land, and for the safety of sheep; and besides, by giving them a good width at top, and keeping them narrow at the bottom, they thus have a great slope on the sides, which is an advantage. The soil in all cases of main drains should be spread out on each side, to prevent it being trodden in again by sheep. The main drains *e f* and *g h* may in many instances be sufficient to carry away the water from the hill either into a stream at the foot or into closed drains in fields below; but in many cases it may be necessary to make other main drains, through natural hollows in the hill, as the case may be, as shown at *a b*, *b e*, *a b*, *b d*, and *a i*, in fig. 67.

The small drains are usually cut according to fig. 68. They are cut

Fig. 68.



about twenty-four inches wide at top, from *a* to *b* on the sketch, making a good slope from *a* to *b*, and eighteen inches deep, measuring by the slope, and from twelve to fourteen inches deep on the low side, as at *b d*, the bottom being about nine inches wide. All the soil taken from the drain is put upon the low side, as shown at *e*, but not heaped up too high, as it is apt to be worked back into the drain by the sheep.

This kind of drain has cost me from 9d. to 1s. 3d. per chain of twenty-two yards, according to the hardness of the soil, and the length and strength of heath on the surface.

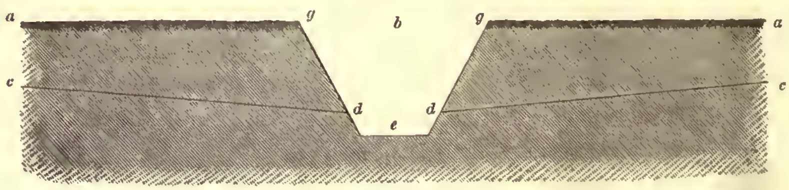
Section 4.—*The Draining of Woods and Plantations.*

Even after all the benefits which have been derived from the drainage of agricultural lands, and the evident desire there is with many landed proprietors to have their farms thoroughly drained, it is surprising that so little has been done for the benefit of trees, and yet trees will not grow to perfection in a cold wet soil. A crop of trees is just as liable to be retarded in their growth from a wet soil as a crop of wheat. The management of woods and plantations is neglected in many respects, and none more so than in the case of drainage. The main drains from fields are even in many cases run through the fence which divides the fields from the woods, and there allowed to discharge themselves as they best may. How often do we find trees making an attempt to grow in wet soils, which in winter freeze and lie in one solid mass around the roots of the trees! I have before stated that air is essential in the soil where agricultural crops are grown; it is also as necessary for the benefit of the growth of trees. Trees also grow better when the heat of the sun is admitted into the soil, and of course this cannot be the case where there is a quantity of water constantly in the soil. I have often seen young trees planted in wet swampy places, where the greater portion of them died; and the planters have blamed nurserymen for supplying inferior plants, whereas the cause of the failure was in the want of drainage. I was once called upon to inspect and report upon an avenue of hardwood trees which had been planted some four years previous to my visit. I found nearly all the trees in a very unhealthy state, and the prospect was that, if there were not some remedy at hand, they would all die in a short time. After a minute inspection, I found that the soil alongside the carriage-drive was of a clayey nature, and the subsoil the same. When the trees were planted, large pits were very properly made for them, the stiff soil which was removed from these pits being carted away to a distance, while a light loam soil, mixed with rotten manure, was put in the pits about the roots of the plants. The consequence was that, the loam being of a lighter nature than the clay, the surface-water ran into the pits, and remained there in a sour stagnant state, which naturally prevented the trees from growing. I recommended that a drain should be made the whole length of the row of trees, at a distance of about five yards from them, into which small drains were run from the pits. The consequence was that the water went freely through the soil in the immediate neighbourhood of the roots of the trees, and passed away in the drains after refreshing but not souring the roots as formerly.

Drainage must be applied to tree-culture in a different mode than that which is employed in the case of field crops, inasmuch as the roots of the trees are strong and remain in the soil for a long length of time, and every year run further and deeper into the soil, while agricultural crops are only for the season, and their roots are tender. If, therefore, covered drains with pipe-tiles were used for drying woodlands, the roots of the trees would disturb the pipes and make the drains of no avail, so that a system of open drainage must be applied. I have found drainage of land for the growth of trees of great benefit in opening out subsoils where there was no apparent presence of water, but where there was a hard band of soil through which the roots could not penetrate, and water could not get through it from above. By having this kind of subsoil opened out by means of open cuts made of sufficient depth, I have found that the action of the air upon the subsoil, and water flowing over the hard band into the drains, was the means of gradually loosening it, and carrying away ingredients in it which were hurtful to vegetable life. I am of opinion that, if drainage had been applied to arboriculture fifty years ago, we should not now find so many of our old plantations in an unhealthy state.

The following is the mode in which I have usually drained plantation-ground. Fig. 69 will give an idea of the form of drain referred to.

Fig. 69.



The main drains I have made thirty-six inches wide at top, as from *g* to *g*, sloping them on each side to a depth of thirty-six inches, as from *g* on each side to the corners of the drain opposite *e*, leaving the bottom twelve inches broad. The letters *c d* indicate the line of the small drains running into the main drain *b*. The regular depth of the small drains being thirty inches at *a c*, they should receive a greater descent into the main drain, as shown from *c* to *d*, making the depth from *g* to *d* fully six inches deeper than at *a c*.

The small drains I have made thirty inches broad at top, thirty inches deep, and nine inches broad at bottom. This has been done where the subsoil was stiff and inclined to clay; on lighter soil less dimensions would answer the purpose.

The distance apart of drains, of course, depends upon the nature of the soil. On stiff soils I have kept them at seven to nine yards apart, and on light soils as far as fourteen yards apart.

The soil thrown from the drains should be spread back over the surface of the ground to prevent it falling in again.

The cost of such drains varies according to the character of the soil and subsoil. On the stiff soils, as I have described, I have got them done by contract for about 2s. 6d. to 2s. 8d. per chain of twenty-two yards.

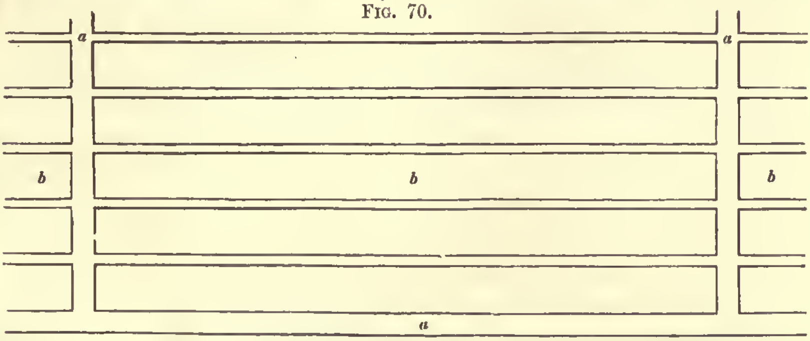
Open drains in woods and plantations should be cleaned out at least once in two years. The fallen leaves and the action of frost on the sides of drains crumble the earth down and tend to choke them.

SECTION 5.—*The Draining of Bogs.*

Bogs in Ireland, and mosses in England and Scotland, are those low-lying flat peaty soils which are generally found in a wet state.

The system, as practised on many estates in Scotland, for drying these bogs will be learned on referring to fig. 70. If, as is usually the case,

FIG. 70.



the bog or moss is flat, large open ditches are cut parallel to each other, at from fifty to sixty yards apart, as shown at *b b b* on the sketch. These parallel drains are run into still larger open ditches at either end of the bog desired to be dried, as at *a a a*. If the peat is not too deep, the drains are cut to its bottom, where clay is generally found. A moss is always well dried and improved if the open ditches can be got to the bottom of the peat; where such is the case, the ditches are allowed to remain open for a few months to allow the peat to dry and subside, and then large pipes are put in the bottom and the open cut filled in.

Where the peat is very deep—and I have sometimes met with it twenty feet deep—there is great difficulty in getting it properly dried. In this case the ditches are laid out as described, and cut about four feet wide at the top, four feet deep, and sloped down on each side to about fourteen inches wide at the bottom. After the peat has dried and subsided, the ditches are then deepened until the peat on the surface becomes dry enough for the purpose required.

In cutting the drains, the peat taken from them is cut in the proper form for use as fuel. Temporary bridges made of timber and turf are put across the ditches to allow stock to get across, and sometimes I have seen the sides of the ditches sloped back in places to make a crossing for stock.

There are different opinions given as regards the drainage of moss-land, some recommending shallow draining and others deep. Peaty soils contain a great amount of water, and as soon as drains are cut, the water is drawn off and the peat subsides; but the water will only be removed to a certain depth in the soil in proportion to the depth of the drains made. Presuming that drains are cut in moss-land to a depth of two feet, the water will not be removed to a greater depth in the soil than one foot, and not to the full extent of the drain, as peat acts like a sponge, and will retain the water to a certain height above the bottom of the drain, so that very little advantage is gained by drainage at a depth of two feet for the cultivation of almost any kind of crop. If drains are cut three feet deep, the drying of the soil to a depth of, say, two feet, will cause the peat to shrink down from eight to ten inches, as I have seen it do in several instances. A few drains cut to the bottom of the peat will dry the soil much more effectually than a large number of shallow ones cut on the surface. In cases of very deep mosses, the expense of cutting the drains to the bottom of the peat would be more than the land was worth; but I repeat, that where it can be done at a reasonable outlay, it is the most effectual and permanent.

I reclaimed a portion of moss-land in Strathspey in a very effectual manner. The extent was ten acres, and the peat ranged in depth from nine to twelve feet. It was, previous to reclamation, of a soft spongy nature, on which neither horses nor cattle could walk. In 1857 I had it drained by open cuts made in the way shown in fig. 70, making the main cuts one foot deeper than the small ones. The small ones were cut four feet deep, with a good slope on the side to prevent any soil falling in. After these drains had remained in operation for twelve months, I found the peat had subsided considerably, and I again had the open cuts deepened; and this time I was enabled to get to the bottom of the peat with nearly all the small cuts, but not so with the main drains, which had been opened in the lower parts of the ground, where the peat was deepest. I allowed the drains to remain open for another year, during which time the peat dried very much and subsided to a depth of fully one foot. In the spring of 1859 I had drain-pipes with collars put in the small cuts, and filled them in. One of the main drains I allowed to remain open, and in the others I put drain-pipes laid on broad wooden soles to prevent the pipes sinking in the moss.

The whole ten acres were in the spring of 1860 trenched and sown down with a crop of oats, and the produce was fully fifty-one quarters per acre. The small drains were put in parallel to each other at a distance of twenty-eight feet asunder. The total cost was somewhat over £8 per acre.

I am of opinion that, in the majority of cases in this country, in the drainage of peat-lands, the most effectual way is to cut the drains at first only to such a depth as will enable the soil on the sides to keep together. Many mosses are so soft that the drains cannot be cut to a great depth at first. After the drains have remained in operation from twelve to eighteen months, the upper soil will have so dried as to enable them to be again deepened, and to go on gradually in this way until bottom is reached. These operations will in many cases extend over from three to four years. It is certainly a slow process, but, generally speaking, it is the only way to make a permanent work of it.

Where the moss is very deep, the drains may be formed with pipes laid on half-inch wooden planks to prevent the pipes sinking in the peat.

SECTION 6.—*How to conduct Drainage Operations on an Estate.*

When extensive drainage operations are contemplated on an estate, it will be found that the agent has not sufficient time at his disposal to attend to the drainage properly. The cutting of the drains should be let by contract to the workmen. An experienced drainer should be constantly with the men, to watch every drain in the course of its formation. I have sometimes appointed one of the most experienced of the workmen as superintendent, who sees that each drain is properly made, and that it has sufficient fall, and that the men cut them to the required depth. This man also attends to the laying in of the pipes, and keeps a statement of the work done in each field.

It will be found very useful to have a drainage plan of the estate—that is, a plan showing each field, and the number and position of the drains in each field—so that the position of any drain can be found out at any time afterwards.

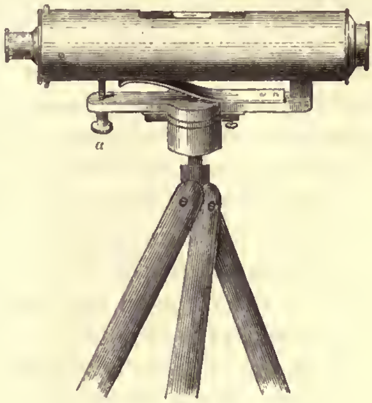
The following is a form of Drainage Report which I have had in use on this estate, and which the drainage foreman fills up, from which the agent can take out the expenses and other information in regard to each field as the work goes on :—

MONTHLY REPORT OF DRAINAGE OPERATIONS on the ESTATE.

NAME OF OCCUPIER.	FIELD.		MAIN DRAINS.			DAY LABOUR.				CONTRACT.	OTHER DRAINS.			DAY LABOUR.				CONTRACT.	REMARKS.
	Name and No.	Acres.	No. and Size of Tiles.	Cutting of		No. of Men.	Rate of Wages.			Per Rood of 7 Yards.	No. and Size of Tiles.	Cutting of		No. of Men.	Rate of Wages.			Per Rood of 7 Yards.	
				Lgh.	Dph.		£	s.	d.			Lgh.	Dph.		£	s.	d.		

A good drainage-level is necessary on an estate. Where a theodolite is kept for surveying purposes, it also does for levelling; but as it is an expensive and complicated instrument, a more simple drainage-level should be kept. I have had one in use for some years which answers the purpose admirably. Fig. 71 is a sketch of it. It consists of an achromatic telescope with cross lines. The spirit-tube lies at the top of the telescope. By turning the screw *a*, the tube can be raised or lowered as required. In the centre, and at the top of the legs, there is a universal joint that will admit of the telescope being turned in any direction. This instrument is manufactured by Mr Cooke of York, who sends instructions along with it. Its price is £3, 10s.

FIG. 71.



SECTION 7.—*Other Improvements which must follow Drainage to make it effectual.*

In order to make drainage of the utmost value to the soil, it must be succeeded by other important improvements; and the chief of these are, deep stirring of the soil, and the abundant application of manures. It will always be found that unless this is done, drainage for a time does more harm than good. I have known fields which were thoroughly drained, but being left in the hands and management of a tenant who was in no way a first-class farmer, they actually became much poorer, and deteriorated in value, under the old system of management.

Both the soil and subsoil should be thoroughly stirred up and opened out after drainage. If it is thought too expensive to trench the land as recommended in a former chapter, the steam-cultivator will be found a most beneficial implement for this purpose. I have had fields stirred to a depth of fourteen inches with this implement. Where a steam-cultivator is not to be got for this purpose, there are several trench and subsoil ploughs which will be found useful for such operations. Amongst the best of these with which I have personal experience are "the Tweeddale" plough and "Howard's subsoil" plough.

Manures always act more beneficially on drained land than on wet soils; and it will be found that a liberal application of manures to land recently drained will have a wonderful effect on the crops.

There are some very poor grass-fields which are grown over with rushes and rough grass, which after drainage remain in a poorer state than they were before, unless something be done to improve the land afterwards. Where pasture-lands are in a very poor condition, and are devoid of a fair proportion of good grasses, they should be ploughed up and either trenched or subsoiled, and then well manured, cleaned, and green-cropped, and then relaid down with good grasses.

I have found it advantageous with some soils of this description, where the sward may be very tough, to take a grain crop from it after being stirred up, and in the following season to have it thoroughly cleaned and put under a green crop, and the crop eaten on the ground by sheep. If it is desired to have the land relaid down in pasture permanently, the grasses should be sown without an accompanying grain crop.

In some cases, however, it may be inconvenient to break up land of this description, and a considerable improvement will usually be effected in its condition by liming on the surface, which will eradicate the coarse grasses. Subsequent topdressings with farmyard manure, which must be bush-harrowed—feeding sheep on turnips scattered over surface, and other feeding stuffs—and dressing with bones and other artificial manures of a phosphatic nature—will also effect much improvement.

CHAPTER XVI.

ROAD-MAKING.

I SHALL consider the above under the following sections:—

1. The benefit of good roads.
2. Farm-roads.
3. Plantation-roads.
4. Walks.
5. Bridges.
6. Stone-breaking machines.
7. Repairing and improving existing roads.

SECTION 1.—*The Benefit of good Roads.*

One great hindrance to good farming is the want of good roads. On a great many estates the farm-roads are very bad; indeed I am near the truth when I state that there are no roads at all—they are merely tracks formed on the surface-soil by the farm animals and conveyances. Railways have done much to open out the country, and where there are good roads the value of estates has been very much increased. Even estates lying at long distances from railways have been increased in value by them, where the roads are good between the railway and the estate. On the other hand, I know landed estates lying not more than six miles from a railway station which have not been much benefited by it, solely from the fact that the roads are so bad between them and the line of rail as to be frequently almost impassable. But even where the parish roads are in good condition, the roads leading from them to the neighbouring farms are generally anything but good. Good roads must certainly accompany and form part of high farming. An improved system of farming must result in an increased produce, and this increase of produce must be sent to a market of some kind or other; therefore the expense of conveying the produce over bad roads will be much greater than if the roads were good. It cannot be denied that farms are increased in value by good roads, for which cause farmers who look to their interests will always give a higher rent per acre for a farm having good means of communication than for one which does not possess such facilities. A landed proprietor who opens out his estate by the formation of substantial roads, carries out a primary, and at the same time a permanent, improvement of the greatest benefit both to himself and his tenants.

Section 2.—*Farm-Roads.*

In laying out a new road on a farm, the first consideration is to secure the best line which circumstances admit of—that is, to have the line of road as direct, and also as level, as possible. In the case of making a new road to a home-farm, or any farm near to a landed proprietor's residence, amenity, however, must be taken into consideration, as in some cases the best and easiest line of road might run too close to places and objects which it may be desirable to keep out of sight. Although some small hills or embankments may come in the line of road, it need not be necessary to go round these elevations, as it is often found to be of some economy to run the line through a small hill or elevation. The materials from the cutting often come to be very useful in filling up hollows and making embankments. There can be no doubt but that the most perfect condition of a road is that in which the line is perfectly straight and the surface level. There are two ways of choosing a line of road—one is that of as near a straight line as possible, and forming embankments and cuttings where necessary; and the other is to keep the line to the surface of the country. The first is certainly the most expensive to form, but is generally the best for after work.

Where there are hills and gradients necessary, they should be made as easy as possible. Hilly roads are just as safe as level ones, although they require a certain amount of additional power to draw a conveyance upon them.

Farm-roads are usually made too narrow, and they have been made so in many cases because it was thought that a narrow road takes less expense in keeping it in repair than a wide one. It is, however, an error to suppose this, as the cost of repairing a road depends entirely upon the nature and extent of the traffic upon it. Supposing we take two roads, one thirty feet wide, and the other fifteen feet wide, and that they have an equal amount of traffic upon them, the one will require the same amount of materials to repair it as the other, all other circumstances being the same—such as quantity or quality of material; or, in the case of a narrow road, the traffic being confined to the centre and in one track, the wear upon that road is more severe than upon one with a wider surface, where the traffic is not confined to one track, but is spread over the surface. One great advantage in a wide road is, that the sun and wind have a greater influence in keeping the surface dry.

The form given to a road is a subject worthy of consideration, as a great diversity of opinion exists regarding it. Many think the best form is one with a considerable curve, while others are of a contrary opinion. So far as my own experience goes, I would recommend that roads made in plantations, where the traffic is only occasional, should be made with a slight curve, as then they are always better kept dry; but where there is any considerable traffic upon roads, they should be made nearly level, having a slight curve in the centre. On this subject Mr Macadam remarked, in giving his evidence before a Committee of the House of Commons:* "I consider a road should be as flat as possible, with regard to allowing the water to run off at all, because a carriage ought to stand upright in travelling as much as possible. I have generally made roads three inches higher in the centre than I have at the sides, when they are eighteen feet wide; if the road be smooth and well made, the water will run off very easily in such a slope." In answer to another question, he states: "When a road is made flat, people will not follow the middle of it as they do when it is made extremely convex. Gentlemen will have observed that in roads very convex travellers generally follow the track in the middle, which is the only place where a carriage can run upright, by which means three furrows are made by the horses and the wheels, and water continually stands there; and I think that more water actually stands upon a convex road than on one which is reasonably flat."

Having chosen the line of route for a farm-road, the next important point is to secure the foundation of the road dry. For this purpose it should be drained on each side, as shown in fig. 72.

The drains *a a* should be made first; they should be cut in the

FIG. 72.

ordinary way to a depth of four feet from the surface. In some soils a less depth might answer the purpose, but as the object of these drains

* Parliamentary Report on the Highways of the Kingdom, 1812, p. 22.

is to dry the substratum of the road only, they should be cut a good depth. Presuming that they are cut four feet deep, the soil will only be dry to a depth of three feet six inches, and perhaps not deeper than three feet, as the soil always holds the water to a certain height above the water-run; as, for instance, if we take a piece of common blotting-paper and dip it in water, the water will rise considerably into the paper.

It is a great saving, in the after expense of maintaining a good road, to have it made thoroughly dry at first; and although it may appear a heavy extra expense at the time, yet it becomes the cheapest course in the end.

The drains having been cut to the required depth, a pipe-tile should be laid in the bottom—and it is best to put in a large pipe, not less than three inches in diameter; this admits a current of air to pass up the drain, and has a great effect in preserving the foundation of the road. Stones broken to a convenient size should be laid down in the drain and above the pipes to a depth of eighteen inches, as at *c*, and then a turf or sod should be laid over the stones to prevent soil getting in amongst them. The drain should then be filled to within one foot of the surface with the soil, and well trodden down, after which the open side drains *b* should be formed. They should be one foot deep at the side next the road, twenty inches broad at top, and about the breadth of a common spade at the bottom. This open drain at the side is to receive the surface-water from the road. It is a common practice to fill such drains as shown at *a* full to the top with stones; but I have found it very injudicious to do so, as the sand and mud, washing off the road, flow through the stones into the pipes and very soon choke them up. I have found it better to have a drain on each side to dry the substratum, and to have separate open drains on the surface to run off the rain-water independent from the other. In other cases, we find that there are no covered drains, but very large open ditches, at the sides. It is a waste of land to have these large open ditches, and besides, it is dangerous to travellers in conveyances.

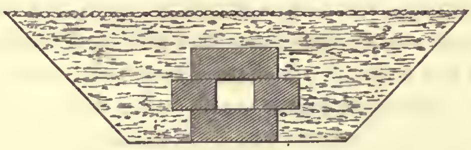
As to the width of road necessary for farm purposes, it is a waste of land and expenditure to have them very wide, and yet it is false economy to have them very narrow. About eighteen feet is, I consider, a very fair width for farm-roads, and for general farm and estate purposes.

In regard to the formation of the surface of the road, it is by many considered of great importance to have the bed of the road formed with a curve. Where the soil is a very stiff clay, impervious to water, it is an advantage to have it slightly rounded; but where this is not the case, no benefit will result from having it rounded, as after the stones have been laid for some time, under the pressure of heavy carts and waggons passing over them, the stones become to a considerable extent mixed with the soil. If, therefore, the soil is a stiff clay, the bed for the reception of the stones should be slightly rounded, keeping it a few inches higher in the centre; but where this is not the case, I would recommend the bed to be made flat. In those roads which I make I next proceed to cart large flat stones and lay them as they are in the bottom without being broken, unless they stand higher above the surface than six inches; this being done, I then cart the broken stones and empty them above those already put on, and lay them so that they will be eight inches thick at the sides and have a slight slope upward toward the centre, but not making the slope more than 1 in 30, as shown in the sketch. Those stones put on the top should be broken to such a size as they will all pass through a ring two and a half inches in diameter.

Where there are hollow places in the road, and where it may be necessary to lead the outfall from either of the side drains across the road, it is always advisable to have a strong culvert built to bear the weight of heavy vehicles.

It may be advisable to make these cross drains frequently, as it is not judicious to allow the water to run a long distance in the side drains without checking it, as it gains force in the open drains on an incline, and cuts the bottom of the drains. The opening of the cross drains or culverts, as shown in fig. 73, should not be less than eight inches square.

FIG. 73.



Where the open side drains are let into the cross drains or culverts, it will be necessary to cover the inlet with a small grating, to prevent leaves or other substances, which might choke the drain, being carried into it.

In some districts large stones cannot be got to break for road-metal, but gravel may be plentiful. In this case the gravel should be put through a screen of three-quarter-inch mesh; the large gravel or stones will do well for forming the surface of the road, if mixed with a little soil. If the round pebbles are put on without anything to assist in binding them, they will shift about and not bind for a long time. The surface of any road should always be as much exposed to the free action of the sun and air as possible; when rain falls upon them, it is very quickly evaporated, and thus the surface is soon dry again. A great many of our existing English roads are always in a bad condition, caused by high hedges and too many hedgerow trees hanging over them. Both the hedges and trees not only prevent the sun and air having a free action on the road, but the drippings of the rain from their branches injure the road very much.

In forming roads across marshy or boggy land, the foundation should be thoroughly drained by cutting deep ditches or drains parallel to the intended line of road, and at each side of it. It is also advisable, in cases where the marsh or bog is very wet, to form cross drains between the side ones, giving the cross drain a fall each way from the centre. Presuming that the bed of the road has been drained as described, it then should be thickly covered over with a good layer of turf or sods, or, what is as good, a quantity of brushwood sufficiently thick, so as it will stand at least one foot thick when compressed; and upon this the body of the road should be formed, in the way already described, with either stones or gravel.

Care should be taken, in forming roads, to see that the stones used are good for the purpose. The stones should not be friable, but of a hard nature. The hard limestones, granite, and whinstone are amongst the best for the purpose.

The cost of making new roads will vary much with the nature of the country or district through which they run, and the nature and cost of the materials with which they are formed. To arrive at the cost of any proposed new road, the line of it must be inspected, plans and sections of it taken, and calculations made accordingly. Mr Telford made eight hundred and seventy-five miles of roads in the Highlands of Scotland. They are excellent roads, always dry, and although made through mountainous parts of the country, yet there are very few steep gradients. The cost of completing the eight hundred and seventy-five miles was £454,189, or at the rate of £519 per mile, which included the cost of bridges.

SECTION 3.—*Plantation-Roads.*

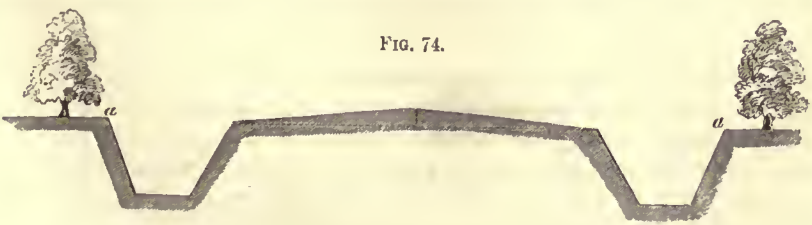
The formation of roads in woods and plantations need not differ in any way from farm-roads, where there is a considerable amount of traffic; but usually plantation-roads are made without stones, and laid down in grass, and are termed "rides." These rides, if properly made, kept dry, and sown down with suitable grasses, stand a great amount of work. It is not usually thought necessary to go to the expense of forming good roads in plantations. It is, however, an error to have any considerable extent of woods and plantations without having the means of removing the timber easily. In my experience I find good roads add considerably to the value of the crop in the wood. Timber-merchants always look to the ways and means of getting the timber removed to a market before purchasing it, and will always give more for a lot of wood where there is a good road to it than for a similar lot not easily accessible. I should say that timber is worth from 15 to 20 per cent more where the roads are good for its removal than where the reverse is the case, or where there are no roads at all.

In the formation of new plantations, spaces should always be left unplanted for the purpose of forming roads. These lines of road should be laid out before the planting begins, and of course the easiest route should be chosen for the removal of the timber. In small plantations, where there is no likelihood of any great amount of cartage, roads fifteen feet wide will be sufficient. This will admit of two carts passing each other. They should never be made less than what will admit of two carts or waggons passing each other freely. In extensive plantations and forests the main roads should be made much wider.

In an enclosure of four hundred and fifty acres, recently formed on this estate for planting, I have laid out the roads of two widths. The surface of the plantation is in some portions flat, with gentle undulations throughout it. Main lines of roads are run through the plantation, and between these main roads, and running full across the whole breadth of the plantation, are smaller roads, connecting the main ones. All the main roads are quite capable of being used for carts, but not all the small ones, owing to the declivity of the surface. They are not meant so much for carting, but they will come to be useful, when the crop has grown, for the removal of thinnings to the main roads, to which they can be dragged; and they are also useful as shooting-roads.

The main roads are left thirty feet wide from the plants on the one side to the plants on the other. This gives room for a space between the plants and the open drains which are made, and also for the drains themselves. This will be better understood by referring to fig. 74.

Fig. 74.



From the plants on each side, as I have already stated, it is thirty feet wide. From the first row of plants to the points *a a* is five feet; the width of the open ditches at the tops is two feet six inches; thus leaving the road fifteen feet wide. This is sufficient width for any ordinary plantation-road, as it will admit of two carts or waggons to pass each other freely.

In proceeding to form the road as shown in fig. 74, I commence first by cutting out the open drains on each side. In doing this I lay off a line of stakes five feet from the first row of trees, and then stake off another line of pins thirty inches from the first line. This gives the width of the top of the drain. The drain is made two feet deep under ordinary circumstances, and sloped down to about the breadth of a common spade in the bottom. Side drains in plantations may safely be made deeper than those on the side of farm-roads, as, there being less traffic in the plantation, and cattle not being admitted, there is less risk of accidents occurring. All the soil taken from the drains is thrown on to the body of the road, and spread over it, keeping it a few inches higher in the centre than at the sides. Cross drains should also be cut where required for the necessary outfall of the water.

Where there are other drains cut in the body of the plantation, and there is a fall towards the road, the roadside drains should be made wider and deeper, so as to make them act as main drains for the others. I consider it best to keep plantation-roads somewhat higher in the centre than farm-roads, as in the former there is not so much traffic upon them, and they are usually for considerable periods never carted on. The object should be to keep them dry and in a fit condition for the proprietor and his friends walking upon them in the shooting season, and also fit for a pony-carriage being driven over them when desired. But it is necessary to have a firmer foundation for either walking or driving upon than the loose soil which is thrown over the surface of the road. With this in view, therefore, we have the roadway sown down with permanent grass-seeds, and some kinds of grasses are much better adapted for this purpose than others.

The following is a list of grasses suitable for sowing down all plantation-roads, with the quantity of each required per imperial acre:—

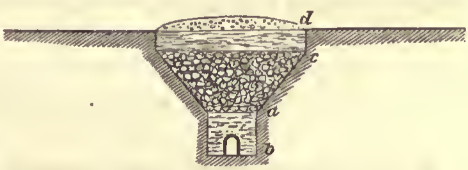
	lb.
Dactylis glomerata, or rough cocksfoot grass,	3
Anthoxanthum odoratum, or sweet-scented vernal grass,	4
Festuca duriuscula, or hard fescue grass,	2
Bucetum elastius, or tall fescue grass,	1
Alopecurus pratensis, or meadow foxtail grass,	2
Poa pratensis, or smooth-stalked meadow grass,	3
Poa trivialis, or rough-stalked meadow grass,	5
Poa nemoralis, or wood meadow grass,	6
Phleum pratensis, or Timothy grass,	1

When the seeds are sown down and bush-harrowed in, the roadway should be well rolled with a heavy roller, and again rolled after the seeds have made their appearance and grown a few inches; this will tend to make the road more solid. If the grasses are cut once in each year it will improve the sward, and the road will be found to stand a greater amount of tear and wear.

SECTION 4.—*Walks.*

The construction of walks in shrubberies, pleasure-grounds, and woods is of more importance than at first sight might be thought, and hence we often find walks improperly made. The chief object to be attended to in the formation of walks is to keep them dry, as they should be in such a state at all times and seasons of the year as will admit of their being walked upon with comfort. To effect this they must be properly drained. Where the soil and subsoil is gravelly, or near the rock, it is a simple matter to form a good dry walk; but where there is a good depth of soil, and especially a clay soil, good drainage is required. In regard to the width of walks, this depends very much on their position in the ground. When made near a residence, it must agree with the extent and character of the house. In any case, they should never be less than four feet six inches in width. This will admit of two persons walking abreast; but they may be made large enough for several persons walking together. Fig. 75 gives an idea of the way in which I have generally made such walks. Having had the walk staked off, all the soil should be dug out square to a depth of eight inches. The soil should then be removed to a further depth of ten inches, but sloped on the sides, as shown in the figure. A drain should then be cut in the bottom of the excavation one foot deep, as shown from *a* to *b*. Having laid a two-inch drain-pipe in the bottom, it should be filled with the loose earth taken from it to the point *a*, after which the excavation is filled with stones to the point *c*, then filled up with lime-rubbish, or, what is very good, broken bricks from a brickyard. This should be laid on a few inches to the point *d*, after which the walk should be finished off with a coating of fine gravel, raising it slightly in the centre. A walk thus formed will always keep dry and in a fit state to walk upon. The soil laid above the pipes will prevent the water washing any sand or

FIG. 75.



small gravel into the pipes, and thus choking them. The lime above the stones will assist in the prevention of weeds.

The cost of such a walk depends so much upon the convenience of materials, and the cost of labour in different districts, that I refrain from giving any statement of cost. Good walks are sometimes made by digging out the soil to a depth of eighteen inches; a line of drain-pipes is then laid along each side of the excavation, having downfall-pipes at every forty or fifty yards, and nearer than this where it may be necessary. These downfall-pipes have small gratings at the top, placed a little below the level of the walk, to carry off the surface-water. These drains, and also that first described, should be connected with other drains in the grounds. The bottom of the excavation is then filled with broken bricks, rough gravel, or stones to within two or three inches of the grass, box, or other edging, as the case may be; the walk is then finished by laying on gravel two inches thick. Roads and walks formed of asphalt have of late years been extensively made. They are very firm and durable when well made. When roads or walks of this description are made, a foundation of stones is laid in the bottom, a few inches thick; a layer of concrete is then laid on about three inches thick, upon which the asphalt is laid in a hot state. There are several tradesmen throughout the country who do this by contract. The cost depends upon the situation.

Excellent walks are also made by pouring boiling gas-tar on a walk after it has been finished in the ordinary way described; and a sprinkling of fine gravel is then put over the tar, smoothed over, and allowed to cool, when it will be in a fit state to walk upon.

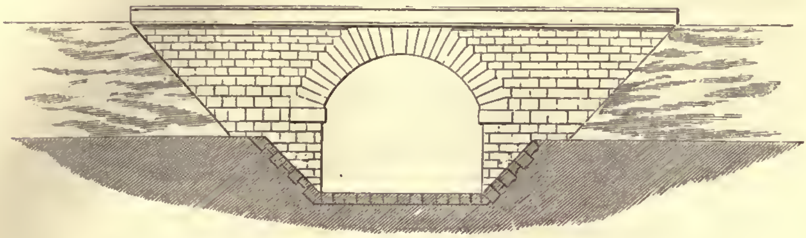
Section 5.—*Bridges.*

I now come to make some remarks in reference to small bridges, which are sometimes required on estates in the formation of roads. Where bridges have to be made on a large scale, the aid of an experienced engineer should of course be called in; but for the erection of small bridges under ordinary circumstances on an estate, this need not be necessary.

Bridges are made of stone, iron, and wood. In the construction of either, the first and most important consideration is to secure an unyielding foundation for the abutments, and also for the piers, if there should be any, and no work of the kind need be attempted until this is done.

In the formation of a new farm-road on this estate some time ago, I had occasion to erect a small stone bridge across a ravine. A sketch of it is given in fig. 76. The road leading to this bridge is sixteen feet

FIG. 76.



wide; the roadway of the bridge is ten feet wide. I commenced by cutting into the sides of the ravine, to get a good solid foundation for the side walls. The subsoil being of a hard nature, and lying close on the rock, there was no great difficulty in securing a foundation; and finding this, I had the foundation cut in the form of steps. I began the building by making the foundation forty inches wide on each side, and carrying on the archway at the same time, which was built three feet wide at the foundation with large flat stones to a height of two feet from the earth. The inside of the arch was turned with good common well-burnt bricks; but the outside of the arch, at the entrance on each side, was built with roughly-dressed stones.

The side walls were carried up the width already mentioned to the level of the top of the keystones, when they were drawn in to eighteen inches in width, and carried up three feet six inches above the roadway, to act as a fence on each side. This height included a coping of two-and-a-half-inch dressed stones on the top. These copestones were two feet broad; this allowed two inches to hang over on each side of the wall. The body of the bridge between the side walls and above the archway was filled to the level of the roadway with stones—large ones in the bottom and small ones at the top.

The bed of the stream between the two side walls of the archway, and to a distance of ten feet on each side of the bridge, was paved with square stones set in the same manner as street pavement. This prevented the water from working into the soil and undermining the foundations.

The cost of this bridge was very low when compared with the amount of work done, as the total sum expended on it was about £12, 10s.

There was a good stone quarry about fifty yards from the bridge, and the lime was burnt on the estate, about half a mile distant.

Iron bridges are made either on the suspension principle with piers, or as chain-bridges. The best form adapted for general estate purposes is to have the body of the bridge of iron and the abutments built up with stone, or what is termed girder-bridges. The following design will give an idea of this kind of bridge, fig. 77.

Fig. 77

Bridges of this description are very ornamental on an estate, and especially where there are carriage-drives. The abutments should be constructed of large dressed stones, first securing a firm and solid foundation. The abutments being built up to any desired height, the bridge is fixed on to them. This kind of wrought-iron girder-bridge is manufactured by Messrs A. & J. Main of Glasgow. A bridge of the description given in the foregoing figure, and suitable for foot-passengers only, will cost about 30s. per foot of span. Considerable expense is also sometimes incurred in securing foundations for the abutments on each side, as on this depends the stability of the bridge.

Wooden bridges can be made of any form for small spans on farm or plantation roads. The cheapest way is to have the abutments constructed of good solid masonry, and then to throw heavy beams across to support the roadway. If the span be too wide for one length of beam, a pillar or pier can be erected of stone in the centre.

Many bridges are made entirely of wood, by driving strong wooden supports into the ground at each embankment, having two, four, or more of these, as may be thought necessary. Where timber is plentiful and well matured, this kind of bridge lasts a long time; but for general utility I prefer abutments built of stone. Several bridges of this description were erected in forming new roads through the forests of Duthill and Abernethy, in Strathspey. They were made of the old matured Scots pine.

In the piling of wooden bridges, the piles are cut to the length required either round or square; and in every case they should be coated with a sheeting of zinc one-eighth of an inch thick, up to the mark generally understood "'tween wind and water." If zinc cannot be got of sufficient thickness, generally yellow-metal is employed, one-sixteenth of an inch thick, which stands better than zinc; but it is much more expensive. Piling is generally driven by what is called the "shears."

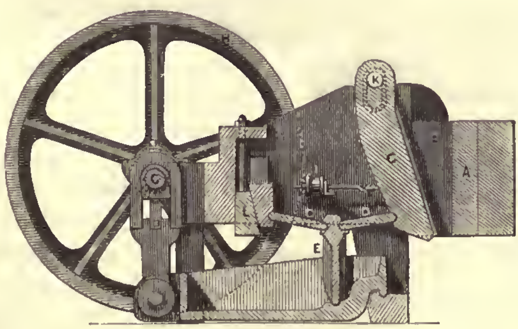
When the span is too long for one beam, it is generally supposed that what is called quarter-splicing and under-rodding is much stronger than piers, for sometimes piers are apt to be damaged by floods. When there is not a constant and steady weight on them, the spring of the timber forbids this.

SECTION 6.—*Stone-breaking Machines.*

In this section I merely wish to call the attention of landed proprietors and their agents to an important machine lately introduced for breaking stones. A large number of them are now at work, and are giving very great satisfaction. The machine I refer to is "Blake's stone-breaker," manufactured by Mr Marsden of Leeds. It is highly useful for breaking ore for blast-furnaces, road-metal, and limestone. It can be driven by steam, water, or horse power.

Fig. 78 is a longitudinal section, and gives a side view of the several

FIG. 78.



parts of the machine. The circle G shows the flywheel-shaft, and E shows the position of the eccentric. A is the fixed jaw against which the stones are pressed; C is the movable frame or jaw, which works to and fro, and presses the stones against the fixed jaw; K is a bar of iron which supports the jaw C, and acts as a pivot upon which C moves to and fro. Inside there is an india-rubber spring which is pressed by the moving jaw, and the spring of the india-rubber assists to throw the jaw back again. L D D are parts which are moved by the revolving of the flywheel, and press the lower part of the jaw C forward. In fig 79 is shown an end elevation. K shows the driving-wheel, on which is fixed the belt from the engine; H H the flywheels; G the crank; F F the lever; C the upper part of the movable jaw; and L L the screws, the raising or lowering of which alters the mouth of the jaws accordingly. Fig. 80 is a plan of the machine. A shows the fixed jaw, C C the movable one, B B tapering check-pieces to hold the movable jaw in its place. The movable jaw C is fluted to fix into corresponding ones in the fixed jaw. The shaft G has two flywheels H H, one on each side, and also a driving-pulley K.

Fig. 79.

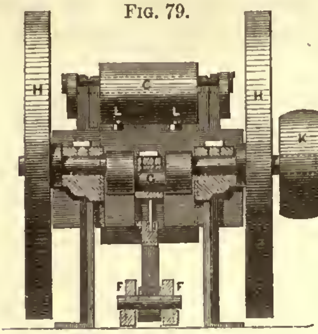
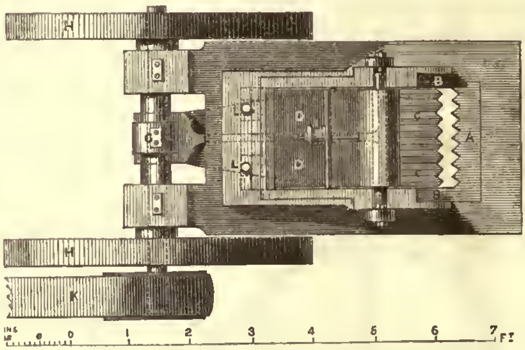


Fig. 80.



Its motion is in this way: Every turn of the shaft causes the moving jaw to advance at its lower end about three-eighths of an inch and return, and so on to and fro; and there being a considerable slope between the jaws, as shown in fig. 78, the stones fall down gradually as the jaw recedes, and the jaw of course crushes them in returning each time until they fall out at the mouth. The jaws can be shifted so as to break the stones different sizes. A proprietor of iron-works informed me that he has one in use which breaks stone to the size of road-metal for about 3½d. per ton; this includes the feeding of the machine and the cost of engine-power, but not of quarrying the stones. When the jaws are fixed so as to break stones which will pass through a ring of two inches, it will crush about ten tons per hour. This cost does not include any interest on the cost of the machine; and it must be kept in mind that coal at the works where it was in use was only 4s. 6d. per ton.

The cost of these machines varies according to the size of the opening in the jaws. The smallest size made has this opening six inches by four, and costs, mounted on wheels, £80. The most useful size for breaking ordinary stones for road-metal is the size fifteen inches by seven, and costs £190.

The following is a statement of the different sizes and their prices:—

Size.	Product per Hour.	Power required.	Total Weight.			Weight of Frame.			Price Net.			On Wheels.		
	Cubic Yds.	Horse.	Cwt.	qr.	lb.	Cwt.	qr.	lb.	£	s.	d.	£	s.	d.
6 by 4	1½	2⅓	36	0	0	18	0	0	75	0	0	80	0	0
10 by 7	3	4	78	0	0	37	2	0	140	0	0	147	10	0
15 by 7	4½	6	108	0	0	54	0	0	180	0	0	190	0	0
20 by 9	6	8	156	2	0	74	0	0	240	0	0	255	0	0
24 by 12	8	12	376	3	0	80	0	0	350	0	0	...		

SECTION 7.—*Repairing and improving existing Roads.*

A great many of our farm-roads might be very much improved by straightening their course and levelling the surface, and also by an addition of good material laid on them. In many cases we find them running over hills and down into valleys without any attempt having been made to level heights or to fill up hollows. They might also be much improved by having the whole surface carefully picked up to a depth of six inches, all bad materials removed, and large stones properly broken, and then have an addition of new material spread on the surface to a depth of two or three inches. Autumn is the best season of the year for repairing and improving roads, when they are in a wet condition, and when, from the roads being in a soft state, all new materials can be better worked into them. It is very injudicious to lay any amount of new material on roads in the summer season, when, from their being in a dry state, the new stones toss about, hurtful both to man and beast. The stones are generally put on too large; every one should at least be able to pass freely through a two-and-a-half-inch ring. The common practice seems to be to lay on large quantities at a time of large stones not sufficiently broken. It will answer the purpose better if small quantities were put on more frequently, and smaller stones used.

I am of opinion that all farm and other roads on an estate should be upheld by the proprietor—of course excepting parish or other public roads; and they should be attended to by one or more men, according to their extent, whose office should consist in keeping the roads clean by scraping, and in filling in ruts and hollow places, whenever they appeared, with properly-broken material. Each man would require a wheelbarrow, scraper, shovel, pick, and broom. In the autumn, when a thorough repair was necessary, they would need some assistance; but if the roads were constantly looked to in this way, they would not want much done in the autumn, as a "stitch in time saves nine."

It will be found less expensive to have a man or men to attend to the roads, as I have stated, than to repair them at certain seasons of the year only, as it is much cheaper to prevent anything getting out of repair than to repair it when it is in a bad state. In scraping roads, the mud should be removed at once, and all the ditches and drains attended to, in order to see that they are clean.

If the roads were kept up by the proprietor in the way mentioned, it would increase the value of the farms; for which some addition of rent could be paid, or the annual expense of maintaining the roads could be paid in proportion by landlord and tenant.

On small estates the roads might be attended to by those who look after the fences. Scraping-machines are now generally employed on well-kept roads; they save a great deal of time and labour. The machine consists of a number of small scrapers fixed to a frame. This frame is mounted on wheels; and when the front part of the machine is lifted from the ground, all the weight is thrown on the scrapers, which are then drawn across the road, and thus takes all the mud with it, over a width of about three feet.

Another machine has been invented for cleaning roads. It consists of an endless broom. There are rollers attached to a cart, and the broom passes round these rollers. There are cogged wheels attached to the wheels of the cart, and when these cogged wheels are in motion, they work up the endless broom, and in this way the mud is swept up an inclined plane into the cart.

When there is a great extent of roads on an estate, it is always advisable to have the work done by contract—and indeed on any estate all work should be done by contract as much as possible. The following is a form of specification for letting the repairs of roads by contract:—

SPECIFICATION for Letting by CONTRACT the REPAIRS of the ROADS on the ESTATE of __________, for one year, commencing on the __________

1. The contractor shall find all materials required, which are to be obtained from such quarries on the estate as the agent shall approve—

____

____

the quantity of stones used to be not less than   tons in each year; and if any further quantity is required, the same to be supplied and broken at a price to be agreed upon between the contractor and agent.

2. The contractor to provide all leadings, and the stones to be carted on to the roads in dry weather, and no carting to be done between February and October without the permission of the agent.

3. All stones to be broken so as to pass through a ring of two and a half inches diameter; and to be placed and used on the roads by the contractor at such times and in such manner and places on the estate as the agent shall direct.

4. The contractor shall at his own cost provide the labour and keep in good repair all the roads on the estate, and preserve the same in perfect form and width, and free from ruts, hollows, water, and loose stones; he shall also scour and keep clean all the watercourses, ditches, and drains belonging to the said roads; and do all necessary scraping, cleansing, and other ordinary surface repairs which may be required; and cut and keep down all thistles and weeds on the sides of the said roads; all scrapings not required for levelling the sides of the roads to be carted away by the contractor to such places as shall be pointed out to him.

5. The contractor is also to keep in repair any culverts or bridges; and any snow which may require to be cut and removed shall be done by the contractor.

6. No materials to be used except such as are approved of by the agent, and the whole of the work is to be done in every respect in a proper and workmanlike manner, and to his satisfaction; and in case the contractor makes default, the agent to be at liberty to obtain the materials required and get the work done, and to deduct the cost thereof from the amount payable to the contractor.

7. The footpaths shall also be kept in order by the contractor, and repaired with suitable gravel.

8. The payments to the contractor will be made quarterly, provided that the conditions herein contained have been fully complied with, and any balance due at the expiration of the contract to be paid within one month.

9. The contractor to find all tools and implements required for the necessary repairs of the roads.

Where any considerable extent of roads on an estate is kept up by the proprietor, it is necessary for the agent to keep a separate statement of the expenses in that department. This is best done by keeping a book for the purpose of entering all labour in connection therewith, whether it may be day-labour or piecework. The following is a good method of keeping a correct statement of the expenses :—

ROAD DEPARTMENT.

——— Estate, for Week ending ———————, 18——.

Name of Labourer.	Day-Labour Work.										Piecework.				Total Amount.
	Description.	Days.						No. of Days.	Rate per Day.	Total Day-Labour.	Description.	Total Piecework.	Stones.	Gravel.	
		M.	T.	W.	T.	F.	S.								

CHAPTER XVII.

EMBANKMENTS.

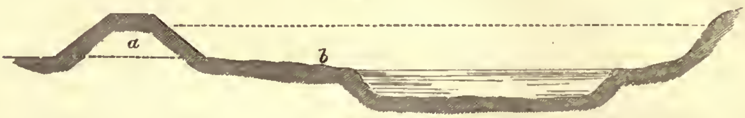
On a great many estates there are rivers and smaller streams which sometimes overflow their usual bed, and inundate land adjacent to them. A large amount of damage is thus often done by the water both to crops and stock. This is the case more frequently in low-lying flat districts, where the rivers flow very sluggishly; and when heavy rains come, the water increases in height, instead of flowing freely away. One great point to attend to in cases of this kind is to see that the bed of the river or stream, as the case may be, is kept free from any accumulation of brushwood, breaks in the banks, or any other thing which might tend to check the water in its course. The chief thing, however, which has or ought to be done to confine the water within prescribed limits is, to form embankments on its sides.

Embankments are structures formed of earth or a wall, or both combined. The idea of protecting crops from the overflowing of rivers seems to have originated at an early date in the world's history, for we find that this was done in Egypt as far back as we have any history of it. The embankment of the Thames appears to have been first done at the time of the Roman invasion of this country. Large embankments were formed in Lincolnshire to protect lands from being submerged by the sea in the time of Cromwell, and these banks have been improved upon and kept up ever since, and enclose what is called "the Fens." Large tracts of country in Holland have also been reclaimed from the sea by the formation of embankments.

In forming banks on the sides of rivers or streams, care must be taken not to make them too close to the water's edge. Of course they could and may in certain cases be made with advantage quite close to the water-way, but this will involve the necessity of raising the banks to a much greater height than would be required if they were made at a little distance from the edge of the usual water-way. I have found it the best system, under ordinary circumstances, to make the banks at a good distance from the water-bed, as when the waters rise, they spread over a larger surface than when the banks are closer to each other. The proper position of the embankments depends upon the size and character of the stream.

In lately embanking a slow-running sluggish river of about fifty yards broad, we formed the banks at a distance of thirty feet from the edge of the usual water-run. In fig. 81 is given a sketch of one bank of the river

Fig. 81.

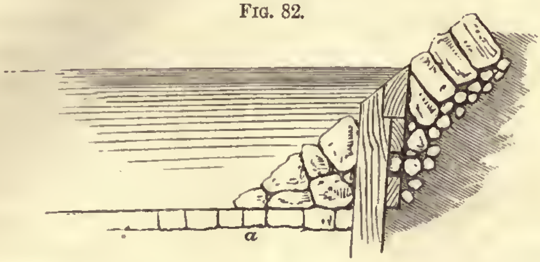


referred to, as shown at *a*. We commenced operations by removing the soil from the space between the bank and the river, as at *b*. In doing this, while we were getting a supply of soil for the foundation of the bank, we were also making a larger space for the water inside the banks.

The banks were made sixteen feet wide at the bottom, and sloped up on each side to a height of five feet in the centre, leaving the top flat, and three feet six inches wide, to form a walk. After the entire embankment had been done to this height, levels were taken, so as to see that the whole length of the banks were of an equal level, as compared with the course of the river, and where deficient in this respect, they were raised to the necessary height. In the course of formation the earth was firmly beat down, and when made up to the required size, it was turfed over. The space between the banks and the river was then planted over with willows. The roots of the willow-plants strike quickly, and very soon bind the banks together, and prevent portions of it breaking.

For the protection of the banks of rivers, rubble facing is sometimes resorted to where stone is plentiful. Very large stones should be employed for this purpose—they are not so easily put out of place as the smaller ones. Before laying on the stones, the banks should receive a careful dressing by levelling any inequalities; and with the view of making a good bed for the stones, the slope should be something like an inclination of 2 to 1. The greatest difficulty in making rubble banks is to find a secure footing at the bottom for the stones, for if something is not done to prevent the water from undermining the stones, they will gradually fall down and get displaced. If the soil is of a loose sandy nature, and of a yielding character, the best plan is to protect the work at first by piles, as shown in fig. 82. The piles, as shown, should be kept as low as possible, as they will last much longer if kept constantly under water, and will also be of greater support to the bank. The stones should be of a large size, and set in edgewise, and the lowest stones should be imbedded in the bed of the river, as shown at *a*. They should

Fig. 82.



be carried up to such a height as will keep them fully two feet above the highest flood-mark. A facing of this description will be sufficient to protect the banks in any case, but may not be sufficient to keep the water from overflowing into lands adjoining when floods occur. Even small streams or rivulets winding through an estate or farm may at times do a great amount of damage to arable land along their course, if banks are not formed to confine the water. All streams, certainly, do not require this, but there are many which are very suddenly flooded in the winter season, caused by snow melting on the high ground. In a case of this kind, the first thing to ascertain is, the point which the water reached at the highest flood within the recollection of those at the place, and then consider at what distance the banks should be made from the usual water-edge. As I have already stated, it is much better policy to sacrifice a piece of land, and give ample room between the banks and the river, as of course it gives the water more surface, and therefore it will not rise so high as if the banks were made close to the edge of the water, thus confining the space. But the nature, size, and character of the stream must be taken into account in arranging this point. The height of the banks must be regulated by the height to which the water reached when at its highest flood, and the banks should be made at least eighteen inches higher than that point.

Having arranged these points, the line of the bank should next be laid out; and care must be taken, in doing this, that, where there are turns, either convex or concave, on the side next the water there should not in any case be any sharp turns and sudden points, as these will present obstacles to the water. All the turns should be made with fine gentle sweeps, and quite unbroken in any way.

The work should be commenced by lifting any sods or turfs which may be along the line, and laying them to one side, and these should be kept to lay over the bank when completed. Stakes and pins should next be put up along the line of the bank and in its centre, and these pins should be put the height to which the bank is to be raised, and will thus act as a guide to the work-people employed. We shall suppose that the embankment is to be made four feet high and eight feet wide at the base. The first operation will be to procure good, tough, and thick turfs, and build them up very firm and compact. These turfs should be laid with the grassy or natural side downwards. As the building of this turf wall goes on, earth should be packed in behind it, and firmly beat down and pressed together with a wooden beater, and gradually raising the embankment of earth as the building of the turf wall proceeds. The wooden beater is made of timber four feet long, and with a diameter of five or six inches at the bottom, with a hoop of iron round the bottom rim to keep it from splitting. It is then gradually thinned from the bottom to the top, leaving it about two and a half to three inches diameter at the small end. At about one foot from the top a cross handle is inserted by which to work it up and down with the hands.

When the earth embankment has been carried to the desired height, the side should be carefully sloped down and made generally equal all along the bank. It should then be turfed over; the lower turf should be let into the soil about three or four inches, as this prevents the water from working it out of its place before it has had time to grow into the soil forming the bank. The top of the embankment should then be levelled and laid with turf. It need not be very broad at top; but if brought to a narrow point at the top, that part is apt to give way under the pressure of a heavy flood passing along.

This kind of embankment should be made as early in the spring as possible, as then the turf has time to grow into the soil and form a solid piece with the bank before there is any likelihood of flood coming. During the summer the turf may possibly require watering, especially if the season is dry. Attention should be paid to the bank from time to time, to see that there are no holes in it. Water-rats sometimes make holes in such banks, and thus allow the water to get an opening, which gets larger from the force of water working on the loose soil. All such holes should be rammed full with earth, and the surface turfed over again. The grass on the banks should be mown at least once in each season, which will cause it to grow thicker.

The cost of forming such an embankment as described will vary with the description of soil at command, and also with the distance that the turf may have to be brought.

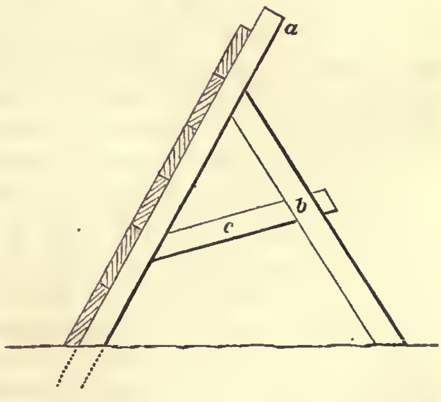
Similar embankments are made by having the side nearly perpendicular, and building a dry-stone wall in front of the turf, and so to join the stone wall and the embankment. This makes a more secure fence than the one we have described, and there is more likelihood of the bank being kept in good preservation. We have formed similar embankments where the soil was of a loamy nature, and both soil and turf were procured along the line of bank, at 2s. per rood of seven yards.

Should water be required for stock from a stream banked in as we have described, the best plan is to have a stone trough in the field close to the bank, and below the level of the ordinary run of water in the stream, and have the water conveyed from the stream to the trough by means of an iron pipe laid through the bottom of the bank into the water. The end of the pipe in the water should have a *rose* upon it, to prevent gravel getting in to choke it; and the other end, dropping into the trough, should have a plug attached to it, to stop the supply of water when necessary.

When the soil is of a sandy or gravelly nature, and not likely to make a good resistance to water by itself, a mortar wall should be built in the centre of the bank and the gravel thrown up on each side of it; or a puddling of clay may be built in the centre, in place of the wall, where stones are scarce.

Where timber is plentiful, and land is wished to be protected against a sudden flood, facings of wood can be quickly put up within a short time by driving down wooden piles, as shown in fig. 83.

FIG. 83.



The piles are driven in in an inclined position, and supported at the back by other strong piles, as at *b*; and the two piles are again connected by a cross support, *c*, to give strength to the centre of the inclined pile. On the inside the piles are closely lined with planks laid horizontally, these planks being securely fastened to the piles by nails. The timber facings may be supported by packing earth firmly in behind them. This cannot be recommended as a permanent bank, and is, on the whole, a costly one; but it answers the purpose of getting up a protection against sudden floods in a short space of time.

Embankments are at any time, and under any circumstances, expensive operations; but when judiciously laid out, and the works properly executed, they are of immense advantage to large tracts of land on some estates. Where rivers overflow upon grass-lands, the damage done is not so much as when arable lands are submerged, sometimes carrying away quantities of good soil, and otherwise spoiling the land for some time afterwards. Caution and judgment must, however, be used in forming embankments, as it is very essential to avoid projecting any portion of them so as to place it in the way of the water. All turns and curves should be made with bold sweeps, so as to allow the water to pass freely along without receiving any impediment in any way.

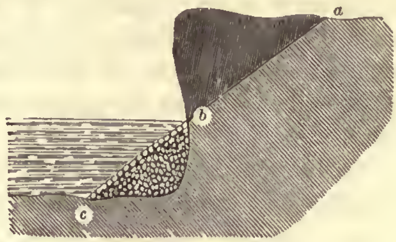
The course of the river itself should be examined, and any projecting points should be removed and curved round, and all other obstacles likely to check the water from flowing freely.

The cost of the formation of embankments may be calculated previously by taking the distance the earth has to be removed, and calculating the amount of cubic feet or yards a man will remove in one day. If the earth can be removed with shovels alone, it will of course cost less than if it is of such a degree of hardness that it requires to be loosened with a pick. From experiments made, I find that an able-bodied workman can throw out on an average nearly nineteen cubic yards of loose soil in one day of ten hours. Presuming an able labourer at work by contract, who will earn 3s. per day, this will give nearly 2d. as the cost of throwing the soil into a cart, waggon, or barrow.

Supposing the earth to be conveyed in wheelbarrows a distance of about one hundred feet on an average, one man will wheel a loaded barrow and empty it and return with it in the time that another man will fill another barrow—that is, presuming the ground is level. Thus the cost of transportation will be about other 2d. per yard. There will have to be added the formation and beating of the bank, and the tear and wear of barrows, planks, &c.; also the first lifting of turf on the site of the bank, and the relaying of it on the bank. The size of the bank will have to be taken into consideration, and the number of cubic yards calculated in it per lineal yard. It is a good plan to have the contractor bound in his agreement to uphold the bank for, say, six or eight months after finishing it. This will cause him to pay more attention in its first formation, and the chances are that the bank will be more substantially made. No data can be accurately given as to the cost of an embankment without knowing the character of the soil to be removed, the size of the bank required, the distance the soil has to be carted or wheeled, and the character of the ground over which it has to be transported.

It often occurs in the case of rivers that the banks are almost perpendicular, and the water gradually undermines the lower portion of them, and this more especially where the soil is loose and friable. When the lower portions have been washed away, the upper parts fall down, and thus there is a continual washing away of the banks. This may be prevented by sloping the banks back, as shown in fig. 84.

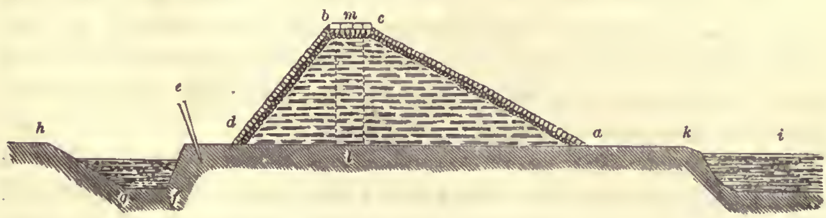
FIG. 84.



The slope should be made, as shown from *a* to *b*, down to the surface of the water. This work should be done early in the season, and either covered with sods sown down with grass-seeds, or banked up with stones. If grasses are sown, *Poa nemoralis* or *Poa pratensis* should be used, as the roots grow thick and help to bind the bank together. That portion of the bank, as shown from *b* to *c*, where the water is supposed to have washed away, should be filled in with small stones, and a layer of larger ones put on the top.

'The Book of Farm-Buildings' has the following on this subject: "We give a section" (fig. 85) "of a form of embankment recommended by Mr Johnstone, for low ground on the side of rivers. The slope of the

FIG. 85.

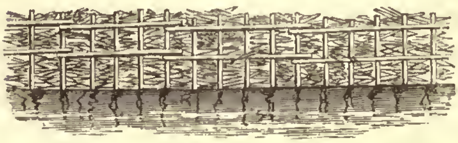


embankment towards the river from *a* to *c* should be longer than that of the land side, as from *b* to *d*. The base of an embankment, as *a d*, should be three times its height, as *l m*; the width *b c* at top one-third of the height *l m*. The distance of the foot *a* of embankment from the river, as the distance *a k*, is shown in the figure at ten feet; and all trees, brushwood, &c., should be removed from the space, as these may shake the earth and render it loose, and give admission to the water. The earth to form the embankment should be taken from the land side, none from the river; this obviates the necessity of breaking and loosening the surface next the river. The earth may be taken from adjoining heights, or from the ditch *h g f*, which is formed at the back of the embankment to lead the surface-water from the field. A paling or fence *e* should be put up at the outer side of the scarcement *d c*, to prevent cattle from going up and trampling upon the embankment, until it be consolidated and well swarded. The slope of the embankment in this case is supposed to be covered with grass turf; but, in the absence of this, a stone facing may be adopted."

In some cases I think it is advisable to remove earth from the river side of the embankment, especially where it is somewhat irregular and undulating. The removal of such irregular earth, and a general levelling to it, will make way for the water, and prevent any impediment to its course.

Cases occur where the water of a river does not rise to any great height; but from the action of it upon the loose earth, the banks keep gradually breaking down, and often make considerable inroads on agricultural lands. This may be prevented by facing with stones or piling with small wood. Fig. 86 shows a system of common piling.

Fig. 86.



This is performed by driving in small posts of wood along the bank, about two and a half feet into the soil at the bottom of the water, and abont eighteen inches apart from each other. Upon these either one or two lengths of rails should be nailed—one row at the top and the other half-way down; and behind this brushwood is packed in pretty thick. When this is carefully done, it lasts a long time, and materially preserves the banks from being washed away.

The materials necessary to form an embankment must depend in a great degree on the force with which the water will flow against it. Thus, if the water is stagnant, as in a pond, or if it flows sluggishly, as many of our English rivers do, then, in either of these cases, an embankment formed of earth alone, properly put together, and with the necessary slope, will be sufficient to resist the water; but, on the other hand, if the water flows with considerable force in the direction of the bank, then that side of it next the stream should be made with piles of timber, masonry, or well packed with stones without mortar. There is generally the greatest danger in the banks giving way at the base, from the force of the water undermining it. It is at that point where it should be made strongest, and attended to from time to time to observe that no undermining is going on, and to put a stop to it before any serious injury is done.

There are two points to be considered previous to forming the embankment along the side of the river: 1st, That the greater the width given between the embankments, the less height will be required on them; and, 2d, That the smaller the space given to the river, the water will flow with the greater force. The latter consideration is sometimes of importance in muddy rivers, as the slower the water flows, the more quickly does mud accumulate in the bed of the river; and they thus get choked up in places, causing the water to overflow. But if such rivers are confined by embankments, a greater force is given to the water; and the mud is either thrown up on the spaces between the bed of the river and the banks, or is carried away.

Care should be taken to avoid forming any sharp points in the banks, as these cause a resistance to the water, which either works into the banks at that point, or the water is thrown to the opposite side with great force, causing it to undermine there.

Great difficulty is often felt in draining lands adjacent to rivers which overflow their usual course, especially in procuring an outfall for the main drains without admitting the water from the river to the fields adjoining. In the first place, the drain should not be cut straight across the bank towards the water, as is very frequently done, where the water from the drain flows *against* the water in the river, and is thus prevented getting freely away; and besides, in such a position the mouth of the drain is very apt to be choked up with foreign matters. The drains should be cut along the bank to a certain extent, and run into the river with the flow of the current, and not against it, as then the flowing current will tend to draw the water away from the drain, and keep any mud, branches, &c., from lodging there.

In order to prevent water flowing into the drains from the river, a system of flood-gates is generally adopted. These are made on the principle of a valve. A wall of masonry is built round the mouth of the drain, leaving an opening like a doorway in the centre of any size thought necessary; in this opening is firmly fixed a frame of wood-work, on which a door is hung from the top, but is not fixed in any way at either the sides or the bottom, so that when water flows from the mouth of the drain, the door or valve is forced open and the water escapes; and again, when the water rises in the river, it flows against the valve and keeps it shut while it is up, thus preventing the water from entering the drains. These doors and frames should be made of strong well-seasoned wood, and firmly fixed in their place. They should be fixed so that the water from without will not be able to get underneath them, and so lift them up. It is always the most secure to have two such doors at the mouth of each drain—one upon the outside and at the mouth of the drain, and the other a few feet within the drain, and both hung in the same way. Where this is done, if at any time the outer door should be lifted up by the waves, the water will be stopped by the inner door. Care, on the other hand, should be taken to observe that the doors are not hung so tight as will prevent the escape of water from the drains.

Where the water in a river is constantly at such a height as prevents the drains being discharged into it, the drainage-water is collected into a large tank, upon which is placed a pump to lift the water out. These pumps are sometimes worked by steam-engines, such as are used in draining the fens of Lincolnshire; or the pumps may be worked by the wind acting upon sails, such as are used in working windmills. One of the latter was erected by the late Mr Scott on Major Stapylton's estate of Myton Hall, for the purpose of pumping the water from the drains on the home-farm into the river Swale.

There are several descriptions of embankments in use.

First may be mentioned the mound of earth raised up and sloped on each side, as described in this chapter.

Next, we frequently meet with banks of piles of timber, brushwood, or stones put loosely together. These are not so much used for preventing the water from overflowing, as to keep it from washing away the banks, especially where the soil is light and sandy. The young thinnings of plantations are frequently used for this purpose, such as larch and Scots pine trees. These are driven in a row into the soil in front of the river-banks, and put close together, or they can also be driven in at distances of from two to five feet apart; and then the branches of trees and underwood is twisted in about them, so as to make a close bank. It is much better to use stakes and piles of the poplar, alder, and willow timber, than of any other kinds, as, if the bark is left on these kinds, they will grow on the banks, and last much longer in a damp position.

The most substantial, although at the same time the most expensive, embankments to a river or pond are those made of solid masonry. These are necessary in many instances. A fine example of a stone embankment is to be found at Balmoral, the Queen's residence in Aberdeenshire. Some years ago it was found that the river Dee was working in upon the flat of land on which the castle is erected. In order to prevent this, the banks were built up with a solid wall of stones laid on a slope and without mortar. This was carried out under the superintendence of Dr Robertson, her Majesty's commissioner.

Light sandy soils on river-banks and sea-shores can be prevented from shifting by planting on them the plant called the *Elymus arenarius*, the leaves of which are used for the manufacture of mats. There is, however, some difficulty in getting it fixed in the soil before floods come and wash it away, as it is very apt to be washed away before it has inserted its roots in the sand. The best way to prevent this is to have each plant fixed to the surface by a piece of willow, poplar, or alder. These pieces should be about eighteen inches long, with a side branch at one end to form a hook, so that it can be pushed into the sand its full length, only leaving the hook pressing above the plant, and thus keeping it fixed until it takes root.

Willows are very useful for keeping the bank of a river together—the roots spread in the soil and bind the mass together. The elder is also a very large fibrous-rooted plant, and grows well on our coasts in sandy soils.

CHAPTER XVIII.

THE IMPROVEMENT OF OUR WASTE LANDS.

WASTE LANDS are those portions of landed property from which a very small return is derived, and in a great many cases none at all; but what is meant more particularly by the term are those parts of the country which are still lying in their natural condition of surface, and on which no attempt at improvement has been made by ploughing, top-dressing, or otherwise. Of this description of land there is a very large extent in different parts of the country, chiefly in the north of England, the south, north, and west of Scotland, and in the hilly parts of Wales. These embrace, generally speaking, the higher-lying parts of the country, and are now occupied chiefly as sheep-pasture. A large proportion of the lower-lying parts is capable of being made into good arable farms, while perhaps a still larger proportion, from elevation and steepness, is unfit for this purpose; and comparatively only a limited extent may be said to be altogether barren and unprofitable.

These waste lands consist of moorlands, high-lying hill-pastures, bogs or mosses, and land subject to be submerged by the sea.

In dealing with this subject, I shall consider it under the following sections:—

1. The extent, uses, and capabilities of our waste lands.
2. The improvement of our waste lands by rearing plantations on them.
3. Their reclamation by trenching.
4. Their reclamation by horse-labour.
5. Their reclamation by steam-power.

SECTION 1.—*The Extent, Uses, and Capabilities of Waste Lands.*

Many think that it is superfluous to talk of ever bringing the great proportion of our waste lands into such a state as will make them of much more use to the people than they are at present. This is, however, an error, as has been sufficiently tested in several districts. It is a matter of very great importance to us as a nation to consider the best ways and means of improving our waste lands, so as they may assist in supplying food for the use of a gradually-increasing population. It certainly must be a question of vast import to all thinking people, when we consider that in Great Britain alone there are upwards of thirty millions of people depending upon the produce of the land for their food and for their very living, and that nearly seven millions of men are kept in employment by agriculture. Generally in new countries any kind of farming will suffice to meet present wants, but in this country it behoves us to cultivate every inch of soil available for the purpose. It should be our aim to learn the best mode to take the greatest crops we can from the soil, and still keep that soil in good condition.

At the present time (1868) it is estimated that there are upwards of thirty millions of people in Great Britain. The population in 1848, twenty years ago, was twenty millions—thus showing that the population is increasing fast. To get a supply of food for this increasing population, we have to depend a great deal on supplies from other countries; but as these imports are not always to be relied upon, it would be a great advantage if we could make the British soil support the British people.

The area of the United Kingdom, including the Isle of Man and Channel Islands, extends over seventy-seven million acres, of which 45,173,708 acres were under grain and green crops, and under cultivated grasses, in 1867. The following table shows the area of the United Kingdom and the acreage under crops in 1867:—

AREA and ACREAGE in English Statute Acres under Crops in the United Kingdom, from Parliamentary Return, 1867.

Countries.	Population according to latest Returns.	Total Area in English Statute Acres.	Acreage under Corn Crops.					Acreage under Green Crops.		Bare Fallow or Uncropped Arable Land.	Clover and other Grasses under Rotation.	Permanent Pastures, Meadows, &c.
			Wheat.	Barley or Bere.	Oats.	Rye.	Beans and Peas.	Potatoes.	Turnips, Carrots, Parsnips, and Mangolds.			
Great Britain,	24,599,654	56,964,000	3,367,876	2,259,164	2,750,487	52,865	854,388	492,217	3,005,946	922,558	3,989,974	12,071,319
Ireland,	5,571,971	20,323,000	261,908	172,637	1,659,412	7,673	13,507	1,001,545	430,707	26,191	1,658,451	10,057,072
Total, United Kingdom, including Channel Islands,	30,315,072	77,513,000	3,640,925	2,439,947	4,421,998	60,618	868,452	1,500,624	3,451,172	953,998	5,679,433	22,156,541

	Total under Corn Crops.	Total under Green Crops.
Great Britain, . . .	9,284,780	3,498,163
Ireland, ...	2,115,137	1,432,252
United Kingdom, including Isle of Man and Channel Islands, ...	11,431,940	4,951,796

On referring to the foregoing table, it will be found that there were in 1867 in the United Kingdom

11,431,940	acres under	corn crops.
4,951,796	„	green crops.
953,998	„	fallow, or without a crop.
5,679,433	„	clover grasses.
22,156,541	„	permanent pastures or grasses.

To this may be added 2,600,000 acres under timber, which makes a total of 47,773,708 acres under cultivation, leaving 29,739,292 acres under hill-pastures, commons, and other wastes. It is estimated that nearly ten millions of these waste lands are capable of being cultivated; the remaining portion, being nearly twenty millions, are waste lands which may be said to be incapable of cultivation. Taking the population with the area, we have about one acre and one-fifth to each person in the kingdom. This is a very small proportion, especially when the increasing population is taken into account; and the reclamation of waste lands capable of cultivation, would assist us materially in dispensing with foreign supplies.

There was a time when many landed proprietors could not afford to lay out money in the improvement of wastes; but this is now obviated, seeing that the Government supplies money for estate improvements, subject to percentage over a certain number of years; and there are several land improvement companies who advance money for the same purpose on similar conditions.

These land improvement companies enable a proprietor to obtain a loan from them for the execution of permanent improvements on his estate. The landowner must, in the first place, give a statement of what he proposes to do in the way of improvements. If the proposed works meet with the approval of the company, the loan will then be advanced, and the works will have to be approved of by the inspector for the Enclosure Commissioners. The company have their loan returned, and any other expenses in connection with it, by a rent-charge upon the estate, which must be paid in half-yearly instalments for a term of from twenty-one to twenty-five years.

The landowner can charge the inheritance with this rent-charge.

The company will either contract to carry out the works or allow the landowner to do so himself.

The rent-charge to repay capital and interest in twenty-five years is now charged at the following rates:—

£7, 1s. per cent per annum for loans under £500. £6, 14s. 1d. per cent per annum for loans above £500.

The foregoing are the rates of rent-charges in England. In Scotland the rate of rent-charge per annum is £6, 14s. 1d. for any amount, whether under £500 or not.

These waste lands are comprised chiefly of moorlands and hill-lands, while a smaller extent is taken up with bogs and mosses, also land that is subject to be submerged by the sea. There is no doubt but that a large extent of our level moorlands could be reclaimed so as to produce fair average crops of grain, &c. Our hill-pastures also can be so improved as to bear a better and more abundant herbage for grazing.

Section 2.—*The Improvement of our Waste Lands by rearing Plantations on them.*

In commencing to improve and reclaim any portion of waste land, the first point to ascertain is the existence or non-existence of sufficient shelter to the part or parts about to be brought into cultivation. Where there is not the shelter requisite, it will be necessary to form plantations, with the view of checking cold winds and stormy blasts. Any one acquainted with the district in which it is proposed to reclaim land will be able to know from what quarter or quarters the prevailing cold winds come; but generally shelter is desired on the north and north-west sides; this will of course depend very much on the locality in which the operations are to be carried on. In consequence of the increasing demand for sheep and their wool, these waste districts are rapidly rising in value for the pasturage of this description of stock; and hence we find that many landed proprietors and tenants, having grazing on these wastes, are draining a considerable extent of the wet parts of them. These drains are made open, as already described in the chapter upon Drainage. This has improved the pasturage operated on very much, and has added, besides, to the general health of the stock. This system of drainage has acted very beneficially so far as it has been put in operation, and ought to be more extensively employed as an improving agency by all who possess such lands.

But what is wanted in order to secure the full advantage of this step, and at the same time make good a still greater improvement over the whole than it can effect alone, is shelter from the prevailing and cutting winds which are experienced on those high-lying and exposed parts during the greater portion of the year, but more especially in spring and autumn. This shelter can only be secured by a judicious distribution of plantations on them; and to show how this can be best effected I offer the following remarks:—

Looking at the present state of the country from an agricultural point of view, it does not, I think, admit of a doubt, that ere long all the low-lying parts of our waste lands will be taken up and reclaimed, for the purpose of being made arable, in order to increase our supply of food. Keeping this in view, it certainly must be the interest of every landed proprietor who is possessed of this description of land to have all portions of it which can be made at all available for cultivation prepared for this without delay, by planting a considerable proportion of it with trees, in the shape of well-defined plantations on well-chosen sites, in order to produce shelter in the districts before they are taken up for improvement agriculturally. By attending to this in time, the plantations will have attained some height, and be capable of producing shelter over the district, when the land adjoining comes to be put under cultivation; but if on the contrary, no plantations are formed till the land is being made arable, the full advantages of the improvement will not be realised till the plantations shall have grown up to produce the desired state of shelter for the fields.

Great advantages will certainly result from early planting on those districts of waste lands which are capable of being made arable, and also any portions which are left for permanent pasture for sheep-grazing will also be very much improved. A much higher rent will be obtained for arable land well sheltered with plantations than for arable land which lies open and exposed. The foresight of our landed proprietors who have such land to improve will lead them to plant large portions very soon, as it will certainly be to their ultimate benefit; and in order to bring about this desirable condition in regard to the lower-lying portions of their waste lands, they should plant all knolls embraced on them which may be found of a very poor or rocky description, and therefore unfit for being made arable; and the tops of all the ridges bounding the flats, and also the hollows, should be planted altogether to the extent of at least a tenth part of the whole land intended for improvement.

These plantations should be formed of all kinds of trees suitable to the different soils and situations in which they are to grow. Previous to planting, the portions of land to be dealt with in this way should be securely fenced, and all wet parts of them made dry by open cuts of a sufficient depth, according to the nature of the soil and subsoil; but considering the general character of these high-lying waste lands, the drains will have to be made thirty inches deep, the same width at the top, and about nine inches broad at bottom, as already described in the section for the drainage of woods and plantations in the chapter on Drainage.

These drains should be laid out at such distances as the character of the different parts of the land to be operated on may indicate, and the soil taken from them should be spread well over the surface in the spaces between the drains, in order to improve the land. In laying off plantations in those districts where it is intended that their boundaries shall afterwards form the sides of arable fields, care should be taken not to make any sudden curves in them, as these are in all cases found to interfere with farming operations. Curved lines, with bold sweeps, are the best for giving shelter—much better than straight lines; straight lines are certainly the shortest, but they do not please the eye so well as bold sweeps, not too much bent. They should be made to run in a gradual and easy way, and so as to interrupt as little as possible the profitable working of the land adjoining.

Plantations made in such districts should, as far as possible, be in large masses, and never in narrow belts. When it is found necessary, for some local reason, to make them in the form of belts, these should not be narrower than one hundred yards. With these narrow belts there is no shelter to the trees themselves, consequently they are very slow in growing; and when they do get to a sufficient height to give shelter, the cold winds blow through them unchecked. Where there is a considerable breadth of trees planted together, they shelter each other, and get away faster than where there is a narrow belt; and where there is a large mass of trees, the winds are checked in their force before they can get through the plantation; and it should be observed that the wind also acquires a certain degree of warmth in passing through a large body of trees. In order to protect the lands which are proposed to be improved from the winds from the higher ground above, a broad belt should be planted along the higher boundary of the former, and on the lower line of the latter; and this should be so laid out as to stretch in bold convex curves outward and upward, with a view to throw the winds off the lower grounds as they rush down from the higher.

With regard to the portions of waste lands lying at an elevation above those referred to as capable of being made profitable arable land, they also are capable of being made vastly more valuable to their proprietors by having plantations judiciously distributed over the high-lying parts, so as to shelter the lower portions, and thereby make them more valuable for the maintenance of stock. It is a well-known fact among all sheep-farmers, that a hill-pasture farm which is too high lying to admit of its being dealt with properly for arable purposes, is, when sheltered by plantations properly laid out with a view to protect sheep from the prevailing storms of the locality, worth three times as much the rent it could be for pasture without them. This is, therefore, a matter of great importance to the proprietors of such hill-lands, and should induce them to set about the improvement of those portions of their estates with as little delay as possible. Every proprietor of waste lands of this description has it in his power to raise the annual value of such lands considerably, by simply rearing plantations on them, so as to produce shelter, and thereby improve the climate. This should be done in all respects in the same way as has been already described in referring to the improvements by plantations of the portions which can be made arable on the lands lying at a lower elevation than these, with this difference, however, that as the situations are understood to be, generally speaking, much higher lying than those of the parts which can be made available for arable, the plantations should be made, for the most part, in much larger masses.

It is indeed remarkable that this improved condition of our hill-pasture-lands has not long ere now been more extensively adopted than it is, seeing it is certain to be a highly remunerative undertaking both for the present and the future. As hinted in a former chapter, the rents of these, as well as for all others of our waste lands, must continue to rise; and it is clear, therefore, that the proprietors of such who possess the most foresight, and who will improve them the earliest, will reap the greatest benefit from the outlay. Were all the hill-lands dealt with, as far as possible, by planting and draining in the way described, they would not only be of greater value to the proprietors, but they would also add to the benefit of the public at large.

Besides the increased value of the arable and pasture lands caused by the plantations, the timber grown in the plantations themselves would more than pay for the expense in forming them; but I need not dwell on this subject here, as it will be considered more fully in a subsequent chapter.

SECTION 3.—*The Reclamation of Waste Lands by Trenching.*

On many estates in the north of Scotland, and over a great portion of our waste lands, there are tracts which consist of very good soil, but have a large amount of stones upon them. To get such parts thoroughly brought into cultivation it is absolutely necessary to have them dug up and trenched by manual labour. The land should be trenched in the way already described in a former chapter, and need not be repeated here. The stones will be found very useful in building walls as fences, and the smaller ones can be put into the drains and used in the construction of roads. In trenching very stony ground the foot-pick will be found a very useful implement for the purpose, fig. 87; and what cannot be got out by the footpick must be blasted with powder. The stones should be thrown on the surface of the trenched ground, and afterwards removed to form the drains, fences, and roads. It is always the cheapest plan to have the operations of trenching, fencing, draining, and road-making going on at one time, as in that case the materials can be taken and put into their place at once, without having to remove them again. The trenching should be set by contract to one or more workmen at so much per rood or acre, having written conditions describing the manner in which the work must be done. The following are some of the conditions under which stony ground should be trenched :—

FIG. 87.

1. The land to be trenched to a depth of two feet at least, where the subsoil is retentive.

2. In trenching, the stones taken from the land to be all taken out to the depth trenched, and thrown over the land dug up.

3. The surface to be made level in proceeding with the work.

4. The trenching is to be done at the price of £ s. d. per acre.

The expense of trenching stony ground eighteen inches deep has cost me about £7 per acre. This may appear a large sum to many; but when it is considered that the land was converted out of a rough stony waste into a field fit for growing crops, the expense is not so heavy as to make it too formidable in most cases. Trenching by hand-labour is not the cheapest way of reclaiming land, but it is nevertheless the most satisfactory in the end.

In trenching land that has at one time been under a crop of trees, the draining of it should be left until the trenching has been finished, as then all the old roots will have been got out, and this lessens the expense of the drainage. The common mattock is the best implement for cutting the roots of trees in the soil, as an axe very soon gets out of working order under such circumstances. In the case of very large roots, they are quickest got out by a long tough ash pole being employed to act as a lever upon them. The roots must first be cut, and then turned out by the lever. For this purpose, and indeed for any trenching where there are roots or large stones, it is better to have several workmen together, as they can then unite and assist in taking out more than usually heavy roots or stones.

In trenching bog or moss land, it should first be drained before making any attempt at other improvements, as the drainage, by taking the water away from the peat, causes it to subside; and in draining such land it is necessary to proceed slowly with the work. In drains which are meant to be afterwards covered, they should be made with a slope on the sides to prevent them from falling in—say to a depth of from two to three feet—and allowed to remain in this way for some months, when the peat will have subsided so much as to admit of the drains being again deepened; and this must be carried on for one or more years, as may be necessary, until the peat has dried for several feet in depth. If the bottom of the moss has not been reached, the drain-pipes will have to be put in on wooden soles—that is, long boards of wood about three and a half inches broader than the pipes which will rest upon them.

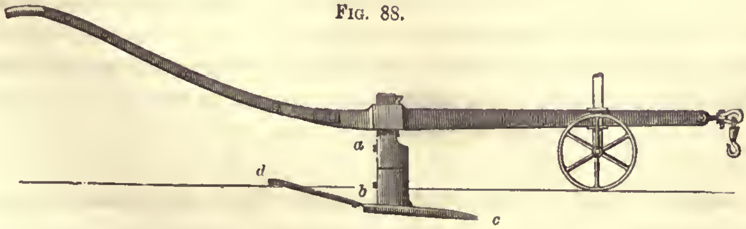
The drainage having been finished, the trenching can be proceeded with as already described in regard to the trenching of other land, and any roots of trees in the moss will have to be removed as described. The cost of the reclamation of moss depends upon its depth and its nature. I drained and trenched a field of moss some years ago in Inverness-shire. The peat was on an average fifteen feet deep; this we drained first, and afterwards removed a large number of tree-roots in the manner described, the improvement of the land costing the sum of £8 per acre.

SECTION 4.—*The Reclamation of Waste Lands by Horse-Power.*

There are several forms of ploughs which have of late years been used in subsoiling and trenching land with horses. Amongst these is the Tweeddale subsoil-trench-plough, which was an improvement made by the Marquess of Tweeddale upon a subsoiling-plough made by Mr Read. It has been extensively used in the subsoiling and trenching of several farms at Yester, county of Haddington, Scotland, and also in other parts of the kingdom.

Mr Stephens, author of the 'Book of the Farm,' wrote a work describing the improvements carried out on the Yester farms, entitled 'The Yester Deep-Land Culture,' which is very instructive, and no one should be without it who has the improvement of estates to carry out. In this work Mr Stephens thus describes the different parts of the Tweeddale subsoil-plough, fig. 88:—

FIG. 88.

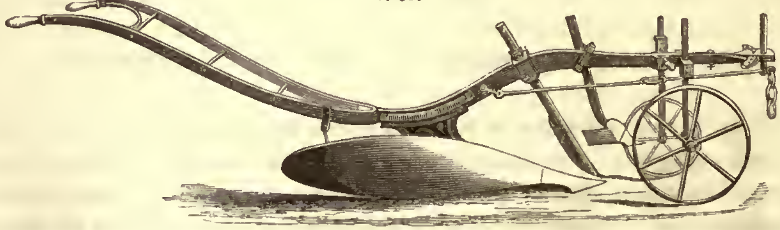


"These comprehend the shank or coulter *a b*, the sock or share *b c* attached to it, and the inclined plane or tail-board *b d*, also attached to the coulter. The coulter is a bar of iron, of the best scrap, about two and a half inches long and three and a half inches broad and one and a quarter inch thick. At the bottom it is forged with a flange fitted to receive the attachment of the body of the sock, and fastened by three screws, so that it may be taken off and repaired. To the hind part of the sock the tail-board is fixed by clamp and screw-bolt."

In employing this implement, another plough, also constructed by the Marquess of Tweeddale, goes first, with two or four horses, as the nature of the ground may require. Then follows the subsoil-plough, tearing up the soil in the bottom furrows of the first plough. Land can be trenched to a great depth by this means.

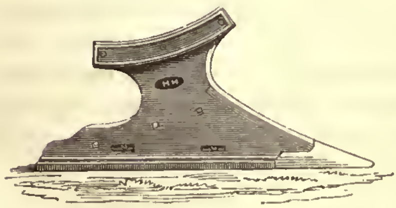
I have used a plough for some years manufactured by the Messrs Howard of Bedford, and found it very useful both in reclaiming new land and in deepening and stirring land which has been in cultivation. Fig. 89 is a sketch of the one I refer to. With four horses it

FIG. 89.



will plough to a depth of one foot. The mould-board can be unscrewed and taken off, and a subsoil body put on, as shown in fig. 90. The cost of these implements are—for the plough, £4, 17s. 6d.; and for the subsoiling body, 17s. 6d. It is, however, better to have two of these ploughs, and also two subsoil bodies, when the subsoiling-plough should be put in the same furrow following the other plough, and thus it can be stirred up to a greater depth.

FIG. 90.



The ploughing and subsoiling of a portion of moorland on this estate with Howard's ploughs, as described, cost about £4 per imperial acre.

SECTION 5.—*The Reclamation of Waste Lands by Steam-Power.*

I am not aware that steam-power has been much employed in stirring up waste lands with a view to reclamation. Where there are no large holdfast stones bedded in the soil, there is no reason why it should not be so employed. There are many large portions of waste land in this country which are free from large stones and roots, and which might be advantageously brought into cultivation by means of steam-power.

There were about one hundred acres of moorland on this estate in 1867, the site of which is comparatively level; the soil is a peaty loam, with a subsoil of a sandy character resting on rock. It was covered with heath intermixed with a few coarse grasses and fern. Considering that it was a good subject for cultivation, the proprietor, Major Stapylton, decided upon having it brought into cultivation, and to have it done by steam-power. Its elevation is about six hundred and fifty feet above sea-level.

Between the soil and subsoil already mentioned there was a thin band of hard pan, usually called *moor-band pan.* This pan is, I believe, formed by the oxide of iron which exists in the soil; and being washed down by the rains, it forms an impervious body into which the roots of any plant will not penetrate, and the rain-waters cannot get freely through it. If this pan is broken, and the soil kept deeply stirred from year to year, the iron matter will not again unite, but will be gradually washed away by rains. In proceeding to reclaim this portion of the estate, we formed large masses of plantation to the north, north-west, and east of it. Two new roads were formed on two sides of it, and then we proceeded to the actual improvement of the soil itself. The heath on the surface was about an average length of eight inches; this we set fire to on calm days, and had some workmen at hand all day to see that the fire did not go beyond the boundaries of the part under operation. Having had this done, I made a contract with a gentleman in the Riding, who possesses a set of Fowler's double-engine steam-tackle, to plough and cultivate the land.

The engines are locomotives, or what are called "traction" engines; and in proceeding to the land to be cultivated, they worked themselves up a steep road with a gradient equalling 1 in 6. They, however, went up quite easily, pulling both a four-furrow plough and large cultivator with them. The engines are ten-horse power, and of the same description as described under Steam Cultivation. I also contracted for the carriage of the coal from our station, which is nearly three miles from the land referred to; and I agreed with an adjoining tenant to supply the engines with water, by using a water-cart, at so much per day.

The engines commenced work by ploughing with the four-furrow plough to a depth of eight inches—this was down to the pan already described; but they had not proceeded far when it was found that the surface of the soil, being full of strong heath-roots, was very tough, and it was considered the strain upon the engines was too much with turning over four furrows, consequently one of the mould-boards was removed, and they proceeded with the three mould-boards, and found that it was much easier for the engines and did the work better.

It is thought by many that it is much better to have the land ploughed without paring and burning a thin portion of the surface, while others are in favour of paring and burning. With the view of testing the merit of both systems, I had about ten acres of the land pared and burned. I let the paring by contract to two of our workmen at the rate of £1 per acre, the conditions being that they were to pare off a turf from the surface about one inch thick, and to have it done equally over the surface, and all the turfs to be turned with their natural side downwards. It is the custom to take off a much thicker turf than I have stated, but I considered that it would be beneficial to get the tough rooty surface burned without taking too much of the vegetable matter away. When the paring was finished, we then had the turfs turned over on the ground and allowed them to lie for a few days, when they were in a good state for burning; and for this purpose we collected a few cart-loads of dead Scots pine and larch branches from an adjoining plantation, and made small heaps of these over all the pared ground, and then collected the turfs and heaped them on the top of the branches, which were then set on fire. Each heap was set on fire in the morning, and they were completely burned before the day closed. During the time of the burning there were a few men in attendance to keep the turfs on the fires, and to see that they did not go out. The ashes were then spread over the surface of the ground, which of itself was a very good manuring.

The steam-plough went on with its work, and ploughed at the rate of five acres per day. From seven to eight acres could be ploughed per day when working on cultivated land; but the surface here was very tough, and the roots of the heath collected between the mould-boards and choked the plough, so that it would not work, and the engines had to be stopped. This occurred at first very often, consequently there was a loss of time; but I afterwards sent a man to walk along with the plough, and, with a common fork in his hand, to keep the roots from accumulating in the plough. This was an improvement, although we had occasional stoppages in places where the roots were very strong. We also found that, from the roots of the heath being strong, they caused the plough to be thrown out at times, and kept it from going so deep as it would otherwise have done. I therefore sent another man to sit upon the back part of the plough, who would by his weight assist in keeping it down in the soil, and also assist in getting it more quickly cleaned when it choked.

The part which we pared and burned was also ploughed by the steam-plough. The work done on this portion was well executed. Having finished all the ploughing, we then commenced to tear up the subsoil with the cultivator. (See chapter on Steam Cultivation.) This cultivator or scarifier has seven long tines, and it takes six feet in width. It tore up the subsoil to a depth of fourteen inches, and broke the pan already referred to. The subsoil below the pan is quite free and open, consequently all we required to do was to break the pan, so as to allow the roots of plants to get through.

After finishing the cultivation of the portion which was pared and burned, we next commenced to use the cultivator as a subsoiler on the remaining part, which had been ploughed only; and, after trying it over a few acres, found that the furrows turned were so tough that they threw the cultivator out of the soil, and that we could not get the tines deep enough to break the pan. I therefore deferred doing any more at it at that time, and left it to lie and rot for a season. It is in this state at present, and we intend to allow it to remain in that state till the spring of 1869, when we expect that the vegetable matter will have decayed sufficiently to admit of its being worked up, and the subsoil also. Last winter's frost has had a very beneficial effect upon it.

The portion which was pared and burned is in a good state for cultivating now, and we intend this season (1869) to put a green crop in it, and have it eaten off with sheep, when it will in 1870 be in good condition for further cropping.

I shall be glad to furnish any one interested in the reclamation of waste lands with a statement of the results after the land has been cropped.

The expenses in connection with the reclamation of this land is given in the following statement:—

Burning heath, ten men one day, at 2s. 6d. each,	£1	5	0
Ploughing with steam-plough eighty-five acres, at 10s. per acre,	42	10	0
Cultivating sixteen acres, at 10s. per acre,	8	0	0
Twenty-eight tons of coal, at 12s. per ton,	16	16	0
Carriage of twenty-eight tons coal, at 6s. 6d. per ton,	9	2	0
Expense of three men working engine and plough,	4	10	0
Cartage of water to engines, at 7s. 6d. per day,	9	0	0
Two men assisting with plough twenty-nine days, at 5s.,	7	5	0
Paring ten acres, at 20s.,	10	0	0
Cartage of branches for burning turf, one cart and man one day,	0	5	0
Burning ten acres, eight men one day, at 2s. 6d. each,	1	0	0
Spreading of ashes, eight men half a day,	0	10	0
	£110	3	0

The total expenditure so far has therefore amounted to £110, 3s., or at the rate of about £1, 6s. per acre. To finish this, and make it all thoroughly fit for cropping, it will have to be broken up with the cultivator twice over—that is, once each way. This will cost about £1 per acre, which will increase the expenditure to £195, 3s. To this will have to be added the sum of £11, being interest at the rate of 5 per cent upon £110 for two years, and also interest at the same rate upon £85 (the expense of the last cultivation) for one year, or the sum of £4, 5s., making a total of £210, 8s.—or at the rate, in round numbers, of nearly £2, 10s. per acre.

A good portion of this land will have to be drained, part of which is now being done. We can now compare the separate expense of reclaiming the land by paring and burning the turf, and also by ploughing it without first being pared and burned. The cost of paring and burning will therefore stand thus:—

Burning heath, proportion per acre,	£0	0	3½
Paring per acre,	1	0	0
Burning per acre, with cartage of branches,	0	0	3½
Spreading of ashes per acre,	0	1	0
Ploughing,	0	10	0
Cultivating,	0	10	0
Coal,	0	3	10
Carting coal,	0	2	1½
Assistance per acre,	0	1	8
Carting water,	0	2	0
	£2	11	2½

This gives a total of £2, 11s. 2½d. per acre, and the land is fit for cropping. Taking the other portion ploughed, but not pared—seventy-five acres—by itself, gives an almost equal expense per acre; but it must be kept in mind that in the latter case there is a year's produce lost, and to the landlord a year's rent.

It may be interesting to many to know that the two engines, in working twenty-nine days, only required an outlay of 26s. in repairs—and these consisted chiefly in broken socks—and used ten gallons of oil, which cost £3.

Besides the methods described of improving the waste lands of this country, great extents of our moorlands could be very much increased in value as pasturage by having the heath burned on them, and the surface then slightly broken up by a scarifier or even with harrows, so as to slightly open out the surface-soil for the purpose of receiving the seeds of the finer grasses suited to the situation. This might be advantageously done in situations which may be thought too expensive to trench. The herbage of all such lands is also very much improved by a topdressing of lime.

Considering the rapidly-increasing population of this country, and the demand there is to have every square foot of land made to grow its share of the people's food, the question naturally comes to be asked, Could not the railway banks be made more profitable? When we take into account the great extent of railways in this country, and the amount of land taken up by the sloping banks on each, the quantity of land thus lying dormant must be very considerable. In many parts of the Continent the banks on the sides of the railways are cultivated advantageously, and I think that a very great proportion of our own railway wastes might be made profitable. Much might be done to improve them for cultivation by an increase of surface soiling and manuring. If the danger from fire or the steepness of the banks prevents them being cultivated for many kinds of crops, yet they, at all events, could be made to grow good crops of grass. In their present state they may be said to be under a crop of grass, but in reality it is a crop of weeds. Where grasses have been sown, they have been of a very inferior description, and the result is that the crop is almost worthless. All the railway banks capable of being dug should be improved by first increasing the soil on the surface, and also by a liberal application of manures. They should then be sown down with good grass-seeds. They should be liberally manured every season, so as to increase the growth of the grasses as much as will allow of them being cut two or three times in each season, either to be converted into hay, or sent by rail to large towns and sold to dairymen.

CHAPTER XIX.

ON FARM-BUILDINGS AND LABOURERS' COTTAGES.

SECTION 1.—*Dwelling-Houses—Farm-Steadings.*

FARM-BUILDINGS may properly be divided into two classes—namely, *Dwelling-Houses* for the farmers; and *Farm-Steadings*, in which the farmers store and manufacture their produce, and rear their cattle. To each of these classes of buildings I shall advert in their order.

It is a remarkable fact that farmers, generally speaking, are worse accommodated in regard to the houses in which they live than any other class of business people having a similar amount of capital engaged in trade. In all parts of the country we see men, occupying considerable farms, who are living in houses very little better than those occupied by the labouring classes in the same districts. Now and then, it is true, we see a farmer occupying a suitable and commodious house; but for one we find in this happy condition, there are at least twenty otherwise circumstanced. To say the least of this state of things in regard to farmers, it must be confessed that it does not indicate a high degree of refinement and intelligence among them; for in most cases where men are intelligent and refined, they live in houses somewhat suitable to their qualifications; and indeed we are generally in the habit of judging of a man's character and attainments by the house in which he lives. But, be this as it may, it is a well-known fact to all who are well acquainted with the subject under notice, that farmers' houses are, generally speaking, of a very inferior description, and but ill adapted to the wants of the people who inhabit them. This, in a great many instances, may be the fault of the landlords more than the farmers. I know of many farmers occupying farms from one hundred to two hundred acres in extent, and who have capital engaged in their business varying from £1000 to £4000, living in houses having only a kitchen and parlour on the ground-floor, with a small bedroom and pantry behind these, and two small attic bedrooms above. The apartments in these houses are generally small, and low in the ceilings, so that there is but little breathing-space in them;

but, notwithstanding this, the farmers, with their wives and families, live in them, along with their servants, male and female. Now, in such cases as these, how can anything like high moral feeling be maintained in the families, not to speak of comfort? But in such cases I have invariably found this was little thought of—the small rooms, and the crowded condition of the occupants, making it out of the question. These are by no means extreme cases; I could refer to many even worse, but I need not, as all I wish to point out is the general want of accommodation in the greater part of farmhouses. In looking over the country generally, no doubt, we find these in all varieties of condition imaginable, from the small cottage of two rooms to the villa of from ten to fifteen apartments; but by far the greater proportion are of an extremely inferior class, and comparatively few are to be found of the superior. Now, what I mean to infer from these remarks in regard to farmhouses is, that while proprietors subject their tenants to live in inferior houses, they must be content to have their estates indifferently cultivated by an inferior class of tenants; for assuredly no superior tenant would condescend to inhabit an inferior house. And, moreover, if they desire to have their properties well farmed by a superior class of men, they must, in the first place, erect a suitable class of houses for them to inhabit.

Every dwelling-house for a tenant-farmer should be built of a size suitable to the extent of the subject. This, at first sight, may seem somewhat difficult to define, but in reality it is easy; for, generally speaking, the suitableness of a house for any tenant may be safely arrived at by considering the probable amount of his annual income from his farm. For example, if a man farms a hundred and fifty acres of land, and cultivates it highly, it is expected that he will have a capital of at least £2000 engaged in his business; if so, he ought, if he manage at all successfully, to realise, on an average of years, at least ten per cent per annum from this amount, or say £200 a-year. Now, the question is, What description of house is considered suitable for a man having this income annually? To settle the question, we have only to look about to see the kind of houses tradesmen and small merchants in country towns occupy who have similar incomes from their business, as the farmer is as much entitled to have a house suitable to his income as they have. And in the same way the kind of house suitable for a farmer on any other size of farm may be easily ascertained. Were farmers' houses erected for them on some such scale as this indicates, the proprietors would have no difficulty in securing highly intelligent men for their farms, with enough of capital for the respective subjects; but until something of this kind is done for farmers, there is little hope of the land being improved as it ought to be, for good men with capital will not occupy inferior houses in the country while they can live more comfortably elsewhere.

Another point in regard to farmhouses is, that they are frequently placed too near to the steadings to be either healthy or agreeable to live in. I would suggest, therefore, that every farmhouse should be erected on a pleasant site at some distance from the steading, and in front of it. If there are no trees growing on the site, these should be planted so as to give shelter and pleasing effect at the same time; and in all cases there should be a good kitchen-garden attached, with a neat flower-garden and shrubbery between it and the house, so as to give the place a villa character.

As there is such variety in the sizes of farms, it may be inferred, from what I have stated, that a great many different sizes of dwelling-houses are also required; but taking the generality of farms, the various kinds of dwelling-houses wanted may be set down as consisting of three kinds — namely, first, second, and third class: a first-class farmhouse being suitable for a farmer paying a rent of from £700 to £1000 and upward per annum; a second-class farmhouse being suitable for a tenant paying an annual rent of from £300 to £500; and a third-class farmhouse being necessary for a tenant paying an annual rent of from £150 and under £300.

With regard to farm-steadings, it is of course understood that they should be of such a character as to accommodate in a comfortable and satisfactory way the general produce of the farms respectively, and the different kinds of animals reared and kept on them; and not only this, but they should also be so arranged, in reference to their respective compartments, as to insure the least possible labour being required in attending either to live stock or crop. Unless a farm-steading is constructed so as to secure these necessary conditions, it is unsuitable for profitable farming.

In examining farm-steadings, however, it is to be found that very few indeed can be said to be sufficiently commodious and well arranged for all the purposes required to carry on farming in a first-class way. In a large proportion of them the accommodation for the beasts is wretched in the extreme; in many others the compartments, from having been added from time to time, and without any fixed plan, are most inconveniently situated for the profitable working of the whole; and in not a few cases we find the buildings on sites either too low lying, and therefore wet, or too high lying, and therefore exposed to cold and cutting winds. These deficiencies in regard to farm-steadings are very much against the interests of proprietors, for whenever farm-steadings are deficient in comfortable accommodation, it is impossible for the tenants to prosecute the various departments of their business to such an extent, or so profitably, as they would otherwise do; and where the compartments are badly arranged, much more expenditure has to be incurred by the tenant than would be required in a different state of things. It is therefore to the profit of the proprietors, as well as of the tenants, to have their farm-steadings of the very best description, suited to the extent of the subjects they are intended to accommodate; for if the tenants have inferior steadings, they can only work their farms in such a way as to enable them to pay low rents.

A farm-steading should never be erected on a low-lying site, nor on a high-lying one, but on one of moderate elevation, according to the character of the locality on which the farm is situated. If built on a low-lying part, it is liable to be flooded by water at times, and to have its drainage deranged from want of sufficient outfall; and besides, on such a site, early autumn and late spring frosts affect the health of the animals much more than is generally supposed, and may be said to be the cause of much disease among them. When a steading is built on a high-lying site, compared with the general elevation of the farm, there is always a difficulty experienced in taking home the produce of the field, all this being up-hill work, and therefore expensive; and a still greater objection to such a site is, that in winter and early spring the cattle can only with great difficulty and expense be kept at all in a comfortable condition—in fact, in such a case as this, they consume very much more food to keep them in tolerable condition than is found necessary on a site of better exposure.

A farm-steading should always have ample accommodation for the wants of the farm it is designed to serve, as I have very often observed that the housing which was considered enough at the beginning of a lease of nineteen years, was found not nearly sufficient for the accommodation of the farm in ten years after, or before the lease was much more than half run. This arises from improvements having taken place on the farms, which enabled the tenants to grow more abundant crops and rear more stock on them than they had anticipated. A few good steadings have been erected of late years in the country. These, when they were built, were considered ample for the wants of the farms on which they stood; but now, after the lapse of only a few years, some of them are found short of the necessary accommodation, and this from the farms having been so much improved that the produce has over-grown the space at first allotted to it. This, then, is a point which should be kept in view by all parties concerned in the building of farm-steadings, and, in fact, neglect of it accounts for the deficiency of farm-buildings as they are generally found at the present time—that is, they were all considered ample enough for the farms at the time they were erected; but as improvements have taken place in agriculture, and more stock and crop been reared in consequence, they are now found not only much too small, but in their general arrangements unsuited to the present state of farming, and therefore require to be generally altered to make them up to the time. A great fault in erecting farm-steadings has always been to have them put up in such a way as to cost as little as possible. Now I am not one to recommend extravagant or unnecessary outlay in any respect, and would especially protest against all superfluity in regard to style and ornament in farm-buildings, as this can only lay an extra burden on the tenant; but at the same time I think it is bad economy in a landlord to stint the steading accommodation for his tenants, seeing that, if they turn out improving and successful, they are more likely to require larger premises than are even at the time considered necessary.

All the compartments of a farm-steading should be roomy and airy, with good ventilation, constructed so as to avoid draughts; and every one should be in connection with the other, according to their respective uses in the economy of the work. A complete supply of good water should be secured for each compartment where beasts are kept, and every requisite should be fitted up for its being readily used by them, as much of the health of the animals depends on this.

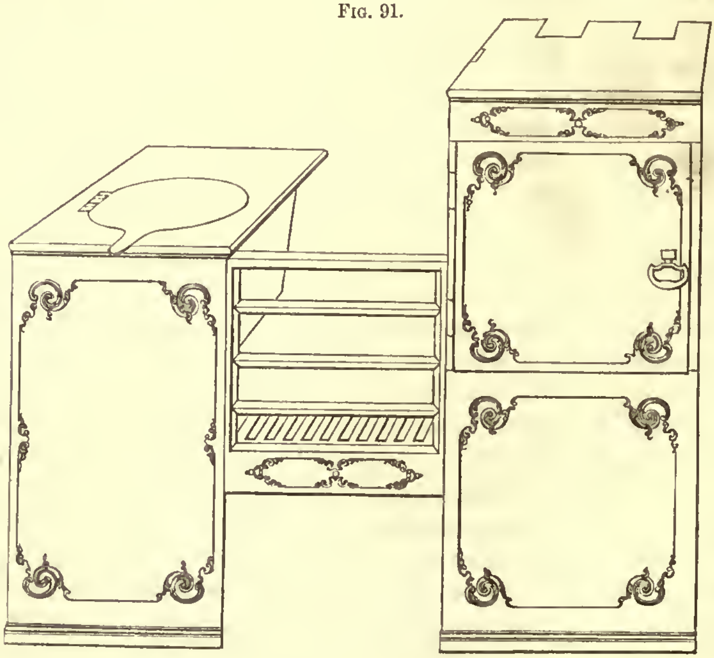
SECTION 2.—*Labourers' Cottages.*

Labourers' cottages are the next branch of farm and estate buildings requiring a few remarks. Although these are indispensably necessary on an estate, and on any farm of considerable extent, to enable the tenant to keep his labourers conveniently for their work, still in all parts of the country there are estates on which there are few or no cottages for the labourers required on the estate generally, these having to be lodged, for the most part, in the houses of the tenants, along with themselves and families, or in villages at a distance from their work. This is not a proper state of things in rural districts, as every tenant's family should have their own house to themselves, and should not be subjected to the inconvenience of having to shun the part of the house occupied by the labourers who lodge in it. In regard to labourers' cottages, I have to suggest, then, that there should be one erected for the accommodation of each permanent labourer on every farm. Of late years, however, much more attention has been paid to this than formerly; for we now find in many parts of the country excellent cottages fitted up for the accommodation of farm-labourers. This is generally in the best-improved districts only; for although it is pleasant to have to note this improvement, still there are many parts wretchedly deficient in this kind of farm-buildings, and hence farmers in such districts cannot get on at the same pace as their more fortunate neighbours who have the requisite cottage accommodation for their labourers.

A cottage for a labourer should contain at least four apartments—namely, a kitchen and three bedrooms—besides a pantry, w.-c., and coal-house; and in each room there should be a wall-press. The cottage should either be a double one, all on one floor—that is, the kitchen and principal bedroom should occupy the front half, and the bedroom for the boys and the one for the girls the back half—or with kitchen and one room down-stairs, with two rooms above. No cottage for a married man should contain fewer apartments, as, without such a division as to bedrooms, proper moral conduct cannot be well maintained in a family. All that is wanted for a labourer's dwelling is a cottage suitable to his circumstances and wants, and I think that these can be met by such as I have described. Many of the cottages inhabited by labourers are disgraceful both to the landlords and tenants under whom they sit; but it is gratifying to see that in most parts there is a spirit of improvement being exemplified in respect to labourers' cottages, which must ere long result in placing the labouring classes in the position they ought to be.

When we come to consider the cost of erecting labourers' cottages, it is difficult to state a sum likely to act as a guide to any one, as so much depends on local circumstances and the material of which the cottage is to be constructed. If the cottage is to be erected of stone, much depends on the nature of the stone, and the distance of the site of the cottage from the stone quarry, which affects the cost of cartage. Where stone can be got at all convenient, it is the most preferable for the purpose, and is much more substantial than bricks. Good foreign timber should in all cases be used. It is mistaken economy to use home-timber grown on the estate on which cottages may be erected—larch timber especially, as it is so very much apt to twist and split. Good oak timber is the only exception in this case, as it might be used in certain cases with propriety; but, generally speaking, good oak timber can be sold for a much higher price per foot than foreign timber can be bought for. Slates are best for roofing. Some proprietors prefer tiles, but it is always economical to use slates, as they cost less than tiles in keeping up afterwards. The kitchen should be paved with flags, and all sleeping-apartments above laid with timber. I have often seen the sleeping-rooms of cottages either paved with stone or bricks—this is more especially the case in Scotland. Wooden floors for bedrooms in cottages are more healthy and comfortable for the inmates. Stone and bricks gather damp, whereas boards, being kept from the soil by the joists, remain perfectly dry. Brick and other tile paving are sometimes used in kitchens, but do not last long in any room where children and heavy-booted labourers live. Bedroom fireplaces should be fitted in with the common Sham register grates, which are now very cheap; and the kitchen fireplace should receive a range with oven and hot-water boiler. These are in common use in England, but not so in Scotland. Ovens and boilers are not given to Scotch labourers, because it is not thought necessary, as bread is usually bought from a public baker; but I am aware that it would add much to the comfort and economy of Scotch labourers if each cottage were provided with both hot-water boiler and oven. Fig. 91 gives an idea of what is commonly used in Yorkshire for labourers' cottages.

Fig. 91.



The chief point to be kept in view in erecting cottages is to give ample space and accommodation, combined with comfort, and at the same time to make them substantial and neat, without elaborate ornamentation, and all this at the least possible cost.

Cottage-building, as a rule, on country estates does not pay, at least not directly. They usually give a very low percentage on the outlay, and on the value of the land they occupy; but they pay the estate or farm with which they are connected indirectly, in supplying a class of steady workmen who take an interest in the estate or farm, and are always at hand when required.

CHAPTER XX.

BUILDING MATERIALS.

To those who are intrusted with the erection of buildings, a knowledge of the different materials used in their construction is of very great importance, so that they may be able to make a judicious selection of them. On many estates the local circumstances are such that there is not much choice in this respect; but, under any circumstances, an acquaintance with the different materials at the builder's disposal will enable him to judge which will be the most economical for his purpose, and also at the same time the most permanent. Amongst the many different materials used for building purposes, I propose making a few remarks on the following:—

1. Granite.
2. Sandstones.
3. Limestones.
4. Bricks.
5. Slates.
6. Tiles.
7. Mortar.
8. Cements.
9. Concretes.
10. Timber.
11. Metals.
12. Glass.
13. Paints.

1. *Granite.*—Granite is composed of different substances, such as quartz, felspar, and mica. These are easily distinguished on an examination of a piece of granite. The quartz has a transparent appearance, very much like glass, with a dim hue; the felspar is sometimes found of a white colour and sometimes red, commonly of an opaque appearance, and is composed of aluminous and silicious matter, with a small mixture of potash and lime; mica is of a glittering appearance, and very much resembles the scales of a fish when removed in pieces. In some granites a substance called hornblende is found in place of mica. It is of a dark colour, consisting of alumina, magnesia, flint, and a proportion of the oxide of iron.

Granite rocks are found over a very great portion of Europe—in Scotland, England, and Ireland, Germany and Switzerland. The chief quarries from which we receive the granite in this country are in Aberdeenshire and Argyleshire in Scotland, in Cornwall and Devonshire in England, and also in the islands of Guernsey and Jersey. The best granite is received from Peterhead, in Aberdeenshire, and it is of a reddish colour. A large amount of granite is now received from Argyleshire in Scotland, and Guernsey and Jersey, for paving purposes. The quality of granite varies very much, some kinds being quite brittle and others very compact. The quality depends very much on the size of the particles of which the stone is composed. Thus the best stone will be found with the particles fine, closely packed together, and uniformly distributed throughout the mass. Where the stone is very hard and brittle, great difficulty will be experienced in dressing it, and there it will be found that the predominating substance is quartz. If felspar is abundant in the rock, the quality will not be first-class, as it gives way to the action of the atmosphere; an over-abundance of mica has also the same effect—therefore the best stone will be found where the three substances are equally divided throughout. The cost of Aberdeen granite, delivered in London, was, in 1867, 4s. 6d. per foot cube in blocks; and for sizes suitable for paving it was 2s. 6d.

2. *Sandstones.*—Sandstone is the principal stone found in the Silurian system, and is found over a great portion of this country. Some of the principal sandstone quarries are to be found near Leeds and Whitby in Yorkshire, Portland in Dorsetshire, and Craigleith and Dundee in Scotland. Sandstones are generally found of two classes, the *grey* and the *red*, both of which are known as freestones. Their principal composition is quartz in small particles, kept together by a calcareous cement. These stones are very durable, and are much used for building purposes. Some kinds of sandstone are very porous, and when saturated with moisture in the winter season, the frost causes the stone to split up in pieces. This kind of sandstone should not be used for building. It will be found that the red sandstone has not this defect so much as the grey. I have always preferred using the sandstones for the purposes of coping, water-tabling, and corner-stones, and using other stone for the main building. The most simple way of finding out the propensity of any stone to take in water is to immerse a portion in water, and take the weight of it before and after being in the water. This will tell how much it has taken up. A large portion of Edinburgh has been built of sandstone from Craigleith quarry. Among the chief buildings erected with this stone may be mentioned the College, Register Office, National Monument, and also several churches. The Craigleith stone has also been exported to Hamburg and other places on the Continent. The cost in the quarry is from 9d. to 2s. per foot, in

blocks from five to twenty feet cube. The colour of this stone is a whitish grey. The following are the constituents of the Craigleith stone:—

Silica,	95.725
Carbonate of lime,	1.065
Iron alumina,	2.150
Water and loss,	1.060
	100.000

The average weight per cubic foot is about one hundred and forty-two lb.

We have many examples in this country of the durability of sandstone in buildings. In Yorkshire we have the example of Rivaulx Abbey, which was built in the twelfth century of sandstone found in its vicinity, and the stones are in fine preservation, even showing the original chisel-markings.

3. *Limestones.*—Limestones are found over many parts of Great Britain in different forms. They are of very great importance in building, being very durable, easily worked, and altogether they much surpass the sandstones as a building material. They are chiefly composed of carbonate of lime, mixed up with some metallic oxides. They are sometimes found in a pure state, and then they are of a white colour. As a cement for uniting stones they are well known. We have many examples of the durability of the limestone in buildings. Byland Abbey, on Major Stapylton's estate, Wass, was erected in the twelfth century. The inner walls were built of a silicious grit, and the outer walls of a compact oolite, got from the Wass quarries about half a mile distant. The front of the building was built of the oolite, and is in very good condition, and the original chisel-markings are still entire.

St Paul's Cathedral, London, was built of oolite from Portland in 1700, and the markings on the stone are still very distinct.

Marble is usually taken as a limestone, and the term is applied to those limestones which take a high polish. There are different kinds of marbles, but the difference chiefly lies in the colour of the stone. Some of the best are *bird's-eye, conglomerate,* and *veined.* These are much used now in the erection of chimney-pieces.

It is not always easy to find out the quality of a stone by its appearance, but there are things to be seen outwardly which should tend to condemn the stone for building purposes—such as cavities and cracks, and an over-abundance of iron in the stone. These are defects which will cause the stone to be coarse-grained and weak. The chief points in selecting good stone is to find them of compact texture, fine-grained, and of a dark colour.

Frost is one of the most destructive agents on stone, and especially with stone which imbibes moisture.

4. *Bricks.*—These are formed by submitting common clay to a heat sufficient to convert it into a solid mass like stone; and when bricks are carefully made, they have great strength and durability, almost equal to stone.

The best clay for the making of bricks, tiles, &c., is that composed of pure clay and sharp sand, and should be perfectly free from small stones of any kind. Clay is not always found existing with a proper admixture of sand for brick-making; and when there is a deficiency of sand, it should be added in proper quantity, to ascertain which, experiments should be tried with the clay, mixed with different proportions of sand.

Machinery is now coming into use for pressing and moulding the clay. This causes a great saving of labour; and from the density given to bricks by the pressing, they are much superior in quality. Great attention is required in the drying, burning, and cooling of the bricks, to get them of good quality. First-class bricks give a clear ringing sound when struck, and are of a red and brown colour, and exhibit a fine texture when broken. Bricks which are of a pale colour are not of good quality. Thin bricks are usually the best, as they are burned more equally; but generally they are made about nine inches long, four and a half inches wide, and two and a quarter inches thick.

"In estimating the quantity of brickwork, ascertain by calculation the number of cubic feet in the wall; reduce the number of these cubic feet so ascertained to the standard of brick and half, by multiplying them by eight and dividing by nine; or find the area of the face of wall in feet, multiply the number of feet thus found by the number of half-bricks in the thickness of the wall; divide the result by three, which will give the superficial feet; divide the amount by two hundred and seventy-two, and the result is the number of 'rods' of the standard thickness."*

Where bricks have to be used for hydraulic purposes, they are found to be much improved in durability by having been sunk in water for some days, and then burned again.

Firebrick is that which is used in building fireplaces. It is made of a kind of clay which remains uninjured by strong heat.

One rod of a brick-and-half wall will take four thousand five hundred bricks of the sizes which I have stated as being in general use; one thousand of the same kind of bricks will weigh two and a quarter tons.

5. *Slates.*—Quarries of roofing-slate are found in England, Scotland, and Ireland. The best are procured from Caernarvonshire in Wales, and good slates are also found near Valentia in Ireland, and Ballahulish and

* 'Book of Farm-Buildings.'

Easdale on the west coast of Scotland. The best quality is that which splits into thin layers with an even surface, and should be free from iron ore. At the Bangor quarries one thousand men are kept in employment, and a profit of about £80,000 per annum is realised. The slate-stone is removed in large blocks, and those fit for roofing are split up to the necessary thickness with iron wedges, and are then trimmed with a knife.

Slates are cut in different sizes, and the various kinds are distinguished by particular names. The following is a list of the different kinds of slate in the market:—

Imperials, ...	30 inches by	24 inches.
Duchesses, ...	24 "	12 "
Rags, ...	36 "	24 "
Queens, ...	36 "	24 "
Countesses, . . .	20 "	10 "
Ladies, ...	16 "	7 "
Doubles, ...	13 "	6 "

Westmoreland slates are of various sizes.

It may be useful to know the weight of each kind of slate, and also the number of each required to roof a square—a square being one hundred square feet of roofing.

Imperials—500 will cover 2 squares, and weigh 1 ton.
Duchesses—500 will cover 5 squares, and weigh $1\frac{1}{2}$ tons.
Rags and queens—500 will cover $1\frac{1}{4}$ squares, and weigh $\frac{1}{2}$ ton.
Countesses—500 will cover $3\frac{1}{2}$ squares, and weigh 1 ton.
Ladies—500 will cover $2\frac{1}{4}$ squares, and weigh $\frac{1}{2}$ ton fully.
Doubles—500 will cover $1\frac{1}{4}$ squares, and weigh $7\frac{1}{2}$ cwt.
Slab slate, 1 inch thick, will weigh 14 lb. per superficial foot.

The following table shows the cost of roofing with each kind of slate per square, as done in 1867:—

Names of Slates.	Slating per Square. With Zinc Nails.	Slating per Square. With Copper Nails.	Labour only. Without Zinc Nails.	Labour only. Without Copper Nails.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Imperials, ...	2 6 0	2 8 0	0 9 0	0 11 6
Duchesses, ...	1 15 0	1 16 0	0 5 6	0 7 6
Rags and queens, . .	1 18 0	2 0 0	0 9 0	0 11 0
Countesses, ...	1 12 0	1 13 0	0 6 0	0 8 0
Ladies, ...	1 9 0	1 10 0	0 7 6	0 9 6
Westmorelands, . . .	3 0 0	3 3 0	0 12 0	0 15 0

The heavier kinds of slate are suitable for roofing in exposed situations, and the lighter ones in more sheltered places. Copper nails should in all cases be used. Zinc nails are very apt to be weakened by rust, which causes the slates to fall from their place.

6. *Tiles.*—For roofing tiles do very well in some cases. They should be made of the best clay, and moulded with great care. Under general circumstances, however, they are not nearly so economical a covering in roofing as slates. Once slates are properly fixed on, they remain many years without requiring any outlay in repairs; but tiles very soon require attending to, and cause a considerable outlay in repairs. It takes eight hundred three-inch plain tiles to cover a square, and six hundred four-inch of roofing, with plain and pan tiles, cost from £2 to £3 per square.

Both tiles and slates are estimated by the square of one hundred superficial feet. The tiles are generally made ten and a half inches long, six and a quarter broad, and five-eighths of an inch thick.

7. *Mortar.*—After slaking common lime with water, it is then made into a paste which is termed mortar. This is always of the best quality when it is not allowed to lie too long after being made. A sufficient quantity of water should be poured over the burned stones, so as to reduce them thoroughly to a fine powder. Before the powder is made into a paste it is mixed with a proper quantity of sharp sand. Some varieties of lime require more sand than others. There is a very injudicious habit amongst masons of adding too much sand to the lime, thus weakening it very much, and making it so that it will not adhere for any time to the stones or bricks. The proportions in common use amongst masons are—

	Parts.
Lime,	1
Sand,	6
Water,	1

The proportion of sand necessary must be guided by the character of the limestone. Some limestones contain a portion of sandy matter. Most of the superior kinds of lime in the north of England are best made when mixed with only four parts of sand to one of lime. The sand must be of a fine quality, especially when used for fine work; but for common rubble-work a coarser sand will suffice. Common lime in a powder costs about 1s. per bushel; and when mixed up with hair for the purpose of plastering, it costs £1, 4s. per load, and in towns 1s. per hodful.

With builders sand is classed into three kinds—namely, fine, middling, and coarse. It is either procured in pits, from the sea-shore, or from the sides of rivers. Good pit-sand is by far the best for building purposes. Sea-shore sand is seldom used, from the salt which it contains. River-sand is generally preferred for plastering purposes, the grains being finer and of a whiter colour than any other. Sand which contains earthy matter should not be used; this may easily be known by rubbing a small portion between the finger and thumb, and if it leaves a dark stain it is not fit to use without being washed.

8. *Cements.*—These are usually made from argillaceous stones, but sometimes are found in a natural state. They are very valuable in many cases, and especially in forming hydraulic lime. The principal cements in use with builders are Portland cement, and gypsum, or plaster-of-Paris. The latter is generally used for stucco-work. It hardens very rapidly; but it must only be used in a dry situation, as it absorbs water and then cracks. An artificial hydraulic cement is made by mixing equal portions of lime, cement, and sand. In doing this, care must be taken to have the lime made very fine before adding the cement and sand. In fact, to get it made fine enough it is usual to grind it in a mill made for the purpose.

A good cement for repairing tanks is made by mixing one part of lime to two parts of chalk; and another, for filling up cracks in iron boilers, is made by mixing one part of iron-filings and five parts of clay, and mixed to a paste with oil.

The following are the prices of some cements:—

Portland, ...	2s. 3d. per bushel.
Roman, ...	1s. 4d. „
Blue lias, ...	1s. 6d. „

9. *Concretes.*—Concretes are now much used for building purposes, especially in forming the foundations.

I have found the following composition form a good concrete:—

Cement, ...	0.30
Sand, middling, ...	0.25
Coarse gravel, ...	0.25
Broken brick or stone-chips, ...	0.40
Hydraulic lime, unslaked, ...	0.35

The sand, lime, and cement are first mixed up together as minutely as possible, so as to make apparently one mass. This is then allowed to remain for a day, after which it is spread out thinly, and the stones, broken brick, and gravel are mixed with it thoroughly, when it is used. It must be used quickly, as it very soon sets hard. Concrete is exceedingly useful in filling in about the foundations of buildings; it prevents damp from rising, and assists in securing a solid foundation. I have also used common gas-tar with advantage in the foundations of buildings in damp situations, by applying it thinly over the concrete when it was set hard.

10. *Timber.*—Timber holds an important position in the construction of buildings, and it is of great consequence to choose timber suitable for the different purposes required. The timber of a tree may be put down as consisting of two parts—namely, the sap-wood and the heart—the sap-wood being that next the bark, and the heart-wood the inner portion; the latter is much more durable, firm, and compact than the former, and less liable to decay.

Generally speaking, timber should never be used with the bark on, as it tends to assist in the decay of the timber enclosed within it.

The seasoning of timber should be attended to before it is used for building. Trees cut for this purpose should not be felled while the sap is in full flow. The best months for this work are November, December, January, and February. If timber is used in a green state, it not only is very liable to decay, but it is apt to shrink and split up very much; and when this takes place in a building, the consequences are often very serious indeed. Trees are either seasoned naturally or artificially. The natural system is to expose them to drying winds in some place where they are kept dry and away from the sun's rays. This system of seasoning is by far the best which can be adopted; but it takes a long time to do this, as most trees take nearly two years to dry properly. In shipbuilding-yards the timber is often artificially dried by steam. This makes the green timber less liable to decay, but the strength of the timber is deteriorated. It is a very quick process, and is useful in causing the timber to bend for shipbuilding and boat purposes.

The best timber is got from trees which grow on exposed and dry situations, those being more inferior in quality which grow on sheltered and moist situations. This is fully exemplified in the natural forests of Scots pine in Scotland, such as exist in Strathspey, and at Invercauld in Aberdeenshire. In these cases, the trees growing on the highest parts of the forests and the most inferior soils are found to produce the best timber. The growth of those trees has, of course, been very slow. I have numbered as many as sixty annual rings or growths to an inch in the diameter of a tree. Such trees are full of pitch, and are very compact and durable.

In many cases the quality of the timber alters very much with the character of the tree itself. Thus, timber of a straight grain and free from knots is, as a building material, much superior in strength to that which is twisted in the grain and full of knots.

The two great evils the builder has to contend with in timber are its liability to *dry* and *wet* rot. The cause of these rots is *fermentation,* which is followed by *putrefaction* of the timber. The *dry-rot* generally takes place in situations which are close and confined, and where there is a want of a free circulation of air about the timber. When timber which has not been properly seasoned is used in the erection of buildings, it very soon begins to decay from dry-rot; and this takes place more especially where there is a large proportion of sap-wood in the timber. Many pretended cures are given for dry-rot; but the best way to prevent the possibility of its taking place is, to use only well-seasoned timber, and, in the construction of the buildings, to provide that the roofs, floors, &c., shall receive a free circulation of air about them. This can be easily accomplished, without destroying the warmth of the buildings, by providing small openings in the outside walls, in which are placed iron gratings. This can be done in the case of the roofs above the ceilings, and also for that of the floors immediately between them and the foundations. When moisture is allowed to accumulate on the timber of roofs and floors, and there is no means of allowing the air to dry them, then dry-rot is sure to follow. Timber is also often destroyed by being painted before it has become perfectly dry. When this is done, the wet is prevented from escaping, and decay consequently ensues.

There is often a large quantity of our home-timber used for building purposes. On many estates it has been the practice to use timber from the home-plantations in the erection of farm-steadings and cottages. This, as a general rule, will be found to be mistaken economy, and that for two good reasons. In the first place, I have always found that I could sell the timber from the plantations at a much higher price than I could purchase good foreign deal; and therefore I have preferred selling the home-timber, and purchasing what foreign pine we required for building. I do not mean to assert that this will be found the case in every quarter of the kingdom; I merely state what my own experience is in the matter. And again, I have always found that good foreign timber is of a much better quality for building purposes than our own home-grown timber, with some exceptions, which I shall mention. I have frequently had farm-buildings to re-roof where ash and elm timber had been used in the construction of them, although such timber had only been in use for about seven years.

The *oak* is the chief tree which we can depend upon in this country for producing a timber which is durable. The grain is straight, and it is easily split up if required, and may be used for almost any purpose; and if kept dry, and used when well seasoned, it is found to be almost imperishable. Oak timber which has grown on a heavy soil—such as clay—is more durable than that grown on light soils. I had occasion this year (1868) to pull down a cottage on this estate which was built in 1760, and from which we removed oak beams in a perfect state of preservation; and I again used the same timber in the construction of a new cottage.

The *ash*, when well matured, is very tough and hard, and is found very useful when used in situations where there is great pressure; but for the general purposes of buildings it cannot be recommended.

The *larch* is much used on some estates. When of old age and well seasoned, it certainly is very durable; but it is much given to split, and it is very seldom that well-matured larch is to be found, as a rule.

The *Scots pine* when young is soft, and not adapted for building purposes; but when found of very old age, and when it has been grown on a poor soil, it is a first-class building material, such as the timber found in the old Scotch pine-forests, which has been for many years used in the construction of ships at Aberdeen and Garmouth.

The *pine tribe* generally come next to the oak for the purposes of building. The timber of the pine is straight-grained, easily worked, and strong, and is used in all the general construction of buildings where timber is used.

The *pine* which we receive in this country under the name of "*foreign timber*" is divided into three classes—*red, white,* and *yellow pine.*

The red pine is found in Canada under the name of *Pinus resinosa.*

The white pine is found under the name of *Pinus strobus,* and the yellow pine under the name of *Pinus mitis.*

The red pine is first-class timber, being fine-grained, free from knots, and resinous. It is well adapted for outside work—such as doors and windows—and also for beams, joists, scantlings, &c.

The white pine makes excellent flooring and inside doors. The colour of its timber is white. It is also very light and fine-grained.

The yellow pine is suitable for fine work inside the buildings, such as panellings, window-shutters, and other fittings. It is fine-grained, strong, and durable in the heart, but the outside sap-wood is not lasting.

That class of foreign timber which we receive in this country under the name of *Norway battens* is also very valuable for general building purposes.

Another kind of timber which we receive under the name of *Swedish plank* is derived from a spruce tribe—*Abies excelsa*—and is generally an inferior class of timber, being rough and full of knots. It is, however, very useful in the erection of weather-boarding, wooden partitions, &c.

11. *Metals.*—The chief metals in use in the erection of buildings are iron, lead, zinc, copper, and brass. *Iron* is that which is chiefly used, and it consists of two kinds—namely, wrought or forged iron and cast iron.

The quality of wrought iron can be judged by examining a fracture recently done, and, if of good quality, the colour in the broken part should be a clear grey, with a bright lustre, and the grains should have an elongated form. When the grains are short, and have a crystallised appearance, there has been some fault in the forging or in the quality of materials. The strength of this kind of iron varies very much, and this is caused by the two faults already stated—namely, either from the presence of some foreign ingredients in the iron, or from some fault in the forging; and where either occurs, such iron should never be used in positions where great strength is required. Wrought iron may generally be used in any position but a vertical one. In such a position cast iron should be used. Wrought iron is divided into two classes —hard and soft. The former is strong, and capable of being easily drawn out. The latter variety is much softer than the other, and yields easily to the hammer.

Cast iron possesses great strength and durability. It is divided into two kinds—*white cast iron* and *grey cast iron.* The white variety is very hard and brittle. The grey is tougher than the white, and yet is of a softer nature. The white variety is suitable where hardness is requisite, but not where great strength is necessary, as the grey cast iron is most suitable in such a position.

The quality of cast iron may easily be tested by striking a portion a heavy blow with a hammer. If of good quality, the iron will yield slightly, and not break. If it breaks, the quality is inferior, as it shows it to be brittle, and this indicates a want of strength. Any defects which may be found in cast iron are often caused by the manner in which the moulding takes place.

Lead is found in Yorkshire, Durham, Cumberland, Derbyshire, and Scotland. The ore is found in beds, generally in the limestone formation. The produce of the English mines is about twenty thousand tons per annum, and that of the Scotch from ten to twelve thousand tons per annum. The price of lead at one time was very high, but since the opening up of extensive mines in Spain, its value has fallen considerably. It is a very valuable material in the erection of buildings, such as piping, soldering, guttering of the roof, and other purposes.

Zinc is an ore also found in this country. It is chiefly found in the limestone formations. It is naturally hard and brittle, but it can be rendered soft and useful for building purposes. It is found very valuable in the making of roofing, baths, cisterns, pipes, &c.

Copper is a very durable material, and when made into thin sheets is found useful, and is not much affected by the atmosphere.

Brass is a combination of zinc and copper. British brass is made of about sixty-six parts of copper and thirty-three of zinc.

12. *Glass.*—This indispensable article for buildings is sold under the name of "sheet window-glass," which is divided into four qualities—namely, *best, seconds, thirds,* and *fourths.* Best is the first quality of the kind manufactured; seconds is a medium quality; thirds is that which is generally used for common glazing; and fourths is the poorest description made, being very inferior, and unfit for general use. The following price-list will show the value of each kind. The prices are given per foot superficial, including glazing :—

	Best.		Seconds.		Thirds.		Fourths.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
12 by 9 inches, $\frac{1}{16}$-inch thick,	0	8	0	6	0	5	0	4
14 by 10 „ „	0	10	0	7	0	5½	0	4½
18 by 18 „ „	1	0	0	8	0	6	0	5
24 by 24 „ „	1	1	0	9	0	6½	0	5½
30 by 30 „ „	1	2	0	10	0	7	0	6

The best quality of plate-glass, of a size about a foot square, costs 2s. 2d. per foot superficial.

13. *Paints.*—The painting of woodwork, both in the erection of farm-buildings and cottages, is an important point to be attended to; and it should also be repeated from time to time. In fact, it should be a rule on estates that at least all outside wood and iron work of buildings should receive a coat of paint once in every two years. There are many cheap paints to be had, and it is no excuse to leave painting undone on the score of expense. The two colours generally used for preparing any other colour are lead and white, and the oil used for mixing them is linseed, and also turpentine.

The following are some receipts for the mixing of paints for outside work :—

For making a stone colour, use—

	lb.
Whitelead,	2
Brown amber,	0½
Yellow paint,	0½
Linseed-oil.	

For making a white paint, use—

	Parts.
Whitelead,	80
Boiled linseed-oil,	10
Raw oil,	10
Turpentine,	5

For making a drab colour, use—

	lb.
Whitelead,	1½
Brown amber,	0½
Yellow paint,	0¼
Linseed-oil.	

For making a fawn colour, use—

	lb.
Redlead,	$0\frac{1}{2}$
White,	2
Linseed-oil.	

For making a green paint, use—

	lb.
Whitelead,	2
Verdigris,	1
Linseed-oil to mix.	

The interior woodwork of cottages can be very finely stained, so as to resemble oak and walnut, by first "washing the cleaned surface with diluted sulphuric acid (one ounce of sulphuric acid to a pint of warm water); this to be washed, when warm, evenly on the surface of the wood to be stained. The next operation is washing over the surface so prepared with a tobacco stain, made by boiling a quantity of tobacco with as much water as will cover it, allowing this to get dissolved to the consistence of a syrup by gentle boiling—this being strained before using. The stain is laid on with a sponge. When the wood is thoroughly dry, it is to be brushed over with eight ounces of bees'-wax, half-pint of linseed-oil, and double the quantity of boiled linseed-oil." *

* 'Book of Farm-Buildings.

CHAPTER XXI.

THE CONSTRUCTION OF FARM-BUILDINGS AND COTTAGES.

I NOW propose to make a few remarks on the different parts of farm-buildings under the following heads:—

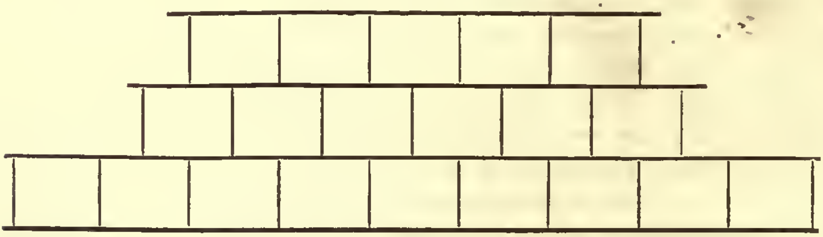
1. Foundations.
2. Walls.
3. Roofs.
4. Spouting.
5. Windows.
6. Ventilators.
7. Doors.
8. Floors.
9. The arrangement of the stable.
10. The arrangement of the cowhouse.
11. The arrangement of the pigsty.
12. The arrangement of the stackyard.
13. The general arrangement of the farm-steading.
14. The cost of the farm-steading.
15. The chief heads of a specification of the different works applicable in the erection of a cottage.

1. *Foundations.*—It is an important point to have the foundations made dry. The best site for a building is on stony or gravelly soil; as in that case the walls will remain dry. In any circumstances, a good firm and hard foundation should be made before proceeding to build. If any soft parts are found in digging the trenches, these should either be rammed hard down and filled up with a hard material, or the soft soil should be removed until a firm bottom is met with, and then the openings filled up with sand, firmly rammed down, or concrete. Clay does not make a very good foundation, as it is apt to be affected by the atmosphere. Where clay is met with, the best plan is to dig out a trench down to a hard layer of the clay, and then have the foundations laid in concrete, and clay rammed in about the concrete to prevent the air from getting to the clay beneath. The clearing of foundations is

usually done by the cubic yard, and the distance to which the earth has to be removed is estimated by the run of twenty yards. A cubic yard in excavation-work is twenty-seven feet.

2. *Walls.*—The walls of buildings are usually made of stone or brick. The choice of these two materials must be guided by local circumstances. If good building-stone is found on the estate or in the neighbourhood, it should certainly be used in the construction of the building. In many districts, however, stone cannot be got but at a great outlay, therefore bricks must be used. Stone is at all times preferable, where it is to be got of good quality, and not too expensive. Stone walls are generally commenced with a good broad base, this width varying much with the nature of the foundation on which the wall rests. On dry hard soils this will range from twenty-four to thirty inches wide for ordinary walls. The wall is then commenced upon the base usually at a width of twenty inches. The largest stones are used to begin the wall; and it is much better, if stones can be got, to have them wide enough to go across the wall. The wall is laid in regular courses, making each course level before another is commenced. The stones should be so arranged that the joints of the upper course will lie in the centre of the lower stones—that is, the joints of no two courses should meet—as shown in fig. 92. Care should be taken to place the stones in their natural posi-

Fig. 92.



tion—that is, the position in which they lay in the quarry; this may be known from the grain of the stone. It makes the most substantial work, and it gives a more pleasing finish to a building, to have the corners of the walls set with hammer-dressed quoins. The two kinds of walls generally used for farm-buildings or cottages are coursed-work and rubble-work. The former is done by having the stones hammer-dressed to a uniform size, and then built in equal lines, and afterwards pointed off neatly in straight lines, as shown in the sketch. In the latter case, the rough corners of the stones are merely knocked off, and they are then put in their places without any other preparation; and to get the courses level, the spaces not taken up by the large stones are filled in with small chips and mortar. In erecting a wall with plain rubble-work, the great thing is to get the stones to overlap each other in the courses. The stones should not move in their beds; if they stir one bit on being tried, the work is not well done.

The dressing of stone is charged by the superficial foot, according to the amount of dressing it receives. Window-sills and heads and copings are charged by the lineal foot. All pavings and landings are charged by the superficial foot.

First-class walls can be made of brick, when the bricks are good, and they are put together by a clever workman. The necessary thickness for brick walls must vary with the height of the wall and the weight of the roof. For low buildings the thickness will either be nine inches or fourteen inches; the former being what the bricklayer terms "a brick in breadth," and the latter "a brick and a half in breadth." Where a nine-inch brick wall may be thought too light to carry the trusses of the roofs, then, instead of erecting a fourteen-inch wall throughout, it may be sufficient to erect an eighteen-inch pillar, to bear each truss in the roof. In a brick wall, those bricks which lie across the wall are called "headers," and those which lie parallel with the line of wall are termed "stretchers." Bricks are usually made nine inches long, four and a half inches wide, and two and a half to three inches thick. To build a nine-inch brick wall, it will take six hundred and sixty bricks to erect a rood of seven square yards. There are two modes of erecting brick walls, the one being that one course is laid throughout as headers—that is, across the line of wall—and the next course is laid upon the headers as stretchers, or parallel to the wall, and so on alternately, first across and then lengthwise: this is termed the old English bond. Another mode is to lay a course of headers and stretchers alternately, which is termed the Flemish bond. For strength I prefer the old English bond. The bricks should break the joints in the same way that the stone wall does as already stated, and to do this it is necessary to commence each alternate course of bricks with a half-brick.

In building brick walls of any considerable height, it is judicious not to build up too much at once, but to allow one portion to settle before proceeding with the other. The mortar should not be put on too thick between the courses of brick—not more than half an inch.

Large-sized bricks are now made, which enables a building to be quickly erected, and there is also a saving in mortar. Grooved bricks are also in use; this secures a firmer adherence to each other in the courses.

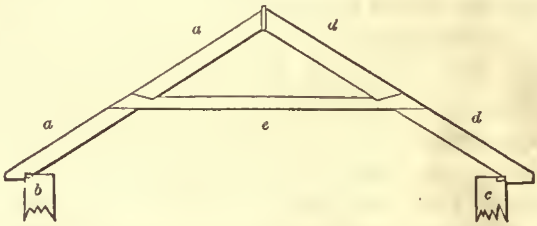
Brickwork is measured and valued by the rod—the price either to include the labour only, or both labour and materials, when these are furnished by the contractor.

An estimate of the value of bricklayers' work may be arrived at by calculating that a rood of seven yards will take six hundred and sixty bricks in its erection; that a bricklayer's wages are usually from 4s. to 5s. 6d. per day, and his labourer's, 2s. 6d. to 3s.; and, at the same time, to take into account that a bricklayer and his labourer conjointly will lay about one thousand bricks in a day. The value of the lime and sand will also have to be taken into account.

When the work is let by the rod, it must be calculated that this measures eleven and a half cubic yards; and a rod of brickwork, when laid so that a foot in height will take four courses, will require nearly four thousand three hundred and fifty bricks; and the same extent of brickwork will take nearly one and a half cubic yards of lime and three loads of sand.

3. *Roofs.*—In the construction of roofs there are several forms of trusses in use. I shall describe the principal of those which I have adopted. In fig. 93 is shown an arrangement of a roof. The rafters are notched

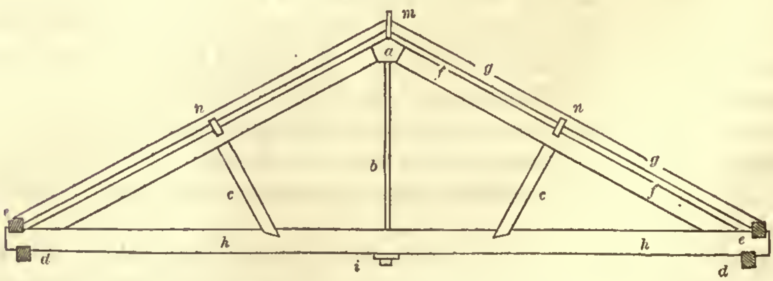
FIG. 93.



at the lower ends to fix into the wall-plates; and to prevent them from separating or pushing out the walls, a tie is put in, as shown at *e*. The sizes of the timbers for such a roof may be thus:—

Rafters *a a, d d*,	9 inches	by	$3\frac{1}{2}$ inches.	
Tie *e*,	6	„	3	„
Wall-plates *b c*,	4	„	3	„

FIG. 94.

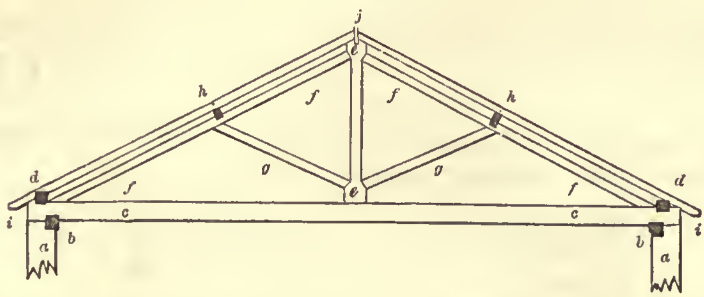


In fig. 94 is shown a roof suitable for a long span, say from twenty-five to thirty feet in width. The following are suitable dimensions of the timbers:—

Rafter-box *a*, made of cast iron.				
Suspension-rod *b*, 2½ inches in diameter, made of wrought iron; *i* nut.				
Struts *c c*, 6 inches square.				
Wall-plates *d d*,	6 inches	by	4 inches.	
Pole-plate *e e*,	6	„	3	„
Rafters *f f*,	10	„	6	„
Small rafters *g g*,	3	„	3	„
Tie-beam *h h*,	12	„	6	„
Ridge-piece *m*,	7	„	1½	„
Purlins *n*,	6	„	3½	„

In fig. 95 is shown a king-post truss. This is a very good form of

Fig. 95.



roof, and may be advantageously used at different spans, varying, of course, the size of the timbers to the span. The following are the sizes suitable for different spans:—

For a Span Twenty Feet wide.

Wall-plates *b b*, . . .	5 inches	by	3 inches.	
Tie-beam *c c*, ...	9	„	4	„
Pole-plate *d d*, . . .	5	„	5	„
King-post *e e*, ...	4	„	4	„
Rafters *f f*, ...	4	„	4	„
Struts *g g*, ...	4	„	3	„
Purlins *h h*, ...	6	„	4	„
Small rafter *i i*, . . .	4	„	3	„
Ridge-pole *j*, ...	7	„	1½	„

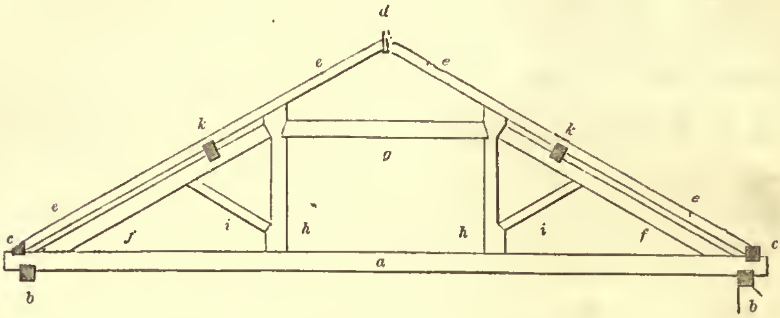
For a Span Thirty Feet wide.

Wall-plates, ...	5 inches	by	5 inches.	
Tie-beam, ...	10	„	6	„
Pole-plates, ...	6	„	6	„
King-post, ...	5	„	5	„
Rafters, ...	6	„	4	„

Struts,	5 inches	by	3 inches.
Purlins,	7 "		5 "
Small rafters,	6 "		3 "
Ridge-pole,	8 "		1½ "

The queen-post truss is shown in fig. 96. It is more suited for greater spans than either of those already described. Such a form of roof may

Fig. 96.



safely be adopted up to spans of forty feet. The sizes of the different timbers for a forty-feet span are thus:—

Wall-plates *b b*,	6 inches	by	6 inches.
Tie-beam *a*,	10 "		6 "
Pole-plate *c c*,	5 "		5 "
Ridge-pole *d*,	9 "		1½ "
Small rafters *e e*,	4 "		3 "
Rafters *f f*,	6 "		4 "
Straining-beam *g*,	8 "		6 "
Queen-post *h h*,	6 "		6 "
Struts *i i*,	4 "		4 "
Purlins *k k*,	6 "		4 "

The pitch of the roofs varies with the material employed for covering them, tiles requiring a greater pitch than slates. Many architects adopt the plan of having a roof for slates one-fourth the length of the total external width of the building, and for tiles they allow one-third.

Iron rods are now taking the place of king and queen posts in many instances, and corrugated iron is also recommended as a covering for roofs. I have not had much experience with it; but from what I have observed, I find it very liable to corrosion, and, in my opinion, it will not last so long as slate.

Felt has also been employed as a covering for roofs. We have used it on this estate; and from what I have seen of it, can state that it is at first a cheap covering, and will do very well for temporary buildings, but it should never be used where permanency is necessary.

The construction of roofs, floors, partitions, &c., is charged at per square of one hundred superficial feet, either to include both timber and labour, or the latter only.

The following weights of different timbers may be found useful:—

One ton of	oak	will contain	39	cubic feet.
„	ash	„	45	„
„	beech	„	50	„
„	elm	„	60	„
„	pine	„	66	„

Timber cut up eleven inches wide is generally called planks; nine-inch wide timber is called deals; and seven-inch wide, battens.

4. *Spouting* or rain-gutters is that which is used on the roofs of buildings to collect the rain-water. It is economical in many respects to have spouting put up, as it prevents the water from running down the walls, which it would otherwise do, and thus keep them damp. It is also a great assistance in keeping the foundations dry. In the case of cattle-courts, it prevents the rain from washing away the best part of the manure; and even for the collection of the water itself into cisterns or tanks, it is an important matter. Cast-iron rain-water pipes are generally sold in six-feet lengths, and the following are the prices of some sizes made of cast iron:—

2-inch diameter, ...	0s. 10d. per yard.
$2\frac{1}{2}$ „	1s. 0d. „
3 „	1s. 2d. „
$3\frac{1}{2}$ „	1s. 5d. „
4 „	1s. 9d. „
5 „	2s. 8d. „

They are also made of zinc; but these, in my experience, are not so durable as the cast iron. The prices of zinc guttering are—

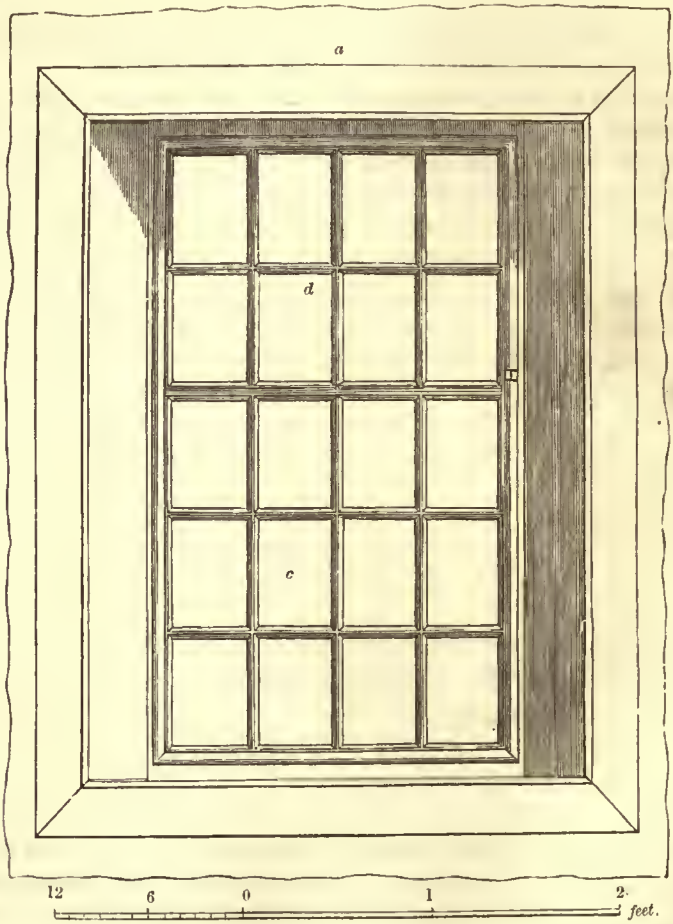
2-inch diameter, ...	$3\frac{1}{2}$d. per foot.
$2\frac{1}{2}$ „	4d. „
3 „	$4\frac{1}{2}$d. „
4 „	6d. „

The cast-iron guttering should receive one coat of paint before it is put up, and another after it is fixed. The mode of fixing guttering differs. If the rafters project over the wall, the guttering may be fixed on to the end of the rafter. If the rafter does not project over the wall, the guttering may be fixed to the top of the rafter.

5. *Windows.*—Windows are capable of being very much improved

for dwelling-houses, and also cottages and farm-buildings. In cottages especially the windows are very frequently made too small. Cottage windows are often made to open as a door; this, when the window is open, prevents the shelf inside from being made useful for any household purpose; and besides, when it is desirable to open the window for fresh air, there is too large an opening made, and that in a position where it is not desirable to have it—that is, down to the bottom. For the purposes of ventilation, only the upper half of the window should be made to open, as then a fresh supply of air can be had at the top without caus-

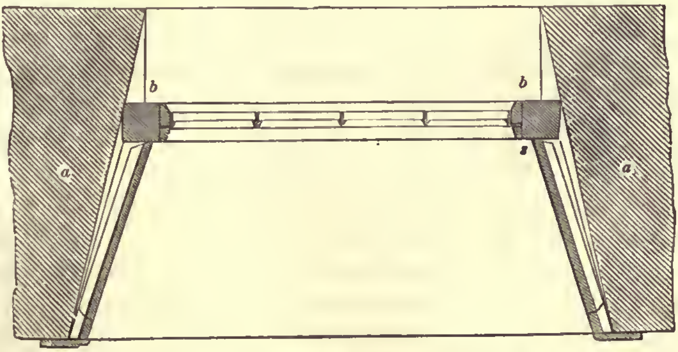
Fig. 97.



ing a draught throughout the cottage from below. Sliding windows have also the same objection, in being open down to the bottom. A very good form of window for a cottage is made by Messrs M'Culloch & Co., Gallowgate, Glasgow, a premium for which was awarded by the Highland and Agricultural Society of Scotland; and it is thus described in the 'Book of Farm-Buildings,' page 323:—

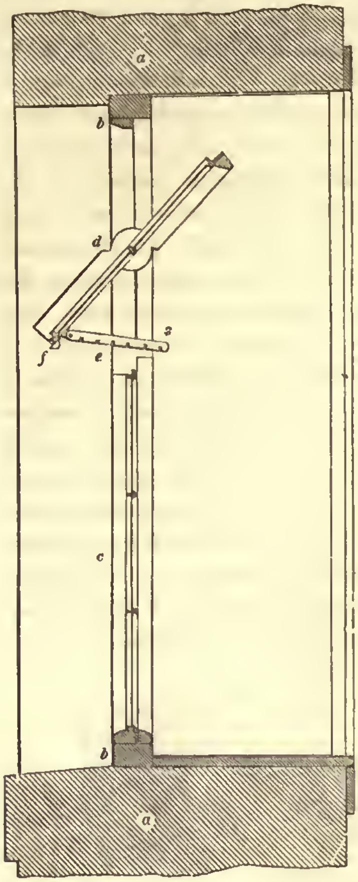
"This window is extremely simple in its construction, and may with safety be pronounced efficient in point of comfort and utility, while the price, it is believed, will not be higher than the cheapest description of iron windows now in use, and, for durability, will be preferable to those of any other material. The dimensions that have been recommended for the windows of ordinary cottages are, thirty-nine inches for the height, and twenty-four inches for the width, within the wooden frames. The size of glass required for these frames is seven and a quarter inches by five and a quarter. The sash is divided into two unequal parts, the lower part having three squares in height, and the upper part two. The lower part is permanently fixed, while the upper part is constructed to turn in the vertical direction on pivots, which are situate in the line of its middle astragal; and both parts are set in a substantial wooden frame, which may either be built in while the wall is erecting, or set in afterwards in the ordinary way, with or without checked rebats, according to the taste of the proprietor. The window and its arrangements will be better understood by reference to the annexed cuts—fig. 97 showing an inside elevation, fig. 98 a plan, and fig. 99 a vertical section, in each of which a portion of the wall is exhibited, and the same letters refer to the corresponding parts of each figure: *a* is a portion of the sur-

FIG. 98.



rounding wall; *b b* the wooden frame of the window; *c* the lower sash, which is dormant; and *d* the upper and movable sash. In fig. 99, the upper sash is represented as open for ventilation. When shut, the parts of the opening sash cover and overlap the fixed parts in such a manner as to exclude wind and water; but when ventilation is required, the arrangement of the parts which produce this, is such as to enable the housekeeper to admit air to any extent. For this purpose, the notched latch *e* is jointed to a stud in the edge of the sash; a simple iron pin or stud is also fixed in the wooden frame at *s*, and the notches of the latch being made to fall upon this stud at any required distance, the requisite degree of opening is secured; and when the sash is again closed, the latch falls down parallel with, and close to, the sash. To secure the sashes when shut, the T bolt *f*, in the middle of the meeting bars, has only to be turned a quarter round, and the movable sash is held fast in close contact with the other. Fig. 97 represents the windows as finished with simple dressings—namely, plain deal shutters, facings, and sole—which, at a small expense, would give an air of neatness and comfort to the apartment, and promote a corresponding taste in the other parts of the cottage. Though the dimensions of the window here stated may be conceived sufficient for lighting an apartment of ordinary size, they can, nevertheless, be varied to suit every purpose. This may be done either by employing two such windows as above described, with a mullion of wood or of stone between them, or the single window may be enlarged by one or two squares in width, or in height, or in both directions."

FIG. 99.



A good sash-window for cottages is made in the same form as the one described, but the upper half moves up and down with weights and rope. The lower half is also useful when made to open, but the most important point for ventilation is to have the upper half to open.

Where windows project out from the roof of a building, they are termed "dormer" and "storm" windows.

Stable windows should be made to open at the top, either with weights to slide up and down, or by having it to swing upon two pivots in the centre. The lower half should also be glazed. Many architects recommend having the lower half of the stable window boarded or filled in with sheet-iron. In this case it is not a window at all; the upper half only can be called the window proper. The lower half should be made to give light; and if there is any danger of a stable utensil being thrown against it, so as to break the glass, then it should be protected by close wire netting. Stables are generally made too dark; and to this cause, and the want of ventilation, are to be attributed the many cases which we meet with of defective sight in horses.

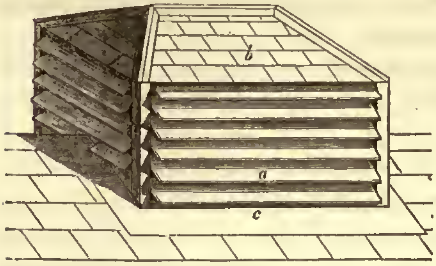
Windows for cowhouses or byres should also be made on the same principle, by having large windows, both top and lower halves being glazed, and the upper half made to open.

Granary windows should be made to admit of sufficient air and light, and at the same time keep any vermin from getting in. There is nothing so well adapted for this as perforated zinc, which can be got in sheets fit for the purpose. Where it may be necessary at any time to have the windows shut close, then a glazed and sashed frame could be fixed inside the zinc one, and made to open and shut at pleasure.

6. *Ventilators.*—It is an important matter to secure a regular supply of fresh air in buildings, especially in those which are to contain a large number of live stock, such as horses and cattle. Even at the present day, grooms seem to think fresh air pernicious to the health of horses. They are careful to stop every hole where it is possible it will get in. The heat and smell which may be discerned on entering many stables when first opened in the morning, are really very injurious to the health of the animals living in them. Such treatment of horses is sure to bring on certain diseases—such as sore throat, glanders, grease, influenza, and inflammation. The ammonia, when kept confined, gives rise to sore eyes, sore nostrils and throat. Fresh air should be admitted to all stables and cowhouses, so as not to cause a draught, or to come into immediate contact with the animal's body, and this can only be done by having the ventilation above the animals. All the gases which arise from the animals, their manure, or urine, are lighter than common air, and therefore they will rise to the top of the building. It is recommended by some architects to have an opening immediately in front of the horse's head, or a little above it. This is not a judicious plan, as it is not desirable to have cold air passing over an animal, especially when it comes into the stable heated. The best means of admitting a supply of fresh air to farm-buildings of any kind without injury to the stock is, in my opinion, to have the ventilator in the ridge of the roof; and one such is shown in fig. 100. It is fitted with louvre-boards *a*, which are placed as fixtures. These always remain open, and are placed so as to prevent rain or snow getting in, but at the same time to admit fresh air. The roof *b* is slated, and the ridges covered with lead. *c* is a covering of lead above the slates and immediately below the ventilator. This kind of ventilator must vary in size according to

the size of the building, and the number of animals kept in it. For an eight-stalled stable I would recommend two, made four feet long, three feet high in front, and two feet above the highest point of the roof. It is better to have two or more small ones than a very large one.

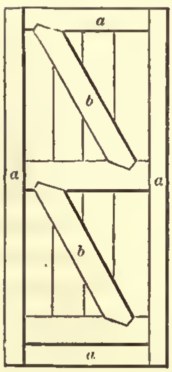
Fig. 100.



Ventilators are sometimes made in the form which I have described, but with the louvre-boards to open and shut at pleasure, by means of a rope and pulleys. This kind of ventilator should not be used. Generally speaking, farm-labourers will not attend to keep them open when required. If they do attend to them at all, it will be to keep them shut; therefore I think it is better to have a fixed ventilator out of their reach.

7. *Doors.*—Doors for cottages may either be made ledged, braced, framed, or panelled, or a mixture of two together. A ledged door is made of a number of boards grooved together and nailed to cross pieces of timber. This is the most simple form of door, but is not so strong as others which are framed. In fig. 101 is shown the form of framed and braced door, which is strong and suitable for the outside doors of a cottage, and it is also strong enough for the door of a farm-building. *a a a a* shows the panel-work mortised into each other, and *b b* the braces.

Fig. 101.



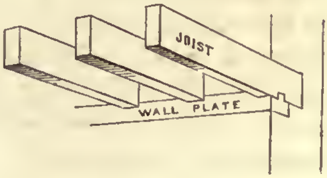
Panelled doors need no description at my hands; they are suited for the inside rooms of dwelling-houses.

Very large doors of barns, carriage-sheds, &c., should not be hinged, but be made to move on rollers. These rollers are either fixed to the upper part of the door or to the lower. When fixed at the top, the small wheels or rollers run upon an iron bar fixed to the wall above the doorway; and the other, with the rollers at the bottom, run upon a rail fixed across the doorway and alongside the wall as far as will clear the door of the opening. In the latter case, the rollers frequently become useless, unless attention be paid to keep them and the rail clean. Those kinds of doors can be used with advantage to nearly all the buildings of a farm-steading. Hinged doors are so very frequently allowed to be tossed about by the winds, that they not only get broken themselves, but also cause injury to the walls.

8. *Floors.*—There are two kinds of flooring generally in use in the erection of farm dwelling-houses, cottages, and farm-buildings; one is called single flooring, and the other double flooring.

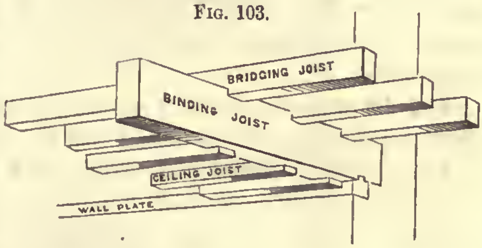
Single flooring is shown in fig. 102. This is the most simple form of flooring, and is put in when the joists are laid on to the walls, on wall-plates of timber, and the flooring-boards are then nailed on to the joists. The joists, in a case of this kind, are laid at distances of from twelve to fourteen inches from the centre of the one joist to the centre of the other. When joists are laid over a wide span, they are apt to bend to the side when heavy weights come upon them, causing injury to the ceilings underneath; this can be prevented by placing short pieces of timber between the joists. The size of the timber necessarily varies with the span; thus a span of ten feet will require the joists seven and a half inches by three inches, and a fifteen-feet span should have them nine inches by three inches, and a twenty-feet span will require twelve inches deep by three and a half inches wide.

FIG. 102.



Double flooring is shown in the accompanying sketch, fig. 103. It is constructed by using strong binding joists or beams a few feet apart, and stretching between the walls; and under these are placed ceiling-joists to carry the ceiling; and above them are fixed other joists, which are termed bridging-joists, on which the flooring-boards are nailed.

FIG. 103.



These kinds of flooring are used in different spans, and where different weights are to be borne upon them. Double flooring is more suited for wide spans, and has greater strength. Where single flooring is used in wide spans, it is apt to deflect, so that the floor bends down, thus causing injury to the ceilings and walls.

For the flooring of barns, stables, and cowhouses, Yorkshire stone paving is very good; and cobbles, or small round stones, well packed together, and laid neatly, make a good floor. For a barn, it is necessary to have a floor laid which will prevent rats and mice getting through it. To accomplish this, it is necessary to use asphalt, and this I have done in the following manner: First lay a course of broken stones in the bottom, about eight inches thick, but they must be laid in a dry bed;

then have some gas-tar boiled along with some lime; let this mixture be poured into and over the stones, so as to cover them; and, having made the surface level, throw some gravel over it, and allow it to settle and cool, when it will be completed. Then, of course, any other kind of flooring can be put over this, if desired.

9. *The Arrangement of the Stable.*—The width of a stable should not be less than eighteen feet—all the better if made twenty feet broad; the length of course depends upon the number of stalls required. The stalls should not be less than seven feet wide; this gives any horse ample room to lie down with comfort, and for his attendant to get up beside him. The width of a stable will be taken up with—

	Ft.	In.
Rack in front, ...	2	0
Stall to guttering, ...	8	6
Guttering, ...	1	0
Guttering to wall, ...	6	6
	18	0

This leaves room behind the horses for stable utensils. The harness should not be placed against the wall in a work-horse stable, as is usually done. There should be a room at the end of the stable for this purpose, or if the stable be a long one, then it should be placed in the centre. The dampness arising from the sweat of the horses is injurious to harness.

The division of the stalls should be made strong, and of wood, with the exception that the heel-post and top bar may be made of iron.

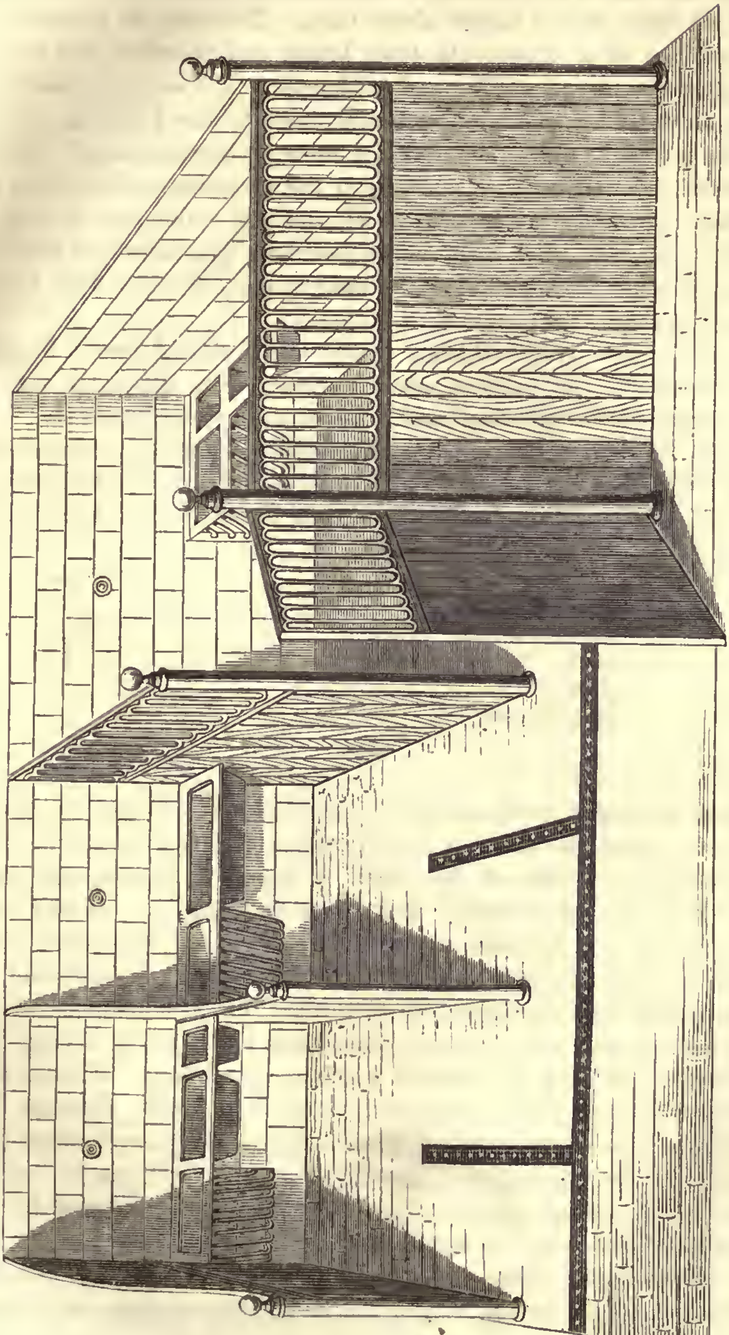
In fig. 104 is shown two stalls and a loose-box of a stable, with the heels of divisions, rails, racks, mangers, and guttering made of iron, the different articles of which are manufactured by several firms. The prices of these articles are—for sunk rack, manger, and gruel-pot, as shown in the left-hand stall, 36s.; for rack and manger, as shown in the right-hand stall, 32s. These fittings for stables have a very neat appearance, are cheap, easily kept clean, and altogether very much suited for the purpose.

The iron guttering is a great improvement on the old open gutter. The price of it in straight lengths ranges from 1s. 6d. to 2s. 6d. per foot, and angle pieces from 3s. 6d. to 6s. 6d. each.

A stable should be open to the roof, and no hay-loft should be allowed above, as is so often the case.

Very neat and durable stall-divisions are also made entirely of wood. The wooden posts are sunk into a stone, which is much better than the plan of sinking the posts in the soil. The old-fashioned hay-racks made

Fig. 104.



over the horses' heads should be condemned, as it is unnatural for them to eat from such a height above them. Naturally all animals collect their food from underneath their heads, and therefore this should be attended to in both stables and cowhouses. The stalls of stables should be floored with small round stones down to the guttering, making it with a slight inclination from all sides to the guttering. The space behind the horses—that is, between the guttering and the back wall—should be laid with flagstones; with such the stable can be kept more clean and tidy than with cobbles behind. The flagstones should have deep grooves cut across them, in order to prevent the horses from slipping on them.

The harness-room attached to the stable should have a fireplace or stove to dry the harness when necessary, and where the men could have their harness cleaned and attended to in stormy weather.

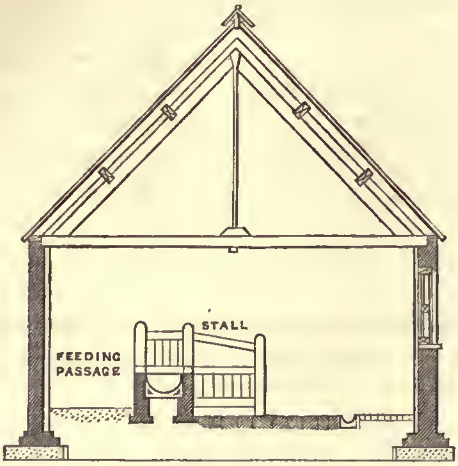
10. *The Arrangement of the Cowhouse.*—Under this head I include the buildings used for the dairy cows as well as for stock put up to fatten. The width of a cattle or cow house where there are stalls should be as follows:—

	Feet.
Feeding-passage, ...	4
Feeding-troughs, ...	2
Stall, ...	8
Gutter, ...	1
Space behind, ...	3
	18

Thus making a total width of eighteen feet between the two walls inside, being the same as that recommended for the stable. In calculating the width of the stalls, it must be remembered that two cattle-beasts are generally tied up in one stall. It is very common to find cow-stalls made seven feet or seven feet six inches wide, and this to hold two large animals. No double cattle-stall should, in my opinion, be less than nine feet in width. This gives four feet six inches to each animal, and it will be found not too much for a large animal. The stall-divisions are made of wood, iron, and stone. Wooden ones are the most comfortable, iron and stone being cold, although I have observed some very good iron cowhouse-divisions manufactured by Musgrave & Son of Belfast. They are very neat, and can be easily kept clean. The height of the divisions are made three feet, and the length about six feet from the wall or passage in front.

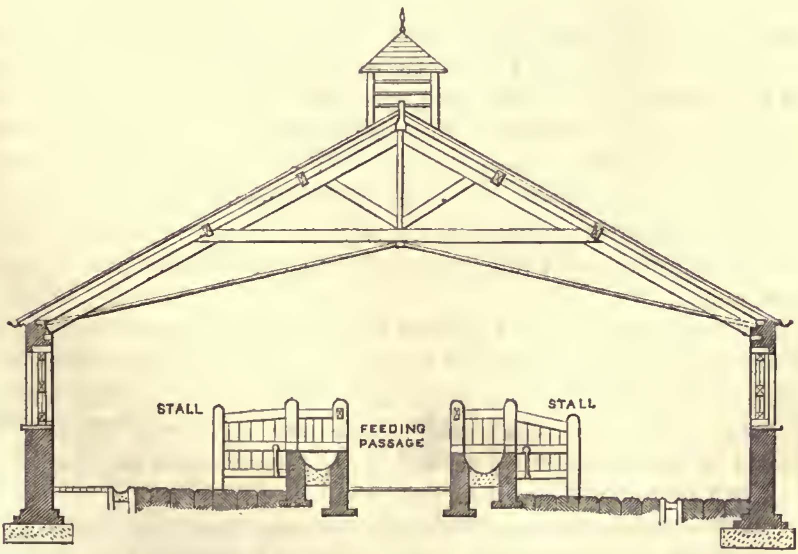
Cattle should always be fed from in front of the head. In figs. 105 and 106 are shown two methods of forming cowhouses: one is with the feeding-passage on one side, and with a single row of stalls; the other

Fig. 105.



shows a double row of stalls, with the feeding-passage in the centre.

Fig. 106.



On large farms it will be found the cheapest plan to make the cattle-houses with a double row of stalls, and to have the feeding-passage in the centre. The width of such a house would stand thus:—

	Feet.
From left-hand wall to gutter,	3
Gutter,	1
Stall,	8
Feeding-trough on left,	2
Centre passage,	5
Feeding-trough on right,	2
Stall on right,	8
Gutter on right,	1
Space to wall,	3
	33

Thus giving a total of thirty-three feet in width inside the walls. In the sketch given of the double cattle-house is shown a roof suitable for such a span.

Where boxes are preferred for feeding cattle, such a space as last described would suit very well by having the centre feeding-passage and a row of loose-boxes on each side. These boxes should be made twelve feet broad by ten feet wide, exclusive of the feeding-troughs. Glazed semicircular earthenware troughs are the best for dairy cows and cattle. It is a great matter to keep them clean, and this cannot be thoroughly done with rough stone as a trough. Caithness pavement, when polished, makes beautiful troughs, and does not absorb water. Water-troughs should also be fitted into the stalls, with a tap to take off surplus water and to allow them to be thoroughly cleaned; and it is an advantage, in the saving of time and labour, to have the water carried in pipes along the head of the stalls, immediately above the troughs, and to have a tap in the pipe above each trough, so as the cattleman can turn on a supply whenever required. Where there is only one tap in a cattle-house, there is a great deal of valuable time wasted in carrying the water to each animal.

The calf-house should be placed in a position in the steading not far from the cowhouse, where it will be convenient for giving the calves milk. Each calf should be placed in a separate crib by itself, as when a number are together they suckle each other's ears and navel. These cribs should be made six feet square, and in each should be a small manger, to give a supply of chopped cabbage, turnips, &c.

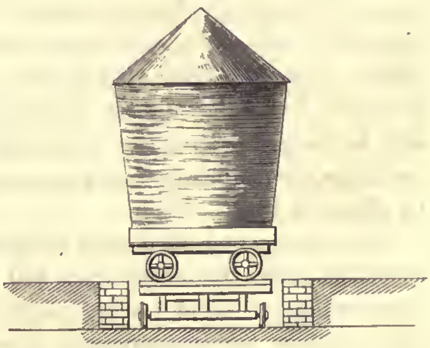
11. *The Arrangement of the Pigsty.*—On some large farms, where large numbers of pigs are kept, it is a very common practice to allow them to run in the yard with the young cattle. This does very well for young pigs and sows which are not wanted to fatten; but those which are to be

made fat for the market or household use, must be shut up in sties. Sties are frequently made with an inner and an outer court, each being made about six feet square. The Yorkshire cottagers, who are great pig-fatteners, prefer to have their sty made all under one roof, and without any outside court. They maintain that a pig fattens quickest when kept dry and warm, and this is quite reasonable. The door of the sty should be made so that any pig will not be able to lift it up with its snout. Where large numbers of pigs are kept and fattened, a shed with a double row of sties and a feeding-passage in the centre would do well.

12. *The Arrangement of the Stackyard.*—The greater number of farmers in this country have their stackyards open. Some prefer having all the grain brought home to the steading; others, again, are disposed to have it divided about the fields. This latter system is to avoid the risk of fire as much as possible. Each system has its advantages and disadvantages. Where all the grain is brought home to the steading, it is more convenient for thrashing in wet weather, but the risk of fire is greater than in the other case. Covered stackyards have been adopted in some places with advantage; but the first cost is heavy, and it is very questionable whether the advantages gained are equal to the outlay.

Tramways and trucks are now coming into use for stackyards. The yard is laid with rails parallel to each other, which in some cases run into a main line in the centre, upon which are turn-tables to turn each truck with a stack upon it, and then to run it into the barn or stack-shed built for the purpose. Others, again, can be made by having the lines parallel to each other, and gradually bending at the ends, so as to curve into the barn. Others, again, can be made by having a main line running from the barn through the yard, and sunk below its level, on which a single truck is used. Other lines run at right angles to this sunken line, and the trucks upon which the stacks are built are run on to the other truck in the sunken line, and then taken to the barn. This system is shown in the accompanying sketches, figs. 107 and 108. The system with the sunken rail, as shown in the figures, is, I am of opinion, the best. The system with curved lines takes up too much space, and that with turn-tables is too expensive.

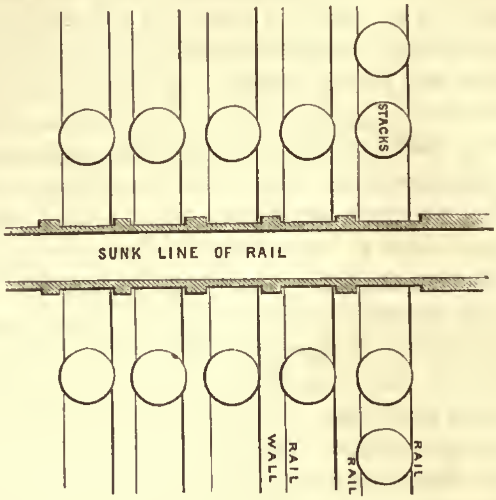
FIG. 107.



13. *The General Arrangement of the Farm-Steading.*—In the erection

of an entirely new farm-steading, it should not be built at random, as there are certain considerations which should be attended to in carrying

Fig. 108.



out the general arrangements—thus: The north side of the square or range of buildings should be taken up by those which are to have the highest elevation, in order that they may assist in giving as much shelter as possible from that quarter. The thrashing-mill and barn are generally made the highest buildings, and therefore these would suit well to be erected on the north side. If it is arranged to have any buildings with a granary as an upper storey, then these might judiciously be placed in that position.

If it is proposed to have a greater length of high or double-floored buildings than the north side will occupy, then, generally speaking, the remainder should be put on the east side of the range of buildings, as cold winds commonly blow from that quarter. The lowest buildings should occupy the south and west sides—indeed, it is very frequently arranged not to have any buildings on the south side, as they to a certain extent shade the inner courts from the sun; but, on the other hand, it is often decided to have the range of buildings in a complete square; therefore, when this is done, the lowest buildings should be erected on the south side.

All cattle courts, sheds, feeding-boxes, and any yards or houses for the accommodation of live stock, should be placed in such a position that they will have all the openings, windows, doors, &c., towards the east and south. All animals thrive best when they get the benefit of the sun's heat and light. They enjoy the sun equally in the morning, and also throughout the whole day; and it is always wisdom to have the buildings named in such a position as will admit, as much as possible, of the stock receiving the benefit of the sun's rays from sunrise to sunset.

It is a saving of time to have the stable and cart-shed close together, as the implements are always at hand in the morning for the horses.

It is often suggested that none of the buildings should be open to the north, in order as much as possible to keep the cold from entering the buildings. The suggestion is good, but it cannot always be acted upon. I have stated that the north side should be occupied by high buildings; this could be done by having the cart and implement sheds on that side, with a range of granaries, wool-lofts, or cake and other food storing or preparing lofts, above the cart-shed. The implement-sheds are all the better of being placed in that position, as it is advisable to keep them from the sun's rays as much as possible. When carts and other implements are left lying exposed to the rays of the sun, the woodwork shrinks and splits, and therefore this is to be avoided.

All buildings made to contain animals should be open to the roof —that is, there should be no second floor above them. It is a very common practice to have hay and straw lofts over stables and cowhouses, but it is very injudicious to do so. From a want of ventilation, it gives rise to many diseases in the stock so housed.

Pigsties should be placed convenient for the kitchen of the house, in order to facilitate the feeding of them.

The poultry-house should be placed so that it will receive the first morning's sun, and should be in close proximity to the stackyard, to allow the poultry to pick up all loose grains in it.

Drains should be made throughout the buildings containing stock, to conduct the liquid manure from them to a tank built outside the range of buildings. A pump should be fitted above the tank to draw the liquid manure from it into a water-tight cart or barrel, to be thence conveyed to the fields.

The turnip-shed and other food-stores should be placed in such a position as will admit of the stock being regularly fed in the shortest space of time, and at the least possible expense.

All the buildings should be spouted, and the rain-water conducted to cisterns or tanks for the use of the stock.

Where it is necessary to have workshops in connection with the farm — such as the blacksmith's and carpenter's — these should be placed separate from the other buildings, in order to have as little risk from fire as possible.

14. *The Cost of the Farm-Steading.*—Under any circumstances it is an expensive affair to erect either a whole or a part of a farm-steading. Where old buildings exist, these are, for the sake of economy, made to stand as part of the new steading, and additions are made to them. Old buildings are often so inferior, and so very much out of place in the position they may occupy, and also not up to the requirements of the age in many respects, that it is judicious to carefully consider whether they should not be removed altogether, and to have an entire new steading made complete. Generally speaking, it will be found the best plan to have an entirely new set of offices, but of course this must be decided upon according to the nature of the existing buildings.

In the erection of new farm-buildings, it should be studied to have them all strong and substantial, and ample accommodation given to each building, according to its requirements; but no extravagant ornamentation should be gone into, as this is merely a waste of money; and when a tenant-farmer has to pay interest upon it, it certainly is not fair and just to require him to do so. It is always wise to keep cheapness in mind in the erection of this class of buildings, as well as in any other transaction; but at the same time it is false economy to allow utility and substantiality to give place to cheapness.

No rule can be set down as to what the cost of any size of steading will be, even if the plan and specification are given, unless the site and locality of the proposed buildings are shown. There are many items which affect the cost of buildings considerably, and amongst these may be stated the nature of the foundations and site; the nature and quality of the stone; whether they are to be built of stone or brick; the distance the stone, brick, lime, sand, timber, slates, and all other materials have to be carted. It is with this as with dwelling-houses and cottages, each estate has its advantages and disadvantages in the procuring of materials for building, and consequently the cost of either must be more or less according to circumstances.

It is, however, the case with farm-buildings as with the enclosure of a field or plantation—the larger the field or plantation embraced within the fence, the less will be the cost per acre; and so it is with farm-buildings—the larger the farm, the less will be the cost per acre of the expense of erecting a steading upon it.

It may, however, be stated, as being very near the truth, that to erect suitable buildings for the extent of each farm, and that for farms of mixed husbandry, the following are about the rates per acre under ordinary circumstances:—

Mixed-husbandry farms of from eight hundred to one thousand acres in extent will require an expenditure in dwelling-house and steading of about £4 per acre of its whole extent.

Mixed-husbandry farms of from four hundred to six hundred acres in extent will require an expenditure in dwelling-house and steading of about £6 per acre of the whole extent.

Mixed-husbandry farms of from two hundred to three hundred acres in extent will require an expenditure in dwelling-house and steading of about £8 per acre of the whole extent; and

Farms of the same description extending from one hundred to one hundred and fifty acres will require an expenditure of about £10 per acre to erect a suitable dwelling-house and steading.

There are many farmers who do not appreciate good buildings, or who at least do not consider it worth while to pay a percentage on the outlay, but happily these are becoming fewer every year; and good farmers will not now cultivate a farm unless it is provided with a proper dwelling-house and steading, as they are coming gradually to know that high farming cannot be carried out with profit either to themselves or to their landlords without suitable buildings.

15. *The chief Heads of a Specification of the different Works applicable to the Erection of a Cottage.—Foundations:* The entire site of the building to be excavated to the necessary levels that may be required for the foundations of the walls and other works. To ram down to a hard foundation any soft places which may be found in the footings of the walls; and to fill in, level, and remove if necessary, the soil which has been dug out after the walls have been erected, and to clear away all rubbish after the completion of the works.

Drains.—All drains and cesspools to be constructed as shown on the plan. The pipes used to be of glazed earthenware, carefully jointed together with cement, laid with a proper fall.

Stonework.—The walls to be built of stone (coursed or plain rubble). The foundations to be laid with two courses of large flat stones, having five-inch scarcements on each side. The building of the walls above the foundations to be commenced in the form shown on the plans and sections, and to be built of good stones, firmly packed in their beds and well hearted, and to be laid in their natural position—that is, the position in which they lay in the quarry.

At every foot in height of the wall, and at four feet from each other, through-band stones are to be laid in the wall. The walls to be levelled at every three feet in height, to receive bond timbers where required.

All door-steps, landings, and sills to be of hard stone.

Windows, heads, sills, and quoins to be of good stone, dressed on the face, and laid in the natural position.

All mantels, jambs, and shelves of chimney-pieces to be of good clean hard stone built into the walls, and each fireplace to have a rubbed stone hearth, to project six inches on each side of the jamb, and to be not less than two feet broad.

All chimney-flues to be one foot four inches in diameter, and built round, carefully pointed with mortar.

The kitchen, scullery, pantry, passages, outhouses, and yard to be floored with good stone flags not less than two and a half inches thick, squared, and laid firm on mortar.

Fit up a sink in scullery.

The quoins of corners of building to be of dressed stone, header and stretcher alternately.

Perform all mason jobbings that may be required, such as holes for pipes, &c.

Joiner-Work.—Provide all inside lintels for doors and windows, and bonds for walls. The lintels to have not less than eight inches of wall-hold on the ends. The bond timber to be four inches by two inches.

The roofs to be made as shown on plans. To have the necessary purlins, straining-pieces, spars, wall-plates, ridge-pieces, ceiling-joists, and laths for slates, according to the sizes as shown on the plans and sections.

The sitting-room and chamber floors to be made with joists nine inches by two and a half inches, and laid with inch flooring, and properly fitted to hearths, firmly tongued and fitted together. Wood bricks to be provided where wanted.

One-inch beading to be provided for all angles. To fix skirtings, eight inches by one inch, and all window finishings.

Provide all windows of deal-cased frames and sills, sashes one and a half inches thick, and double hung with box-pulleys, line, and weights.

Outside-door frames to be four inches by two and a half inches, and inside doors to have two-inch casings, and as broad as the walls and plaster.

The doors to be panelled outside and flush inside. Frames to be two and a half inches thick. Outside building doors.

Inside-door frames to be one and a half inch thick, and panelled.

All presses and cupboards to be filled in with inch shelving, and the kitchen to be fitted up with thirty lineal feet of belting for utensils.

The stairs to be made of one-inch deal. All the outside timbers to be of the best red pine, and the inside woodwork to be of the best white pine; all to be properly seasoned before being used, free from sap-wood, knots, and shakes.

Slater.—The roof to be covered with the best full-sized ladies slates, to have two and a half inches of cover at the eaves, and to be laid double there. The slates to be nailed to the laths with copper nails, and pointed with good lime-and-hair mortar, and all to be made completely water-tight.

Plumber.—All valleys, ridges, and gutters to be covered with lead to weigh seven lb. per superficial foot, and that laid in the gutters to be turned four inches up under the slates. Flashings of six-lb. lead. Eave-spouting to be of cast iron six inches wide, hung on iron straps fixed firmly to the roofing, and placed two feet apart. The downfall-pipes to be from the spouting to the drains, and to be two and a half inches diameter, and of cast iron.

Plasterer.—To lath and set ceilings in all rooms, and to plaster all walls in the same. All ceilings and walls to have two coats of plaster. The plaster to be made of the best lime and sharp sand, with a proper proportion of hair, and all to be finished free of cracks and blemishes.

Glazier.—All the windows to be glazed with the best crown glass firmly set with putty.

Ironmonger.—The outside doors of cottage to be hung with six-inch butt hinges, and fitted with seven-inch rim locks with black-wood handles. All the inside doors of rooms to be hung with four-inch butt hinges, and fitted with six-and-three-quarter-inch mortise locks. All press and cupboard doors to be fitted with good press locks and hinges.

All the windows to have brass spring-fasteners.

Provide gratings for ventilation below floors and above ceilings.

Painter.—Paint all the woodwork outside three times in good oil colour. The inside woodwork to receive two coats of paint. Paint all window-sashes with one coat before being glazed.

The foregoing heads may be found useful in many respects in the drawing out of a specification suitable to the erection of a cottage when built of stone. It may, however, be equally useful to give a few headings of a specification suited for a cottage erected with bricks. I shall therefore give a few rules under the heading of

Brickwork.—All the walls to have two courses of footings; the first footing to be laid on a bed of concrete eight inches thick. Before the erection gets on a level with the point at which the flooring will be, one layer of the bricks is to be covered with tar, well boiled and mixed with quicklime. No three courses of bricks to rise more than one inch beyond the height of the bricks. The bricks used to be of the best quality, well burnt and compact. Build all chimney-flues one foot four inches in diameter, and made round, taking care to point closely. Turn all openings with brick arches.

To lay all floors of kitchen, scullery, pantry, and passages with Staffordshire tile-paving, of a red colour, firmly fixed in mortar.

Set all grates with fire-bricks. The mortar used in all cases to be good, and mixed with sharp sand.

Construct cesspool in backyard with bricks, three feet square, five feet deep. Bricks to be set in cement. Chimney-tops to be built with fire-bricks.

CHAPTER XXII.

AGRICULTURAL LABOURERS AND ESTATE SCHOOLS.

SECTION 1.—*Farm and Estate Labourers.*

IN any department of business, the success of those who carry it on depends very much on the character of the work-people they employ. Where these are not intelligent and well skilled in their duties, the work performed by them is for the most part of an inferior description, and the results unsatisfactory; consequently the employers realise small profits compared with those that are realised in the same kind of business by men who employ only well-qualified workmen. If this holds good in regard to the management of business generally, it does so in farming especially; for wherever we find inferior workmen employed on farms, the labour is indifferently performed, and the produce small accordingly. Seeing that such is the case in regard to farm-labourers, it certainly is a matter of very great importance to the interests of all farmers that they secure the services of intelligent and well-qualified men for the different branches of work on their farms. Comparatively few farmers take this view in regard to their workmen, however, as a large proportion of them act as if ploughmen in general required only the qualifications of superior bodily strength to make them superior workmen. Many farmers, in engaging ploughmen, look to their outward bulk and quality of muscle, more than to their intelligence and general ability, much in the same way as they would in choosing a horse for work. This is a very great mistake, as every observant farmer well knows that even a small-bodied man, if he is intelligent, active, and skilful, makes a very much better ploughman than a large-bodied one who is not so well qualified otherwise. In Scotland I have found farm-labourers generally much more intelligent than the same class in England, and there can be no doubt that much of the success of the Scottish farmers is to be attributed to the superior character of the workmen they employ. This superiority of the Scottish agricultural labourers is to be traced chiefly to the advantages they derive from the education they generally receive in their early youth in the parochial schools, and in this respect they have a great advantage over the English labouring classes. In England a large proportion of farm and general country labourers can neither read nor write, and, generally speaking, I have found these inferior as workmen; while in Scotland there are comparatively few who cannot both read and write, and who do not understand the first rules of arithmetic, and in consequence of this the Scotch are generally more intelligent, and therefore superior as farm-workmen.

Seeing, then, that education is necessary to make a superior ploughman, as well as it is to make a superior workman in any other department of business, both landed proprietors and tenant-farmers should make it a point to secure the highest education possible for this class, on whose labours and skill they depend so much for the profitable working of their estates and farms. It need not be feared that, if better educated, they would be less obedient to their employers. This is not at all consistent with our experience in dealing with human nature; for we invariably find that the more any class of men are educated, the more useful they become in their sphere of life, inasmuch as they are thereby made more reasonable and intelligent, and therefore better able to understand how all matters in connection with the business they are employed in should be conducted, both for their own advantage and for that of their employers. In order that farm-labourers may become better educated, so as to fit them for properly acting their part, as agriculture becomes more and more refined and complex in its details—which it certainly must do as improvements are effected in it—landed proprietors should see that the children of every man employed on their estates are so trained and taught as to fit them for being more intelligent than their parents, and therefore more profitable servants, and better members of society. Were proprietors to see to this, and were farmers to be more particular than they are in respect to giving higher wages to educated and skilful men than to uneducated and comparatively unskilful ones, there would ere long be found a greater desire for education among labourers themselves than there is at present, as they would see that there was something substantial to be gained by education and intelligence.

I could point out many praiseworthy examples of landed proprietors who have recently established reading-rooms on their own home-farms for the improvement of the workmen employed in their establishments, but I merely refer to the fact to show what is being done in some quarters for the improvement of the labouring classes in the country. I ought to note in regard to this, however, that in these reading-rooms newspapers are supplied regularly, and also various periodicals and books on the subjects of agriculture, gardening, geology, botany, geography, &c., all having a tendency to improve the minds of the readers, and to make them more valuable workmen to their employers. I know, also, of some farmers who supply their workmen with newspapers and periodicals, as well as with books of a useful kind. In all these cases the men are more intelligent and superior as workmen, besides more civil and obliging to those who have to deal with them, than men are generally found where no such attention is paid to them, and where no such advantages are bestowed on them. It is to be hoped, therefore, that such examples as these will have the effect of stimulating other proprietors and farmers to do likewise; and that ere long, from the attention of landed proprietors and farmers to the improvement of the workmen they employ, we shall see farm-labourers as intelligent and skilful in their business as workmen are in any other profession. No doubt the more intelligent and skilful that workmen are in carrying out the details of their particular profession, the higher remuneration they require; but, on the other hand, it must be taken into account that the greater the skill and intelligence which a workman can bring to bear upon his work, the more profitable he is to his employer. This is a fact now recognised and acted on by all men engaged in business; for in few occupations, except in rural labour, do we find unskilled men employed.

It may be useful to many of my readers if I detail the way in which we manage our reading-room and library on this estate. A few years ago, the proprietor, Major Stapylton, found that the chief portion of the labourers and cottagers on his estates could not read nor write, and he at once determined upon using some means for improving them. He thought that if it were not possible to induce the elder people to improve themselves, every means should be taken to give the young men and children a good opportunity of learning reading, writing, and arithmetic. He therefore established a reading-room and library. The reading-room has been constantly supplied with several daily and weekly newspapers, and also with a few monthly magazines, such as 'Good Words,' 'Sunday Magazine,' 'British Workman,' and the 'Journal of Agriculture.' The library has now a good supply of standard works of different kinds, among which may be found Wilson's 'British Farming,' Stephens's 'Book of the Farm,' and Brown's 'Forester,' and a number of other useful works on rural subjects, suitable to workmen employed in the general work of an estate. There is also an evening-school in operation each winter, where the young men are taught reading, writing, and arithmetic chiefly. The result is, that while in 1861 I could only get one or two of the men to sign their names in my pay-book, in 1868 nearly all of them can do so, and they take a pleasure in trying to do it well when pay-night comes. Much good can be done in this way. Every village and every farmstead ought to have a library open to all in connection with each place. For the sake of giving a few hints to any one who may contemplate establishing a reading-room and library, I will here give a copy of the Rules of the Wass Mental Improvement Society:—

Rules for the Members of the Wass Mental Improvement Society.

1. The object of the society is the intellectual advancement of its members, by means of a library, reading-room, lectures, conversational discussions, &c.

2. Religious subjects not to be entertained.

3. The committee may, if they think proper, promote occasional soirees.

4. All subscribers of 4s. or upwards per annum shall be members of the society, and each member shall be eligible to vote in the election of officers, and any other business, at the general meetings.

5. That parties, at the discretion of the committee, may be admitted members on payment of 2s. 6d. per annum, and be entitled to every privilege in connection with the society except the right of voting.

6. That family tickets be issued at the charge of 6s. per annum, which shall entitle the members of such family to all the privileges of the reading-room and library; but the head of the family only being allowed to vote.

7. That ladies be admitted members on the same terms as in rule 5.

8. All payments to be made quarterly, and in advance.

9. The members shall elect annually a president, vice-president, treasurer, and secretary; also a librarian, to be permanent, or at the disposal of the committee.

10. The society to be governed, in conjunction with the honorary officers, by a committee of five, to be elected annually; they shall meet every quarter, when fair and accurate minutes of their proceedings, and all other receipts and payments, shall be kept.

11. The committee shall have power to make by-laws, not at variance with the fundamental rules or declared objects of the institution; to fine or expel members for misconduct; have full control over the funds for the purposes of the institution; and have the management of the books, newspapers, lectures, and other departments: but a member being expelled can appeal to the society at the general meetings.

12. Every resolution put from the chair, at any meeting of the members or committee, shall be decided by a majority of votes; the chairman to have a vote, and casting vote in cases of equality.

13. The annual general meeting of members shall be held in the month of January, to receive the reports of the retiring committee, with a statement of their accounts, and to elect by vote officers for the ensuing year.

14. Non-subscribers visiting the reading-room shall for every such visit pay 1d.

15. Each member shall have the privilege of introducing in the reading-room a stranger, who must sign his or her name in a book kept for that purpose, which must also be signed by the member introducing.

16. No book or newspaper shall be admitted until sanctioned by the committee; but any member may propose books for admission, by entering the title, size, price, and publisher's name in a book provided for the purpose, and affixing his signature.

17. The reading-room shall be open on Tuesdays, Thursdays, and Saturdays, from half-past five to half past eight P.M., during the winter months, and during the same hours every day in the week (Sundays excepted) in the summer months.

18. The librarian will attend at the library on the evenings of Saturdays, from seven to eight o'clock, for the purpose of receiving and delivering books.

19. The books to be kept according to the time and manner stated on them.

Where a regular squad of workmen is employed on an estate, I have found it very beneficial, and to the benefit of both master and servant, to have certain rules drawn out as a guide to both. Of course any one given form of rules will not answer the purpose for every estate, as the character of the work and other circumstances will affect this. The following is a copy of the rules which I have had in use for some years :—

Rules for the Labourers upon the Estates of Wass, Byland, and Oldstead.

1. All orders to issue only from the foremen, for their respective departments, and to be given the previous evening if possible.

2. Labourers to be on the ground, to commence work at the hours stated.

3. From the 1st March to the second week of October, work to be from seven A.M. to half-past five P.M., with dinner from twelve to one, and rest of ten minutes at ten A.M. and at four P.M.

4. From the second week of October to the 1st March, work to be from the earliest light after seven to the latest light before six P.M.; with rest of ten minutes at ten, dinner-hour from twelve to one, and rest of ten minutes at four o'clock.

5. Except at resting-times, smoking is not allowed during hours of work; nor at any time within farm-steadings, saw-mill, tool-shop, or carpenter's shop.

6. Payments are made monthly.

7. The rate of wages to be strictly according to ability.

8. Labourers to attend regularly, if not prevented by sickness or other necessary cause, of which notice must be given to the superintendents. Any labourer wishing to be absent must also give sufficient reason and notice.

9. Labourers are responsible for the safety and good keeping of any tools committed to their charge.

10. Every labourer is expected to write his or her own name.

11. When practicable, the superintendents to be first on and last off the ground.

12. No workman will be kept on the estates who is given to gross immoral conduct, such as swearing, drunkenness, or otherwise.

13. If any workman find any person taking wood or underwood from the plantations without a written authority from the agent, he shall immediately give information.

14. Any labourer wishing to leave the employment must give a week's notice to that effect. Similar notice will be given by the employer when their services are not required.

15. Want of attention to these rules will form the cause of dismissal, on evidence to the agent.

16. *Punctual attention to these rules, and other proper behaviour, will be the sure means by which the proprietor can raise wages, give promotion, or recommendation either here or in other parts of the country.*

SECTION 2.—*Cottage-Gardens, and the Allotment System.*

It is an excellent system to allow labourers to have a small portion of land to cultivate as a garden. Many landed proprietors and agents seem to think that the system is not a good one — that the allotments are generally badly cultivated, and that the labourers often neglect their daily work to attend to their gardens. This may have been the case in some instances, but my own experience leads me to state that it is a good system to allow a labourer to have a garden or allotment. He generally takes an interest in his garden—he prides himself in keeping it tidy and clean, and tries to outstrip his neighbours in producing good crops. As a rule, I have found that the cottagers on an estate keep their gardens in much better order, and produce much superior crops from them, than the farmers do. A farmer's garden is very often anything but cleanly kept, and is frequently the worst-tilled place on the farm. This is not the case with cottage-gardens. A few cases may occur where the tenants, from some cause, do not attend to their gardens; but I maintain that where a labouring man has a garden to attend to, it generally tends to keep him at home from the public-house and from poaching. In it, also, his children receive their first lessons in the cultivation of the soil; and I certainly think that a proprietor is looking to his own interests when he sees that each of his cottagers has a small garden.

The garden should not be large—not more than one-fourth of an acre. This will be found sufficient for one man to keep properly with profit to himself. It should be drained for him; and in those cases where gardens are not drained, but require it, an arrangement should be made for the labourer to execute the cutting and filling-in of the drains at his own expense, and the landlord to find and cart the pipes for them. He should also be instructed to trench his garden and manure it well, so as to make it highly productive. Although these works may take up some of his time and give him some trouble, yet he will reap the benefit afterwards; only he should be guaranteed some compensation should anything occur to cause him to give up possession of the garden.

It is even judicious in many instances to let out a few acres of land to labourers as allotments or cow-keepings, in portions of, say, from five to ten acres. A much higher rent will generally be got for these allotments than a farmer would give for them; and, as a rule, they are better kept in every way. With more encouragement from the landed proprietors, the crofters in the Highlands of Scotland would be considerably improved in condition. As they are, they are left to plod on in their own way, receiving no encouragement to drain, trench, or enclose. The present Earl of Seafield is, however, an exception to this, as he makes it a condition with the crofters on his Strathspey estates to allow them £5 for every acre which they reclaim from the wastes. Another noteworthy instance is shown on an estate in the north of Scotland belonging to her Grace the Duchess of Sutherland. Some years ago (1849) expatriation was very common in the north of Scotland, to make room for deer-forests and shootings. At that time the Duchess of Sutherland allowed a number of poor peasants to take possession of an unreclaimed moor; and in a very short time the land, which was only worth 3s. per acre, returned 21s.*

Much good can be done in this way, both to the labouring classes, and also, by increasing the value of the estate, to the proprietor; but in whatever form the land may be let to small tenants, proper rules should be laid down for them to work by. These rules must be drawn out according to the circumstances of the case. The following may give some hints in doing this:—

Rules for Small Tenants and Cottagers.

1. No crop of any kind to take up more than one-half the land in one year.

2. All the land to be properly and well manured in each year.

3. No portion of the land about the corners, end-ridges, or fences, to be left undug; but every available part to be properly dug up and kept under cultivation.

4. Each tenant is responsible for the good keeping of the fences around his garden, garth, or allotment, and he must constantly keep them in good repair.

5. The walks, as well as all the other parts of the garden or allotment, to be kept free from weeds and moles.

6. In the case of any allotment being given up, or of the tenant being discharged from it, the tenant to be paid for any digging which he may have done.

7. Should any tenant be convicted of theft, poaching, or other misconduct, before a magistrate, he will be liable to be ejected from the estate at the following term.

8. No garden or allotment, or any part of it, shall be underlet.

9. Each cottager must send his children to school regularly. The teacher will report every month as to the attendance.

10. Each cottager must keep his cottage tidy and clean. He will keep it in good repair, and all cesspools and drains clear and in working order.

11. If any garden or allotment be not properly cultivated, or if any of these rules are not strictly carried out, the tenant will be subject to be ejected from the estate.

12. Prizes will be given every year to those tenants who have cultivated their land best.

13. Prizes will also be given to those tenants who have kept their house in the most tidy and clean manner.

14. Three judges will be chosen in each year, to inspect and report upon the condition of each cottage, garden, garth, or allotment, and to award the prizes accordingly.

SECTION 3.—*Estate Schools.*

It often occurs that schools are upheld by landed proprietors on their own estates, and therefore come under the management of the agent on the estate.

* 'Estate Management,' by MacDonald.

It is a matter of very great importance that the schoolroom should be large, commodious, and well ventilated. Where this is not the case, the health of the children suffers in consequence. The Government regulations are, that "the grant is withheld altogether if the school be not held in a building certified by the inspector to be healthy, properly lighted, drained, and ventilated, supplied with offices, and containing in the principal schoolroom at least eighty cubical feet of internal space for each child in average attendance."

In country schools there is often a great want of proper offices outside for the children, so that all of them, both boys and girls, generally use the same water-closets, &c. This is far from being proper, and in schools which are under Government inspection, and are receiving Government grants, this is not allowed. A complete separation should be made between the sexes.

It is, of course, of the greatest importance to secure a first-class teacher; and in this case it is not wise to take an inferior master at a low salary, but rather employ one who is thoroughly efficient at a remunerative salary.

On some estates it is the custom to pay the teachers a fixed salary, and the managers receive the school-fees. This I think is not a good plan, as there is no inducement for a teacher to strive to enlarge his school; and consequently I consider it better to pay a salary, and also to allow the teacher to receive the school-fees. He has thus an inducement to push on and enlarge his school.

Attention should be paid to the amount of the fees to be paid by the different classes of children on the property. Sometimes the charge for labourers' children is made too high, and the result is that the children are kept away from school from the inability of the parents to meet the school-fees. It is better to rate them at a lower sum, and secure their constant attendance at school. I have found in many districts that the parents do not appreciate the benefits of the school for their children, and they keep them at home rather than send them to school. On a landed estate where this may be the case, a little tact on the part of the managers will generally secure the attendance of the children at school; and by frequent visits to the school of those interested in it, the parents will come to know that it is necessary the children should attend.

In order to procure regular information in regard to the school—as to attendance, admissions, and withdrawals—the teacher should draw out a monthly statement according to the form on next page, and send it to the managers.

________________ SCHOOL.

RETURN FOR THE MONTH ENDING SATURDAY, ________________ 18___.

	ON THE BOOKS.					AVERAGE DAILY ATTENDANCE.		ADMISSIONS.		WITHDRAWALS.			DAYS.
	Workmen's Children.		Other Children.		Total.								
	Boys.	Girls.	Boys.	Girls.		Boys.	Girls.	Boys.	Girls.	Boys.	Girls.		
1st week,												School open, . .	
2d ,,												Regular holidays, .	
3d ,,												Occasional do. .	
4th ,,												Sabbaths, . . .	
													28

REMARKS :—

________________, *Teacher*.

In the management of an evening-school for labourers, attention should be paid to a good selection of subjects to be taught. The great thing is to teach them only plain useful things to begin with.

In the first place, reading should of course be taught, and along with this writing; and to carry either of these out properly, they should be taught *grammar*. This will enable them to understand the construction of the language, and they will all the easier learn composition and letter-writing. Arithmetic should also be taught; but, with the general class of labourers, no attempt should be made to master the more complex rules of arithmetic. The chief thing should be to teach them thoroughly the first rules only, and of course if any pick it up quickly, they may be able to go further into it. The great thing with many teachers seems to be to give their pupils a skimming only of all the different rules. They evidently think it a matter of importance to get them as far advanced in the book as possible, whether they may understand the different rules or not. Where this is done, a pupil very soon forgets what he got at school. If he is taught thoroughly what he does attempt, he will not forget it afterwards. The great object in all schools, and more especially in evening-schools, with labouring people, is to make them understand thoroughly what they do attempt, and on no account to proceed further into the subject until this is done. In arithmetic, what a working man wants is addition, multiplication, division, and reduction, and perhaps he might be carried as far as practice. These are always useful to a working man, and once he had these thoroughly, he would be enabled to teach himself more. It is also a useful thing to practise them in *mental arithmetic*—that is to say, questions should be put to them, simple to begin with, which they should be encouraged to answer from memory.

After labourers have been taught these primary departments of a common English education, it is very advantageous to teach them the simple parts of land-surveying. To men working on an estate or farm this is very useful. I do not mean that they should be made professors of land-surveying, but simply to give them such a knowledge as will enable them to make an estimate of the extent of any portion of land. In the event of their doing any work by contract—such as ploughing, digging, trenching, draining, &c.—this knowledge would be of great advantage to them.

Major Stapylton has recently offered prizes for the best essays written by the workmen on his estate. This is an excellent system, as it encourages the men to read and write, and also to *think*. The subjects of the essays are descriptions of their own work.

The following course of study will be found a useful one for working men:—

First year—Reading, writing, arithmetic.
Second year—Composition, grammar, accounts.
Third year—Accounts, land-surveying, drawing.

The course of study should be confined to a few months in each year—that is, in the winter season, when the men are at home in the long evenings. Presuming that there is a reading-room, library, and evening-school on the estate, three nights should be allotted for the evening-school, and three for the reading-room, thus:—

Monday, ...	School.
Tuesday, ...	Reading-room.
Wednesday, ...	School.
Thursday, ...	Reading-room.
Friday, ...	School.
Saturday, ...	Reading-room and library.

In the organisation of a night-school, the ventilation of the room, the supply of light, the temperature in winter, and the cleanliness of every part, demand careful attention. The room should be pleasant in its associations, due regard should be had to neatness and effect, and the style of decoration should be simple and tasteful.

But as it is the man and not the room that makes the school, care should be taken in the selection of a teacher. Some night-schools are taught by unpaid teachers; but such schools, dependent as they are upon gratuitous labour, are often to a great extent precarious. In my opinion, the best plan is to connect the night-school with the day-school, so that the two may help to improve each other. There would thus be three meetings in the day instead of two. In small villages the teacher of the day-school might superintend at all the meetings. But where an assistant-teacher is employed, the principal teacher could take sole charge of the night-school, and be released from duty in the less important afternoon-school.

Thus the evening-school might be maintained at little or no expense to the managers. Besides, no small advantage would accrue to those children who are obliged to leave school at an early period of life in order that they may earn their livelihood, or add their quota to the fund necessary to support the family, since by the plan I have suggested they would keep up their connection with the school where they had received their primary education, and be enabled to pursue the studies they have commenced. Besides the class of children I have referred to as attending evening-schools, there are those of maturer years, whose education has either been entirely neglected, or who have received but a smattering of learning. As their stay at school must at least be brief, they ought to confine themselves to the subjects of reading, writing, and arithmetic—or, as they are sometimes termed, the three R's—as taught under the system of education in national schools under Government inspection.

Closely connected with the success of a night-school are the terms and rates of payment. Inasmuch as the pupils are dependent upon weekly wages, they should be allowed the opportunity of making weekly payments, as they feel more directly the value of the instruction they receive when thus identified with their contributions. All experience has proved that much larger payments are made at shorter periods than at long ones. The rates of payment ought to be within the reach of all, but not so low as to make the education given undervalued.

CHAPTER XXIII.

TRACTION-ENGINES *VERSUS* HORSES ON FARMS.

THAT horses are expensive to maintain for farm-work is now well understood by all parties engaged in it; hence the most intelligent and enterprising among them are anxious that some other power should be substituted, with a view to its being more cheaply performed. In the mean time, steam-power seems to be the only one likely to take the place of horse-power in farm-labour; but before referring particularly to this, we shall consider the actual cost of horses as maintained for the purpose of working our farms.

Many farmers maintain their horses cheaply—that is, at a small outlay—but in all such cases the animals are badly fed, and therefore unable to perform their work in a profitable or satisfactory way; while others, from having a particular hobby in keeping their horses in very high condition, maintain them at a greater expense than is necessary. In order to arrive at a fair estimate as to the cost of horse-labour, both these extremes are to be avoided, and the expense of a medium plan of dealing with the subject should be taken. In attending to this, I shall give an estimate according to my own experience in keeping horses for farm-work; and by reference to my account-books, the expenditure I find stands as follows per horse per annum :—

Oats and hay, ...	£18	10	0
Bran, &c., ...	4	10	0
Farrier and saddler, ...	2	0	0
Blacksmith, ...	2	10	0
Interest on value, ...	2	0	0
Deterioration in value, ...	2	0	0
	£31	10	0

Of course some will tell us that their horses do not cost so much as I have stated, as they put them out to graze in summer, and that does not cost them much. I have even been told by farmers that their horses cost them nothing in the summer season. They seem to forget that their horses cannot live on nothing, and that they must consume a large quantity of grass which would otherwise have been eaten up by cattle.

From this statement it appears that the cost of maintaining one horse is £31, 10s. a-year. In some years, however, they have cost less than this per head, and in others more, according to the value of hay and oats, and also as they happened to require more or less attendance of the farrier; but the statement given may be taken as a fair average of the expense of maintaining one horse in a medium way, so as to be in all respects in good working condition. But besides this, there must be taken into account the expense of the men who work the animals. The wages of an able ploughman may be taken at £30 a-year, and the value of his cottage and garden at £4—thus making £34 as the cost of each man for a pair of horses. The half of this sum taken as the expense of the man in attendance on one horse, and added to the sum already given as the cost of maintaining one, gives £48, 10s. per horse per annum. On a farm of three hundred acres arable, ten horses would be required, and five men, to work it properly. Now, if the cost of maintaining one horse is £48, 10s., including the proportion of cost for attendance by the man who works it, then ten will cost £485 a-year, or a sum equal to about 32s. 4d. of rent on each acre of the land operated on. This, then, is about the average cost of horse-power, as it is applied in the performance of farm-work at the present time—and it is certainly an expensive power. No wonder, therefore, that farmers are calling out and asking how soon they can be relieved of such a heavy burden on their farms. The annual expense of maintaining horse-power for the working of farms in the mean time is perhaps nearly equal to the amount of their rents, and of itself would form a fair income to the tenants. When we view the subject in this light, as of course it ought to be viewed, it shows us how much behind we still are in our appliances to agriculture. We are now well advanced in the nineteenth century, and while manufacturers and most people in other occupations have called in the services of steam-machinery, whereby they are enabled to perform their works at a tithe of what such cost previously, and also in a much superior way, agriculturists are still plodding on in the footsteps of their forefathers, cultivating the land by the old-fashioned horse-plough at an annual expenditure nearly equal to the annual value of the land cultivated. This being the state of things, the question is, What can be done to obviate the necessity of keeping horses on farms? The direct answer to the question is—Adopt steam-machinery. The greater part of farmers concur in this, and a large proportion of them have adopted it for thrashing purposes; still the great drawback is, that it has not yet been made fairly available for all the purposes of the farm. The fault of this cannot be said to rest with the farmers; it lies with our engineers, who have not yet been able to bring forward a steam-power with machinery in all respects suitable to the wants of agriculturists generally in all circumstances. What the farmer wants, and is desirous to have as soon as possible, is a simple, cheap, and easily-wrought steam-power, so constructed as to plough, harrow, cut, thrash, &c. &c., or to go on the roads when necessary; which could also be maintained for all the works of the farm at a very much cheaper rate than horses, and at the same time do its work better than can be accomplished by them at present. Various inventions have from time to time been brought forward with a view to this; but it cannot be said that any of them have been brought to the state of perfection required to warrant farmers in general embarking their capital in the purchase of machines which are ponderous and expensive, not applicable to working in all conditions and in all circumstances on a farm, and which require a greater degree of skill to be applied in the working of them than most farmers can be expected to give. But, keeping out of view for the present the steam-machines which are now being used in some parts for the purpose of tilling the land, I would here introduce to the notice of farmers the steam-power which is now being made available for hauling on the country roads, called the *Traction-Engine.* This is a locomotive engine, constructed with broad wheels suitable to admit of its passing along the common roads of the country without injuring them by its weight; and it propels itself, with many tons of a load, according to its constructed power, even up considerable gradients. There are two engines of this kind now in operation on the very unlevel roads in the upper part of Aberdeenshire. There they are used for the purpose of hauling waggons laden with timber a distance of nearly twenty miles to the nearest railway station; and for this purpose they have succeeded far beyond the most sanguine expectations of the parties who have adopted them. These engines perform the work of hauling the timber at less than half the cost it would have entailed if horses had been employed instead. Now, what I would infer from these remarks in regard to the traction-engine is, that seeing it has proved itself a power well suited to haul heavy loads on our country roads at less than the half of the cost which the same work could be performed at by the use of horses in the ordinary way, could it not be made as successful as a hauling power in farming operations? I have no doubt as to its general adaptation to this purpose, and have therefore to advise agriculturists to turn their attention to it, to ascertain for themselves how far it may be made available to meet the wants of the times and their own respective cases, so as to enable them to dispense with horse-power to a large extent.

In the chapter on "Railways for Farms and Estate Improvements," as well as the foregoing remarks, I have referred to the fact that Colonel Farquharson of Invercauld has commenced to construct a tramway from the Ballater station, on the Deeside Railway, to his estates. In the mean time, until the tramway is completed, the thinnings from the extensive forests on the Invercauld estate are being conveyed to the Ballater station by means of a traction-engine and trucks on the common roads. A large quantity of the thinnings from the forests have been bought by an enterprising firm of timber-merchants and shipbuilders in Aberdeen; and when they first purchased, two years ago, they found that the expense of carting by horse-power a large quantity of timber by road to the Ballater station was excessively large—the cost amounting to nearly 10s. per ton; and when the quantity to be removed annually was upwards of six thousand tons, the firm calculated that, if a slight reduction could be made in cost of the carriage per ton, the saving would be considerable, and they decided upon purchasing a traction-engine and trucks to remove the timber to the railway. They accordingly purchased one from Messrs Aveling and Porter of Rochester. The engine is ten-horse power, weighs ten tons, and requires a width of eight feet of the road to run in. The wheels are eighteen inches wide in the rims, and six feet in diameter. The waggons are made in much the same way as the low-sided railway waggons are, and the wheels are nine inches broad. These are for the carriage of manufactured wood, such as railway sleepers and barrel-staves. They have another form of waggon in use, for the carriage of timber in its rough state; it is made similar in form to the ordinary horse wood-waggon. The cost of the engine was £650, and of the waggons £200. The gradients on the road are in some places considerable—as much as 1 in 12. This system has done the work admirably, and has given its owners great satisfaction. The load taken at each time by the engine, however, is not great, being only fifteen tons. This is not to be laid so much to the fault of the engine as to the soft state of the roads. If a liberal supply of fresh materials were kept on the roads for some months after the engine has commenced to work, the weight of the engine and waggon would press them down, and in a short time improve the condition of the roads very much; and if this were done, and a firmer foundation procured for the engine and waggons to run upon, then a much heavier load could be taken. The great consideration in the construction of a tramway, or of a common road on which engines are to run, is to procure a firm and solid foundation, and also to have the bearing surface so made that the wheels will not slip in running. For instance, we all know that, in our everyday railway travelling, trains are often behind the proper time in frosty and wet weather, from the rails being what the engine-drivers term "greasy." This is more especially the case with heavy goods-trains, and on lines where the gradients are steep. When the rails are wet and slippery, the wheels often slip—that is, they revolve round without making much progress. To improve the catch of the wheel upon the rail, or what is by the engine-drivers termed the "bite," sand is allowed to run down upon the rail in front of the wheel. This, however, would not answer the purpose on tramways with very steep gradients.

I see no reason why tramways should not be made over hilly countries with steep gradients, the chief points to attend to in such lines being to make the locomotive wheels in such a way as to have a firm catch on the rail. Mr Page, C.E. (the engineer of Westminster Bridge), has taken this subject into consideration, and has invented a system of tramway suitable for steep gradients. The arrangement is to have the wheels of the locomotive broad—about eight inches—and to have the running surface of the tram rough, so as to give "bite" to the wheels. On the inner edge of the tram iron rails are fixed on which the wheels of the carriages or waggons run. The wheels of the carriages are flanged the same as on our ordinary railways. Mr Page suggests that tram-railways may be made at a small cost by laying down the rails along the sides of our common roads, and that the owners of the tramway undertake to keep the road in good repair for the right of using part of its surface for the tramway. Most of our highways would require to be widened to admit of this being done; but where the roads are of sufficient width, it might be done with great advantage to any district through which it passed. Mr Page estimates that the cost of the new tram-railway would not exceed £1800 per mile for a single line at English prices; but where timber or stone is abundant, and at a reasonable cost, this amount would be considerably reduced.

In experiments made with a model of Mr Page's system of tram-railway, it worked on a gradient of 1 in 3.

CHAPTER XXIV.

THE MANAGEMENT OF THE GAME DEPARTMENT AND SHOOTINGS ON AN ESTATE.

In this chapter I do not mean to enter into any details as to the management of game, but merely wish to give some statements which may be of advantage to those who have to deal with shootings, &c.

On most estates there is a head-gamekeeper, who looks after and pays any assistants he may have under him, and the head-keeper has to account for his transactions either to the proprietor or to the agent on the estate. Very often the gamekeeper is placed in a position quite independent of the agent, and hence the frequent disagreement often met with. An agent on an estate should be his employer's agent in everything in connection with the estate; and where this is the case, the general work of the property goes on much more smoothly, and in a more economical manner, than where the heads of departments have independent and separate powers given them.

In order that a full and proper statement of the dealings in the game department may be clearly shown at stated intervals—and this may be either once in each week or month, as may be found necessary—the gamekeeper should keep strict and proper accounts of all his transactions. Statement No. 1 is the form which we use for keeping an account of the game killed, being the same form as issued by Gardiner & Son of London under the name of "Webb's Game-Book."

No. 1.

18 Day.	Where killed.	Deer.	Hares.	Partridges.	Pheasants.	Woodcocks.	Grouse.	Rabbits.	Snipes.	Wild Fowl.	Total killed each Day.	By whom killed.	Observations.	How disposed of.	Deer.	Hares.	Partridges.	Pheasants.	Woodcocks.	Grouse.	Rabbits.	Snipes.	Wild Fowl.
Monday																							
Tuesday																							
Wednesday																							
Thursday																							
Friday																							
Saturday																							
Total of each killed in the week, . .												Total of the week.		Totals,									

In statement No. 2 is given a form which enables the gamekeeper to give a detailed account of all the income from the sale of game, rabbits, dogs, &c., and all expenditure on the other side, with a list of payments to be made or due at the end of each month; and also columns for the number of dogs in the kennels, and of the game killed, which is taken monthly from statement No. 1. A space is likewise given for entering an account of the manner in which the game, &c., has been used or otherwise disposed of, while a sheet is left for any general remarks. We use printed forms similar to statement No. 2, which are filled in each month by the keeper.

No. 2.

GAME DEPARTMENT.

Estate of ______________________.

REPORT FOR MONTH ENDING ________ DAY OF ______________ 18 ___.

DATE.	RECEIPTS.				DATE.	PAYMENTS.			
		£	s.	d.			£	s.	d.

STATEMENT OF PAYMENTS TO BE MADE.

NAME.	PARTICULARS.	AMOUNT.		
		£	s.	d.

DOGS.

Retrievers.	Pointers.	Setters.	Spaniels.	Mastiffs.	Terriers.		

GAME KILLED.

Date.		By whom killed.	Grouse.	Pheasants.	Partridges.	Wild Ducks.	Woodcocks.	Snipe.	Plover.	Hares.	Rabbits.	Total.	Grand Total.

		Lands on which killed.	Rabbits killed.	Half grown.	Full grown.	
				Pairs.	Pairs.	
			For week ending			
			Do. do.			
			Do. do.			
			Do. do.			
			Total Game and Rabbits killed this month,			

Disposal of Game and Rabbits.

GENERAL REPORT.

CASES OF POACHING, STOCK OF GAME, &c.

The statement as given is folded up, and marked on the back as follows, which makes it more convenient for reference :—

*No.*____________________________*18*__

WASS ESTATE.

GAME.

Report for month ending____________

day of______________________

18__

When shootings are let, a proper form of lease requires to be drawn out to insure that the game will be properly protected. Shootings should be let for a term of years, and never by the year, as in the latter case the tenant has no interest in protecting the game, but takes away all he can from the grounds. A shooting-lease should be drawn out under the following heads :—

1. *As to the Term of the Lease.*—This should not be for less than ten years, and more if thought proper.

2. *The Rent.*—This should be made payable in the autumn of each year—say in the month of October.

3. *The Termination of the Lease* should be at the end of the shooting season; and this, with shootings in the Highlands of Scotland, will be on the 11th of December; and with low-country shootings, on the beginning of February in each year.

4. *Subletting* should not be allowed without the consent of the proprietor in writing.

5. The gamekeepers should be appointed by and at the disposal of the proprietor, and not of the tenant; but at the same time they should of course be subject to the directions of the tenant. The proprietor should pay the wages of the gamekeepers, and this will of course require to be considered in putting a rent on the shootings. The tenant should

have the power of calling upon the proprietor to dismiss any keeper who has given reasonable ground for complaint.

6. It is sometimes the custom for the proprietor to reserve the right of a few days' shooting or fishing, even when let to a tenant.

7. Strict clauses should be entered in a shooting-lease as to the rabbits on the grounds. If the tenant have the sole right of shooting them, they may be allowed to increase so as to become a great source of destruction to the farming tenant's crops on the estate. And again, if the proprietor reserve the rabbits entirely, this may also prove a great source of annoyance to the tenants. It is better in this case to allow the tenant to shoot the rabbits whenever he may choose ; but the proprietor should reserve the right of trapping or otherwise destroying them whenever he may think it necessary.

8. Where there is an extent of moorland, the proprietor should arrange for a certain portion of it to be burned in each year. This is found to be necessary for grouse.

9. The moor-burning should be undertaken by the gamekeeper, who should know where and when to do it. It is sometimes necessary for an extent of the heath to be burned for the improvement of the sheep-grazings in moorland districts. Instead of allowing the grazing tenant to burn at his pleasure, he should state to the proprietor or his agent the position and extent of what he wishes done, and then, on being approved of, the keeper should be instructed to carry it out.

10. A clause should be inserted stating that the proprietor will not be responsible for any disease in the game, or for any other loss which may occur.

11. Where there are deer, hunting with dogs should not be allowed ; and the number of deer to be shot should be restricted, and a date should be fixed for the closing of the deer-shooting. In the north of Scotland, stags are usually allowed to be shot up to the 20th of October, and hinds to the 1st of January, but not later.

12. The greatest number of pheasants, partridges, grouse, or hares to be shot should be stated in the lease, and this more especially in the last year of the lease.

13. The tenant should be made liable for any poor-rates or other taxes which may be laid on the shootings.

14. The right should be reserved of making any improvements on the estate which may be desirable, such as the reclamation of waste lands and the formation of plantations.

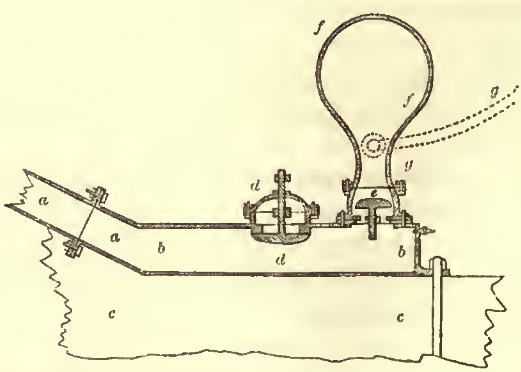
CHAPTER XXV.

THE WATER-SUPPLY OF LANDED ESTATES.

On many estates there are frequently tracts of land on which there are no streams, springs, or wells, and the want of a supply of water is often much felt by the tenants. This is more especially the case on high-lying table-lands; and in many other situations there is also a great expense and waste of time in procuring water. A good supply of pure water is essentially necessary for the health of the inhabitants, as well as the animals, in such districts. In many cases this can be got by the formation of a reservoir at a spring, conveying it from thence through pipes to the place where it is wanted. In other instances, a supply may be got from a lake or pond, but always provided such lake or pond is above the level of the place to which the water is to be conducted. Where, however, no water can be got from a higher level, a supply may be obtained from a lower level by means of a clever contrivance called the "hydraulic ram." It is very simply made, and is not liable to get out of order; and I have known it to work for some years without any heavy repairs being necessary.

Fig. 109 is a sketch of a hydraulic ram as manufactured by Messrs

Fig. 109.



Gwynne, of Essex Wharf, Strand, London. *a a* is the supply-pipe, which comes from a lake, stream, or dam, as the case may be. The water is led to the chamber *b b*. A valve *d d* is made, which, when the chamber *b b* is empty, remains open by falling down; but as soon as the water rushes down the supply-pipe, it closes the valve *d d*, and at the same time the water raises another valve at *e*, which operates the opposite way to the valve *d d*, and then the water passes into the air-vessel *f f*; and upon the water entering the part *f f*, it receives the pressure of the air, which causes the valve *e* to shut, and which in turn causes the valve *d d* to fall down, and this allows the water to escape from the part *b b*. A reaction then takes place, when the flowing water again acquires a force as at first, which closes the valve *d d*, and opens the other valve *e*, and the water again rushes into the air-vessel *f f*. This action goes on constantly, resulting in a regular opening and shutting of the two valves alternately, the water being thus forced up the pipe *g g* to the required height. *c c* shows the position of the block of wood or stone to which the ram is fixed.

The hydraulic ram, as described, will be found a most useful apparatus for raising water to any height or distance, only it is necessary to have a fall of water from the stream or lake to the ram itself, in order to give it a sufficient force for working the valves.

In giving estimates for the cost of erecting and completing an apparatus of this kind, it is necessary to find the following particulars:—

1st, The fall in feet which can be obtained from a lake, river, stream, or from whatever source of supply.

2d, The horizontal distance from the source of supply to the place where it is wished to convey the water.

3d, The elevation to which it is required to raise the water.

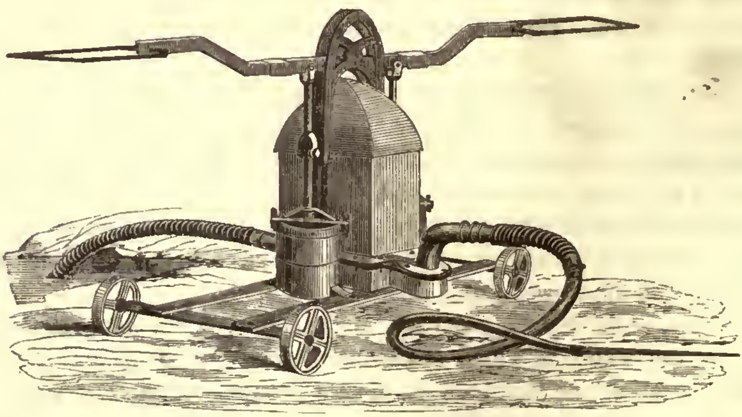
4th, The quantity of water required to be raised in a given time—that is to say, the number of gallons per minute.

The greater the fall from the source of supply to the ram, the greater will be the height to which it can be raised. Under general circumstances, a fall of one foot from the source of supply to the ram will raise the water ten feet in height. Messrs Clinton & Owens, of Whitefriars Street, Fleet Street, London, also manufacture hydraulic rams, which raise water thirty feet in height for every one of fall.

It will be understood, from what I have already stated in regard to estimates for this apparatus, that no precise statement of cost can be stated, inasmuch as local circumstances altogether control the strength of ram required and the length of piping necessary. It is, however, not expensive; and, as an example, I may state the following particulars relative to one which we purpose fixing on this estate. The fall to the ram is about twenty-two feet, the horizontal distance from the ram to the farmhouse to which it is desired to take the water is three hundred yards, and the height of the house above the ram is one hundred and eighty feet. The estimated cost of fixing a ram which will deliver one thousand gallons of water per diem is £55.

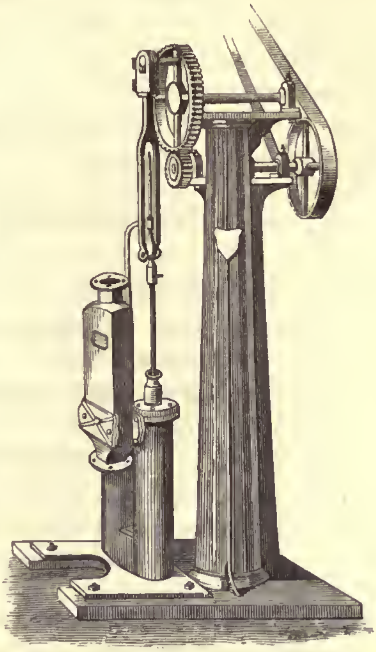
A ready supply of water about a mansion-house or farm-steading is very important in the case of fire, and no premises of any extent should be without such a supply; but for the purpose of applying the water with force and immediate effect, it is necessary to have some apparatus to spread it. Where a supply of water can be produced above the level of the buildings, a good fountain-head, with pipes leading from the same, to which a gutta-percha hose can be attached, may in some instances be sufficient to throw a stream of water over the buildings, so as to extinguish fire; but where this cannot be obtained without considerable expense, some kind of force-pump must be procured, which can be worked to throw the water with some power. Messrs Gwynne & Co. manufacture a force-pump, which is a very powerful apparatus for throwing water in the case of fire, and is also very useful as a liquid-manure pump. In fig. 110 is shown this form of pump.

Fig. 110.



Some firms manufacture engines for the purpose of throwing water, several of which require to be worked by steam; but these are almost useless for the purpose, as before the steam can be got up to work the engine, fires would have advanced very considerably. A large supply of water may be kept in tanks or cisterns fixed in some part of the highest portion of the steading, and from this the water can be spread over by means of a hose. For the purpose of filling these cisterns, a hand force-pump will do; but this causes a great amount of labour, especially if the cisterns are used for supplying water for the different premises, as well as to be ready in case of fire. Where a steam-engine is kept, the cisterns could easily be filled by driving a pump with the engine at any time when necessary. Such a pump as can be driven by a steam-engine is shown in fig. 111. The one illustrated is patented by Mr Holman, and manufactured by Messrs Fowler & Co. of London. There is a double pump, which gives a constant stream of water. These kind of pumps "are adapted for irrigation, fire-engine purposes, or for pumping liquid manure. The advantages of this arrangement consist in the facility with which the pump can be fixed, merely requiring to be securely bolted down, thus saving much expense and annoyance, besides loss of time in cutting a way for supports. It occupies very little space, the supply is continuous, the whole is extremely simple, and the working parts are readily accessible. Where the speed of engine or driving power does not exceed fifty revolutions per minute, the spur-gear may be dispensed with, and the pump driven direct from a drum."*

Fig. 111.



* Figs. 109, 110, and 111 are taken from the 'Book of Farm-Buildings.'

CHAPTER XXVI.

THE VALUATION OF LANDED ESTATES.

IN treating of this subject, I shall do so under the following heads :—

1. Modes of valuing a landed estate—by the rental, and by its capabilities.
2. Climate as affecting the value of an estate.
3. Judging of soils.
4. The valuation of land taken by a railway company.
5. The valuation of woods and plantations.
6. The valuation of quarries.
7. The valuation of shootings and fishings.

SECTION 1.—*Modes of valuing a Landed Estate — by the Rental, and by its Capabilities.*

One system of valuing property in this country is to take the rental as the basis, and calculate the value of it at so many years' rents; and another mode is to find the value of the property from its capabilities, which must be done by one who has had experience, and is able to judge correctly of land and buildings.

I shall, in the first place, make a few remarks on the system of valuing landed property by taking the rental, and valuing the property at so many years' purchase. This is a very simple affair, and may be done by any one. The chief point to ascertain in this case is, whether the property is rented above or below its value; and if it is found that the rents are below the real value, then the valuer usually contents himself with adding five or ten per cent to the so-many years' purchase, as the case may be; and if it is thought that the rental is above the real value, or what may be termed rack-rented, then he merely deducts so much per cent. Land-valuers mostly act on this system, but it is a highly objectionable one; they make a pretence of valuing and judging the land by walking over the property, but they could arrive at the same conclusions by an examination of the rent-book at home.

Many purchasers of property lose largely by employing such so-called "valuers," but the fact is, they are not valuers. In highly-cultivated districts, the value may be ascertained very closely by such means; but where the farming is conducted in an inferior manner, such valuations will not answer the purpose. I have known estates with a low rental, where the tenantry gave out that the soil was poor, and that they had to pay very high rents, while the fact was, that the soil was really good, and the rents low for the quality of the material; but the farmers being poor, they were not able to increase the fertility of the soil, or otherwise develop the resources of their farms.

The rent of a property should never at any time be relied upon as giving the real value of an estate, as, for instance, some may suppose that a well-cultivated farm, occupied by a good tenant, and let at a high rent, should show the value of the farm; but this is not the case in a great many instances, as good farms generally invite a large amount of competition when they are in the market, and hence they are apt to be let at an unusually high rent; and some deduction should be made in valuing the farm by its rental.

I have met with many instances in which farms let on lease at a fixed rent have been greatly improved during the first years of occupancy, and were of much more value when the leases were half run than when the tenants took them at first. It would not, in these cases, be a just valuation to take such farms at so many years' purchase, as the probability is that they would be sold below their real value.

Again, we will suppose that there are two estates with an equal rental, upon both of which improvements have been carried out for some years; but on the one the erection of buildings, making roads, fences, draining, &c., have been carried out in a most substantial manner, so as to continue good for a long period without any outlay in repairs or otherwise keeping them up. On the other estate an equal extent of improvements has probably been performed, but they have been done in a temporary manner, and will in all likelihood require renewing in a few years, or at least require an annual outlay to keep them in an efficient state. Both of these estates could not justly be valued at the same amount, even although the rentals were equal. The former is certainly much more valuable than the latter, and this shows the necessity of not depending upon the rental of an estate as a guide in valuing it. I know an extensive Highland property, with fine granite and slate quarries, producing an annual rental of £3000 per annum, which was lately sold at thirty years' purchase, or for a sum of £90,000. It was bought by an enterprising gentleman, who set to work to develop its resources. The quarries were extended; and at the present time the property is giving an annual rent of £5400, without any considerable outlay to procure it. Everything in my experience tends to show the erroneousness of valuing estates by the rental. An estate should be thoroughly examined by a valuator, and its price fixed by its capabilities. The points to be looked at and considered in the valuation of a landed estate may be comprised under the heads of "Its Situation," "The Quality of the Soil," "The Condition of the Buildings, Roads, Fences, Soil, &c." When a valuer is sent to fix a price upon a property, he should not decide upon that price by the rental, but should examine the property, and by considering everything as he may find it on the estate, put his valuation on by the help of his experience and judgment. He will have to consider the situation, aspect, and exposure of the property, as these in many ways will influence its value; high-lying and exposed estates not being, as a rule, so valuable as those more favourably situated, other circumstances being equal. The climate and temperature of the district in which a property is situated affect its value. Presuming that an estate with one kind of soil is worth, in an exposed district, about 25s. per acre rent; then another estate, with a similar soil and subsoil, but lying in a more sheltered situation, will in all probability let for from 35s. to £2 per acre. But although this is the case, it should be considered that the capabilities of improvement on exposed estates are often greater than in the case of a low-lying sheltered property. Such high-lying estates can, for instance, be infinitely improved by providing shelter in the first place.

The situation of an estate as regards its convenience for railway accommodation adds to or diminishes its value according as it may be situated close to a railway station or at a distance from it. Many proprietors of an estate look more to their own desires in regard to railway accommodation, than to the benefits it confers upon their tenantry. An estate's proximity to a railway, however, adds very much to its value, inasmuch as it opens out a market for the produce of the soil, whether that may be in the shape of grain, beef, mutton, or timber; and it supplies a cheap transit to the farms for different manures and other materials which are requisite to good husbandry. The proximity of an estate to markets for the sale of its produce, increases or diminishes its value according to distance; and besides the influence produced by markets, the means of conveyance must be taken into consideration, whether by railways, canals, or good roads.

The quality of the soil and subsoil is one of the chief points to be taken into consideration in valuing landed property, as where this is satisfactory there is a good foundation for improvement; but where such is not the case, then improvements cannot be carried out so profitably. The geological features of the estate should be considered. The soils on some geological formations are better and naturally more fertile than others, and therefore this should be brought to bear upon the value of the estate. Sometimes it occurs that although an estate may be in bad condition, and the surface may not be very prepossessing, yet, from its geological formation, it may be capable of very great amelioration at a small outlay. The improvements that may be produced on some formations by draining, subsoiling, and trenching, are often immense; and, on the other hand, they may be of such a nature—such as a stiff clay soil—that it will be a very expensive operation to improve them by drainage or trenching. In fact, when a valuer takes into view the capabilities of an estate, he must at the same time consider the expense of developing them, as, generally speaking, "capabilities mean money."

SECTION 2.—*Climate as affecting the Value of an Estate.*

In the first section of this chapter I have stated that the climate of the district must be taken into consideration in valuing a landed estate. Intelligent farmers always consider the climate when they are judging of a farm. When I treat of climate, I mean that of a limited district, or what may be termed local climate. The climate of an estate is much influenced by the nature of the property itself—whether it may be level or hilly, or whether the land is dry or otherwise, or if there should be any considerable extent of swampy portions comprised within its limits. Properties situated near to the sea-coast have generally a more equal temperature and milder climate; and in Great Britain the climate of the west coast is usually milder than that of the east. Generally speaking, estates situated near to the sea-coast experience a more genial winter and a less sultry summer than those at a distance from it. In fact, the difference between the average degree of cold in the winter, and the average degree of heat in the summer, on sea-coast estates, is much less than that of estates situated inland.

Where there is a large extent of flat country without anything to check the force of the winds and storms, these are allowed to sweep over its whole breadth, cooling its surface, and often doing damage to standing crops. Hills and high-lying tracts of country generally receive a heavier rainfall than low-lying and flat districts;

and the proximity of masses of woods and plantations has also the effect of attracting rain-clouds.

Some kinds of plants require more heat than others to bring them to perfection, as, for instance, wheat will not ripen in many districts of this country.

Drainage improves the climate very much; it opens out the soil and subsoil, and allows the air to penetrate into them, and in this way warms the soil, and by the soil being made dry, the drainage admits of the soil retaining the heat which enters it. When a soil is full of water, a course of evaporation takes place, and this cools the climate and makes it unhealthy. This is instanced in the case of swampy lands. Local climate may indeed be taken by the altitude and by the distance from the equator, and by the general characteristics of the locality; and thus latitude and elevation form the chief features of local climate, which is also much influenced by the extent of the mists, the dryness of the soil, and the prevalence of particular winds. Of course an estate situated on a high-lying district has a greater chance of having an inferior climate to one situated on a low level; and yet much depends upon local circumstances—such as shelter from prevailing winds, and its position as to hills or mountains.

If an estate is situated in a long narrow valley, it is apt to be affected by strong winds, as, in such a position, the winds, from being confined, blow with greater force than they do in unconfined situations. Again, an estate may be situated in a flat part of the country, and yet that portion may be elevated—as, for instance, many of our high-lying lands—and flat on the surface, or what may be termed table-land. In such positions the temperature is generally lower than on level land at a less elevation.

All these circumstances produce many different effects in the local climate of this country, especially as it is a narrow island. They all tend to have a beneficial or a prejudicial effect on the produce of the farms, as the case may be.

For the purpose of studying the climate of an estate or a district of country, it will be found very useful to take meteorological observations. Instruments are now made for the purpose of finding the rainfall and the force of the wind; and along with these should be combined observations of the thermometer, barometer, and the direction of the wind, and any remarks thought necessary. If these were carried out every day for some years, the results would be beneficial.

On the subject of the effects of climate on a farm, Mr Stephens makes the following remarks in the 'Book of the Farm,' vol. ii. paragraph 5262:—

On looking at a farm, it is your duty to apply the principles adduced above, as regards climate, to its particular circumstances—a mode of judging which is too often neglected by those who value farms, and is the cause of much discontent to the tenant, after he has discovered the character of its climate by dear-bought experience. Let us run over the particulars which require a serious attention on this subject. The *temperature* of the locality has a considerable influence on all crops. The late Professor Playfair assumed that the lowest temperature at which corn will vegetate is 40°, and that corn will not ripen below a temperature of 48°. He proposed to date the vegetating season from 20th March to the 20th October, and considered 56° as the mean temperature of a good vegetating season. It may therefore be assumed that, if the mean temperature of a place, between March and October, is below 56°, it is not likely to bear good crops. The *altitude* of a place affects its temperature materially. We have seen that an altitude of 590½ feet makes a difference of 1° of mean temperature—making the effect of elevation the same as an increase of latitude. This is a point which is very liable to be overlooked in the interior of the country, where an elevation is insensibly gained much beyond belief. The country may appear pleasant, and everything indicative of a good climate, but, on inquiry, it may be found to be 600 or 800 feet above the level of the sea—an elevation in which wheat will not ripen, and at which even barley will be a precarious crop, in many seasons. At such an elevation it is not improbable that one or two crops may be lost in the course of a lease of nineteen years. In such situations, the *daily* range of the temperature is great, descending low at night, after having indicated a high degree during the day; and every farmer knows that a low temperature during the night has a most injurious effect upon the crops: for warm nights, in effect, double the number of warm days, and a continued existence of heat saves plants from the injury arising from checked growth by cold. In travelling at night in England in summer, there is no circumstance so striking to a Scotsman, as to find the air as warm as it usually is in the daytime in his own country. Hence the harvests in England are always much earlier than in Scotland; and such a superiority in climate will more than counterbalance superior skill. The distribution of *rain* in the vegetating season—it falling frequently being less favourable to vegetation, than in greater quantities at longer intervals—is deserving of inquiry; also, whether the locality is affected by *vapour*, thereby experiencing more cloudy than clear days. The lowness or highness of the *dew-point* has a material effect upon crops. The relation between local climate and the growth and productiveness of the different crops, you thus see, is deserving of your utmost attention. What effect it has upon the money-rent of land it is not easy to determine; but that land so situate is of less value than that which is not affected by such local influences, cannot admit of doubt.

SECTION 3.—*Judging of Soils.*

In the valuation of an estate or farm, one of the most important points to be noticed is the quality of the soil. The best season of the year to look over and value landed property is during the months of March and April, when the soil is being turned up and when the seed is sown; or immediately after harvest, as then the crops have been removed and the soil can be seen. At other times the crops prevent this; and further on in winter the land may be wet, and not in such a state as will show its true character. But, in walking over an estate, the surface should not only be examined, but the subsoil also, and this must be got at by digging to it; therefore a valuer should have an assistant with him, who should carry a spade for use when required. Generally speaking, the subsoil will be found very different from the upper soil, although sometimes this is not the case.

On nearly all landed estates many different kinds of soil will be found. In low-lying valleys the soil is generally rich, having been deposited there by floods from time to time; in upland districts, again, or midway between the lower valleys and the hills, the soils are generally either light loams, sandy soils, or clays; and in the upper parts of the country the soils met with are a kind of sandy peat. I shall make a few remarks on each of the kinds of soil which are usually met with in this country.

Clay Soils.—Clay enters into the composition of many of our soils in a greater or less degree, but what we term a clay soil is one which contains not less than fifty per cent of clay. A soil of this description, if the subsoil is porous, will be found a good soil for cropping by being properly stirred up. If the subsoil is of the same nature, there will be more difficulty in procuring good crops from it. It could, of course, be much improved by drainage; and on being thoroughly drained, and made rich with manure, it will also yield fair crops, although at a greater expense than the first kind. All clay soils are much colder than other soils, from the heat of the sun being prevented from penetrating into them. Dry weather is very favourable to the working of all clay soils; and if they are thoroughly drained, they can be worked more advantageously. If this is not done, they will lie full of water all winter, and in the summer season they become baked and cracked from the heat. They all require more labour and power to work them than any other kind of soil. The great point is to get them as free as possible from water, and then they can be worked to advantage. The following is the composition of a clay soil as stated by Donaldson:—

Silica,	0.35
Alumina,	32.05
Lime,	0.35
Oxide of iron,	0.45
Sulphuric acid,	19.35
Water,	47.00

Calcareous Soils.—These soils contain a large amount of lime, and are found on the chalk and limestone formations. Professor Johnston states that in 1000 lb. of a calcareous soil there are 56 lb. of lime, and that barren soils only contain 4 lb. of lime. Such soils produce crops late in the season, and, as a rule, they do not rent high. Although a good deal depends upon their position as to climate, they are generally warm soils, and in many favourable situations they produce early crops and rent well.

Sandy Soils.—These are made up of the small rough particles of stones which have gradually been reduced to that state by the agency of the atmosphere, or by the action of water at some remote period. We often meet with sandy soils in different forms, where they are mixed up with other matters, such as peat, gravel, loam, &c. Pure sandy soils are not valuable as crop-producers, but when mixed with peat, loam, or clay, they become valuable. Sand is a great retainer of heat, and when mixed with other soils, thus becomes beneficial in the production of crops early in the season. They are easily worked at almost any season of the year. They are, however, hungry soils, and require liberal and constant manuring; and without this, great crops need not be expected from them. In clay soils, from the large proportion of water which they contain, manure will lie a long time before it decomposes and becomes useful to the plants growing on them; but in the case of sandy soils, manure does not lie long, as, from the want of moisture, it decomposes very quickly, and hence the necessity of feeding such soils liberally. But it is not a good system to apply a very large quantity of manure to them at once, as a large portion of it would either sink into the soil beyond the reach of the roots of the plants, or escape in the form of gases into the air, before the plants could have time to take it all up; therefore such soils should be manured frequently, and not too much at once. After a few years' cropping, such soils are much improved by trenching. They bear good crops of turnips, barley, and oats; and when laid down in grasses they give a sweet herbage.

Loamy Soils.—Good loam soils are composed of decayed animal and vegetable substances, and therefore are rich in this respect. They are generally dry, and do not require any great extent of draining. The greater the depth of such soils, the greater is their value; and the thinner they are, they become of less value. Three kinds of loam are usually found—namely, a black loam, clay loam, and a light loam. The black loam contains the greatest amount of animal and vegetable matter, and is the most fertile; the clay loam contains a proportion of clay; the light loam contains a proportion of sand. All are good bearers of the most of our cereals, provided the climate is suitable. A good light loam is the most useful soil we can have for general purposes.

Peat Soil.—This in Scotland is also called moss-land. It is formed from decayed vegetable matters. In the north of Scotland I have had peat dug to a depth of twenty feet, which, from the surface to the bottom, was evidently composed of decayed ferns, grasses, reeds, and other smaller plants, while amongst these I found numbers of decayed oak and birch trees—the oak often in a good state of preservation. These soils are found in level parts of the country and in hollows; and a thin sandy peat is also found on all our heaths and moorlands. Those lying in level parts are often very soft, and not sufficiently decayed to be fit for agricultural purposes; but they can be much improved by being drained, and thus become useful for agricultural purposes. They are also much improved by the application of lime; and if gravel or sand can be got to apply as a topdressing, peat soils are much improved by the admixture.

The thin peat which is found on our higher moorlands is a formation of decayed rock and heath. This is seen from the peaty matter which it partly consists of, and the many small sparkling particles of silica and other portions of rock which are mixed amongst it. Such a soil is generally very much impregnated with oxide of iron, and this must be got rid of before it can be made useful for agricultural purposes. Peat or moss can be very advantageously removed and mixed up with a sandy or gravelly soil. This was done with much benefit by the present Marquess of Tweeddale at Yester, where many thousand tons of moss were removed and spread over other thin soils on the Yester estate. In reference to the use of peat for mixing with other soils, Professor Johnston states:—"This peat ought to supply an inexhaustible store of inorganic matter for the amelioration of the adjacent soils. We know that by draining off the sour and unwholesome water, and afterwards applying lime and clay, the surface of peat-bogs may be gradually converted into rich corn-bearing lands. It must therefore be possible to convert peat itself, by a similar process, into a compost fitted to improve the condition of other soils."

Granite Soils.—These are very thin, sandy, and unfruitful soils, being composed of the debris of granite rock. We can easily form an idea of what granite soil is when we examine Professor Johnston's statement of the chemical composition of felspar, one of the principal constituents of granite—thus:—

Silica,	65	Lime,	a trace.
Alumina,	18	Magnesia,	do.
Potash and soda,	17	Oxide of iron,	do.
	——	Oxide of manganese,	do.
	100		

Subsoils.—I have hitherto only taken notice of the surface-soils. It is, however, an important point to examine the subsoils of all lands. If the subsoil is dry, the upper soil will also be dry—at least this tends to dry it very much. If the subsoil is stiff and wet, then the surface is also certain to contain too much moisture. The surface-soil can never be thoroughly improved unless the subsoil is either naturally dry or artificially made so; and subsoils also frequently contain inorganic matters hurtful to plants, which must be removed before plants will thrive.

To find the nature of a soil, Professor Johnston tells us that, "if an ounce of soil be intimately mixed with a pint of water till it is perfectly softened and diffused through it, and if, after shaking, the heavy parts be allowed to settle for a few minutes, the sand will subside, while the clay—which is in finer particles, and is less heavy—will still remain floating. If the water and fine floating clay be now poured into another vessel, and be allowed to stand till the water has become clear, the sandy part of the soil will be found on the bottom of the first vessel, and the clayey part on that of the second, and they may be dried and weighed separately. If one hundred grains of dry soil, not peaty or unusually rich in vegetable matter, leave no more than ten of clay when treated in this manner, it is called a sandy soil; if from ten to forty, a sandy loam; if from forty to seventy, a loamy soil; if from seventy to eighty-five, a clay loam; from eighty-five to ninety-five, a strong clay soil; and when no sand is separated at all by this process, it is a pure agricultural clay."

All the different kinds of soils on an estate should be examined; every field should be walked over and dug into. No value can be put upon any soil unless from actual inspection of it, and, if thought necessary, from analysis. Some soils may look dirty, and not at all pleasant to the eye, when they have been farmed by poor farmers, but this need not in any way deteriorate from the intrinsic value of such soils.

The value of each soil cannot properly be found in the same way. Some kinds may be able to produce all our grain crops, while others may be suitable for barley and turnips, and may not grow wheat to perfection. Other soils, again, are suitable only for grazing purposes.

The best way to ascertain the market value of any soil is to estimate the total amount of grain it can produce per acre in one year, and take that at so much per quarter, according to the average price of such grain for a few of the preceding years, and then deduct from that the expenses necessary in cultivation, seed, manure, taxes, &c., and allow a fair percentage on the capital required to be laid out by a tenant in stocking his farm per acre. The result of this system would of course vary a good deal, but the experience of the valuator must enable him to put a fixed price upon it. In valuing grass-land, it should be calculated what it can support per acre in the year, taking this at a fair market value, deducting the expenses of rearing the stock, attendance on them, and interest on the capital expended,—and the result should be the rental of the land. On this subject Mr Stephens states, in the 'Book of the Farm:'—"Experience has taught practical men to come to a conclusion at once, as to the capability of every soil, *in the condition they view it;* and it is this criterion of the maturity of their judgment that stamps an intrinsic value on their advice. They estimate the acreable amount of grain which the land will produce, and the quantity of stock it will support, in the condition they see it; and, calculating these at the current prices, the total value of the produce is ascertained, and the rent determined which the farm can afford to pay. Although they estimate the rent of the land in its existing condition, they judge, besides, whether the land is capable of producing more by better farming, and give the rent a latitude in the offer to be made. Upon this last uncertain element, however, many rents have been offered beyond the intrinsic value of the land."

The condition of the fences should also be examined, to ascertain whether they are permanent or not.

The farmhouses, cottages, and buildings also require inspection in walking over farms, to ascertain their condition and accommodation.

As a general rule, in this country at the present time freehold land can be bought at from thirty to thirty-four years' purchase—paying interest on the purchase-money at from three to four per cent.

Freehold houses can be bought at from eighteen to twenty-two years' purchase—paying interest on the purchase-money at from five to eight per cent.

The value of leasehold property depends upon the number of years of the lease which remain unexpired, and also upon the description of the property. Generally speaking, leasehold property can be bought for from ten to fifteen years' purchase, giving a percentage of from six to ten per cent, according to the circumstances which I have stated.

In the valuation of estates, sometimes old maps and statements have to be consulted, where the acreage is given under some other standard than the statute acre; therefore it is necessary to know what the different acres in this country are, although now the statute or imperial acre is the only legal measure, and that which is generally used. The following is a statement of the different acres:—

	Square Yards.
Imperial acre, ...	4840
Scotch acre, ...	6104.1281
Irish acre, ...	7840

	Square Yards.
Westmoreland acre,	6,760
Inverness acre,	6,150.4
Wiltshire acre,	3,630
Devonshire acre,	4,000
Wales acre,	3,240
Cornish acre,	5,760
Cheshire acre,	10,240

SECTION 4.—*The Valuation of Land taken by a Railway Company.*

Many people suppose that land taken by a railway company should be valued in the same manner as other lands. This depends very much upon circumstances. Where a railway passes through a well-cultivated and fertile farm, it cuts up the fields very much, thereby causing it to be more expensive to cultivate afterwards, as the increase in the labour of a farm so cut up is often considerable. No doubt the farm may gain in many respects by having a line of rail running through it, but still the disadvantages stated often counterbalance the advantages. The proprietor or the owner is not justified in paying twice over for any advantage which a railway will confer upon him, as whatever goods he may receive or send away to market by the railway have still to be paid for. I am therefore of opinion that a landed proprietor should receive something more for land taken by a railway company than if it had been sold for agricultural purposes alone, and this more especially in well-cultivated districts.

The usual practice in the transfer of land to the hands of a railway company, is for the company to appoint one valuator and the proprietor to appoint another, with an umpire to decide between them should they not agree ; or, in some cases, the question has been referred to one man mutually chosen. The first step is to ascertain the agricultural value of the land, without taking into consideration the question of any damage being done by severance; and, having done so, then ascertain the value to be put on per acre for the damages done by the severance to the property by the line. The severance-damages must include the inconvenience of level crossings on the line, and the deterioration of any other kind of property on the estate caused by the railway. The tenants' rights should also be looked to, and the damages done to their farms, as the railway might probably take up land which was prepared for cropping.

There are many different points to attend to in the valuation of land when about to be taken by a railway company. There are always a great many disputed questions to examine and arrange; and it requires all the forethought and energy of a land-valuer to keep all parties concerned right, especially as many of the severance-valuations, and perhaps damages to be considered for injured amenity to a proprietor's mansion, are apt to be too slightly valued by the one side, and a too fanciful price put upon them by the other. The great thing is to have a fair and reasonable value put upon all these things; and no attention should be paid to either very low estimates on the part of the railway company, or an extravagant valuation put upon them by the proprietor.

SECTION 5.—*The Valuation of Woods and Plantations.*

In the valuation of a landed estate, it is very important to have the woods and plantations and park timber valued properly. This is often done very injudiciously. I shall describe the way in which I have been in the custom of valuing standing crops of timber for a transfer. I take all the ages of trees in three divisions — the first being young plantations which have only been a few years planted, and which have not been thinned; the second division is that class of trees which are of the ages above the first class, and under full-grown timber-trees; and the last division is that of trees arrived at the size of full-grown timber.

In valuing the first class of trees, I estimate, on the one hand, the probable expense of the first formation of the plantation—this will include fencing, draining, cost of plants, and planting them—and to this I add the value per acre that the land would have realised, if let for farming purposes for the number of years it had been under the crop of trees; and to this sum I add compound interest for the time, at so much per cent, according as I find the crop.

In valuing a crop of trees above those already described, and under full-grown trees, I do it in the following manner:—

Presuming that we have a crop of trees to value, and which are in this year (1868) forty-six years old, and we will suppose, from the appearance of the trees, that they will become matured in eighteen years hence, or in 1886, then the statement would be thus:—

Probable value of thinnings that will be removed from one acre of this crop in the eighteen years from 1868 to 1886,	£12	0	0
Probable value of the crop on one acre in 1886, when matured, ...	70	0	0
Carry forward,	£82	0	0

	£	s.	d.
Brought forward,	£82	0	0
Deduct from this, probable expense of management, and that of preparing it in a fit state for agricultural purposes after the removal of the crop—both, per acre, .	17	0	0
	£65	0	0
From this amount deduct compound interest on it at three per cent for eighteen years, ...	43	19	9
Present transferable value of crop per acre, ...	£21	0	3
Add thirty-two years' rent of the land occupied, at 15s. per acre, ...	24	0	0
Present transferable value of land and crop per acre, .	£45	0	3

The last sum of £45, 0s. 3d. must of course be multiplied by the total number of acres in the plantation to arrive at its total value.

In valuing the third class of timber-trees which I have stated—namely, that of full-grown and matured timber-trees—it is simply to take their value at the time according to the number of cubic feet of timber there may be in each tree. It very often occurs that large trees have to be valued before they are cut down. There are two methods of doing this. The first is by simply judging of the contents of each tree by the eye; and the second is to have each tree measured by a long pole to get the length of the stem, and by a girthing-tape to get the side of the square. The first-mentioned method of valuing trees is, in my opinion, the best, when a valuer has had experience in it; and if a man is in the habit of valuing trees in this way, he can find the contents of each tree very correctly. To get trained to this kind of valuing, the best plan is to judge of the contents of some trees by the eye before they are cut down, and afterwards, when they are felled, have them measured in the usual way with the tape; and by repeatedly doing this, one can very soon come to judge correctly by the eye.

The second method of valuing trees—by means of a pole and girthing-tape—is a very slow expensive way, and is not more correct than the first—namely, by the eye of an experienced person. I have known cases where timber has been valued three times over—first, by an experienced person at sight; secondly, by three or four men with ladders, poles, and tapes; and, lastly, by the tape-line after the trees were cut. In the first instance, the one person did the work in a fourth of the time that it took the three or four men to do it; and after the trees had been measured when cut, it was found that the measurement by the eye was the most correct. It is almost impossible to measure trees correctly when they have large branches growing upon them which come in the way of the tape-line when measuring; and consequently, the length given is generally more than is strictly correct, from the turn which the branches cause the line to take.

Timber-merchants are often in the habit of valuing timber by the eye; in fact, they value not only all standing timber in this way, but also often when it is lying cut; and they generally come very near the actual measurement.

In valuing timber in any part of the country, the valuator should take into consideration the following points:—

1st, The size of the trees and the quality of the timber, and its adaptation to a given purpose. Some sizes of trees are more valuable than others; and of course the better the quality of the timber, the more valuable it is. When suited for particular purposes, too, its value is also increased.

2d, The means of transit from the plantations to the public roads. Sometimes the roads are good between the site of the timber and the highways, or the timber may be situated close to good public roads; and consequently is, in either case, much more valuable than when otherwise situated.

3d, The distance and condition of the roads between the site of the woods and the nearest railway station or seaport. The farther away the timber is from either of these, the less valuable it becomes.

Section 6.—*The Valuation of Quarries.*

The minerals commonly found on landed estates are chiefly ironstone, coal, copper, tin, lead, limestone, slate, and building stone. I intend to draw attention in this section to those which are commonly used for building purposes—and these are sandstone, limestone, granite, and slate. In valuing quarries of either of the minerals stated, the valuator should first ascertain the expense of bringing them to the surface. Some may be got at by the removal of the surface-soil to a greater or less depth, which is termed "baring;" others may have to be worked out by tunnelling—that is, working in on a level from the face of a bank or rock; and others may have to be taken out by means of a pit or shaft. The valuator should therefore fully consider all the different means and expense of bringing the material to the market, and the price of it in the market.

Some quarries are much deteriorated in value by being subject to be flooded with water. This will therefore have to be taken into consideration by the valuer; and he must also judge, from the state of the seam of the rock, whether there is likely to be a good supply for some years; and he must estimate, accordingly, the annual rent that should be got for the quarry, and its full value for a transfer.

I believe that there are good seams of rock on many landed estates which are either not worked at all, or are not fully developed. A valuator should therefore not only take into consideration all the different departments of an estate which are paying an annual rent, but he should also endeavour, by close observation, to discover where it may be possible to find out new sources of profit. There are many quarries of different descriptions on several landed estates which give a very handsome revenue, and this is the case more particularly in Scotland. Granite is becoming more used for building purposes than it was some years ago. The demand for good granite for building houses in large towns in Scotland is now much in request; and there is also a large demand for it for paving the streets of towns, not only in Scotland, but also in England. The seams of rock on an estate should therefore be examined by a valuator, and a judgment of the value of the rock should be come at from its position for transit, the quality of the stone, and the amount likely to be got from the property, and also by the saleable value of the stone in the market.

Having fixed a yearly rental on a quarry, its transferable value may be taken at from twelve to fourteen years' purchase.

SECTION 7.—*The Valuation of Shootings and Fishings.*

In the valuation of shootings there are three classes, which must be taken separately, these are—

Deer-Forests;
Grouse or Hill Shooting; and
Low-Country Shooting.

The first description of game-preserves—that of deer-forests—is sometimes formed at considerable expense; and from the amount expended on them, they ought to pay, and indeed do in many instances pay, a good profit. They, at all events, usually give satisfactory returns to the holders of them, either in the form of money or pleasure. If part of an estate is devoted to a deer-forest alone, there being neither cattle nor sheep grazing where the deer pasture, then, taking into consideration any other expenses of forming the forest, and presuming that there is a good stock of deer in the forest, such a forest ought to give a rental equal to twice the amount the extent of the land would pay if devoted to sheep-grazing purposes. In some instances it is a custom to value a deer-forest by the number of deer which are allowed to be shot upon it in the season. On many estates in the north of Scotland it is the rule to restrict the tenant of a deer-forest to so many head in the season. Thus a tenant, having a large deer-forest, for which he may probably pay £1000 rent, will be restricted to shoot fifty head of deer in the season, the tenant also paying all the keepers and other expenses in connection with the management of the forest. Having fixed the annual rent of a deer-forest, its transferable value may be got by taking it at from twenty to twenty-two years' purchase—this is presuming it is a first-class forest. On the other hand, if the forest is not good, it must be taken at so many years' less purchase, according to its quality—probably ranging from fifteen to eighteen years' purchase. Sometimes higher prices will be got for deer-forests, but these are fanciful prices, and I am only now dealing with their commercial value.

With regard to grouse or hill shooting, if there has been a fixed rent for a number of years, that rent may probably be taken as the annual value, and its total value found by taking it at fifteen years' purchase—more than this is a fanciful price. Should it be necessary to have the rent readjusted, this may be done by examining the shootings; and if there be found a good stock of birds on the ground, then this may be taken at from 6d. to 8d. per acre of the ground occupied, according to the nature of the shooting. Any items should be deducted which are necessary to keep up that fixed rental.

Again, with regard to low-country shootings—such as where the stock consists of pheasants and partridges—then the stock on the ground must be considered, with facilities for keeping that stock together, such as cover, &c. This kind of shooting varies very much in value according to many local circumstances. The prices usually range from 6d. to 1s. per acre of the land embraced.

The shootings on Scottish Highland estates are at present rising very much in value. There is a growing taste amongst English gentlemen to have Highland shootings, and the competition for them has raised their value considerably. The following cases show the rise in the rate of the shootings that have taken place: Some years ago the Glentanner forest, on the Marquess of Huntly's Aboyne estate, was let for £80 per annum; it is now let at over £1000. The Glenmuick shootings, on the Invercauld estates, were let for £450; they are now rented at £800. The Benabourd shootings and fishings were let at £700; they now give a rental of £1300. The Glenurquhart shootings were in 1835 let for £100; they now rent for £2000.

In the valuation of fishings on an estate, this of course must be guided by the extent of water on the property. To get at the real value of fishings, it is almost necessary to find out the total weight of fish caught for each year previously; and when this is ascertained, the value of the fish removed must be taken at market prices. This refers more particularly to salmon and salt-water fishings, and not to small trout fishing. The value of salmon and salt-water fishings may therefore be come at by the weight of the fish removed, and partly by the previous rents paid; and having found the full value of the fishings, the amount of the annual burdens should be deducted from that sum, and then the remainder taken at about fifteen years' purchase.

The rents of fishings have also increased very much within the last few years. Eight miles of the river Dee on the Invercauld estates were some years ago let for the sum of £15; the same extent is now rented for £230 per annum.

CHAPTER XXVII.

REPORTING ON LANDED ESTATES.

ANY one employed to report on the general condition of a landed estate should be able to give good and sound advice in reference to the soil, buildings, drainage, fencing, and culture of the farms, as also the capabilities of the tenants; with suggestions for the improvement, if necessary, of the woods and plantations, mines, &c., and, in fact, on the general condition of the estate, with full suggestions for improving it. Every field, house, cottage-garden, and plantation should be gone through and thoroughly examined by the reporter, and notes taken of their character and condition; and having done so, he will then be able to complete his report at home. The following are the general headings under which a landed estate should be examined and reported upon, with the subdivisions under each:—

I. A general description of the property.
   1. The aspect, altitude, and exposure.
   2. The climate of the district.
   3. Its geological formation.
   4. Its general capabilities.

II. The farms on the estate.
   1. A tabular statement showing the extent, character, culture, and rent of each farm.
   2. The nature, character, and condition of the soil and subsoil on each farm, with suggestions for the improvement of the soil.
   3. The character and condition of the farm-buildings, and their suitability for the extent and character of each farm, with suggestions for the improvement of the buildings.
   4. The capabilities and qualifications of the tenants on the estate, with hints for improving their condition.

III. Suggestions in regard to draining on the property.

IV. Suggestions in regard to the roads on the estate.

V. Suggestions in regard to the fences on the estate.

VI. The woods and plantations on the estate.

1. A tabular statement giving a description of the character of the woods, with their extent.
2. The condition of each plantation, with recommendations in regard to improving each.
3. Recommendations in regard to the formation of any new plantations on the estate.
4. The system of management which should be adopted in order to carry out the improvements suggested, and in the general management of the woods.
5. The income which, under good management, may be annually derived from the woodlands on the estate.

VII. Recommendations in regard to the general management of the estate.

VIII. The improvement of the labouring classes on the property.

IX. The condition of the labourers' cottages on the property, with recommendations for their improvement.

These are some of the principal headings under which an estate should be reported on. Some of them might require sub-headings, according as circumstances might require it; and if there were a home-farm on the property, then it should have a main heading for itself, with sub-headings such as this:—

Home-Farm.

1. Present system of cultivation, with suggestions for improving it.
2. Deep stirring of the soil.
3. The improvement of the growth of root-crops.
4. The application of manures, both farmyard and artificial.
5. The suitability of steam-cultivation for the farm.
6. The kinds of grain crops and other seeds best adapted to the soil of the farm.
7. The general improvement of the home-farm.

For the purpose of giving a full and comprehensive report on the property, every particular should be taken notice of, and any suggestions made which may be useful for its improvement. Under the first head, in giving a description of the estate generally, and in taking into consideration the aspect, altitude, exposure, and climate, it should be carefully considered whether the climate of the district might not be improved. It is not, perhaps, in the power of man to change the climate of any district of country, but it certainly is in his power to modify it to some extent. An estate, for instance, may be much confined with too large an extent of plantations on it, and too much crowded with hedgerow-timber; and, as we often see in many parts of England, the fields may be too small, and shut in with high uncultivated hedges. All these things—both too large a breadth of wood, too many hedgerow-trees, and high uncut hedges—tend to prevent a free circulation of air throughout the property, keeping it damp, and tending to make the district unhealthy for both man and animals. Again, drainage is a great means of improving the climate of an estate, and this should be pointed out in reporting on a property which may require drainage.

On the other hand, if the estate under consideration be a high-lying and exposed one, it should be considered what steps should be taken to lessen the severity of the storms and blasts which are likely to prevail, and what means should be taken for producing a more genial climate over the property. In such cases a judicious outline of plantations, formed on well-chosen sites, will tend very much to improve not only the general character and appearance of the property, but also the local climate; and they should be formed in such positions and situations as will give the greatest possible shelter from the prevailing winds and storms of the district.

When the farms come under consideration, each farm should be treated of by itself, and notice taken of the rotation of cropping, the present condition of the soil, and general cultivation, with suggestions for improving each, and the best means of bringing each farm into the highest possible state of fertility.

The farm-buildings should be carefully looked over, and suggestions made in regard to the improvement of those on each farm, with an estimate of cost of extending or otherwise improving each place.

In inspecting and reporting on the woods and plantations on the property, the present condition of the crops in each plantation should be stated, in so far as the crop may stand thick on the ground or the contrary; the condition of the soil as regards drainage; the capability of the crop to improve; and recommendations for the improvement of each crop separately.

The whole estate should be gone over, and notice taken of its general capabilities, and any recommendations made which may be the means of increasing its productiveness in every possible way, so as to increase its annual value, and at the same time improve the condition of all in connection with it.

Statements should also be made in the report as to the best means of improving and increasing the productiveness of the estate, and what amount of money it will take to improve it as recommended. In some cases it might be well if the proprietor were to inform the reporter what amount of capital he purposes expending on the estate, and then the reporter would require to consider what improvements were most wanted, and how far the capital would carry out those improvements. It is in all cases advisable for a reporter to ascertain the views of the proprietor in regard to the improvement of his estate.

Having done so, the reporter should proceed to examine each field on the property, and with the assistance of a labourer dig into the soil and subsoil, so as to ascertain their quality, and if the field requires drainage, to know at what depth the drains should be put; and, if necessary, he should preserve a portion of the soil for analysis. All the fields on a farm having been thoroughly examined, the buildings will next require attention. The reporter having first ascertained the extent of the farm and the kind of husbandry adopted, he must consider whether the existing accommodation is sufficient for the requirements of the farm, and decide whether, if the accommodation is deficient, it can be best improved by altering the internal arrangements of the steading, or by adding new buildings to meet the requirements; and if the existing offices are very much out of order and deficient in accommodation, it might be advisable to have a new set of buildings complete.

The prevailing mode of farming on the property should be taken note of, and remarks made on the system carried out by each tenant, whether good or bad. Any one accustomed to such work, and the general management of landed property, can easily tell — from the general appearance of the farm, the state of the soil, the crops, the fences, roads, the farmer himself, his family and his dwelling-house— whether he is a tenant capable of improvement or not. In fact, notice should be taken of everything on the property—farms, soil, cropping, fences, roads, buildings, tenants, woods and plantations, labourers' cottages, labourers themselves, drainage, game as affecting the tenants — with suggestions which may tend to improve, develop, and increase the general fertility and welfare of the property.

There are many able men who are well qualified to give such a report; but, as a rule, few men are to be found who can give good reports both agriculturally and arboriculturally, as many experienced reporters can give highly-valuable suggestions in regard to agricultural matters, who cannot be relied on for giving advice in regard to the management of the woods and plantations. On the other hand, there are able men who can give full, comprehensive, and valuable advice in regard to the management of woods, who have not sufficient experience to justify them in giving recommendations in regard to farms, &c. There are, however, very competent and able reporters in the country who can give judicious advice on all subjects connected with any landed estate; and therefore, when a proprietor desires such a report, he should be careful to choose a good man to draw it up, or get the advice of two men—one for the agricultural department, and another for the arboricultural department.

CHAPTER XXVIII.

WOODS AND PLANTATIONS.

In treating of this department of estate management, I shall consider it under the following sections :—

1. The importance of plantations on an estate.
2. The general system of managing plantations.
3. The qualifications necessary in a forester.
4. The kinds of trees adapted to different soils and situations.
5. Estate nurseries.
6. Planting, and expense of forming new plantations.
7. The different kinds of hardy deciduous trees, and their uses.
8. The thinning of plantations.
9. The pruning of forest-trees.
10. The disposing of timber.
11. The management and sale of underwood.
12. The transplanting of forest-trees.
13. The manufacture of timber.
14. The protection of young trees from deer, hares, and rabbits.
15. The preservation of timber.
16. The coniferæ.
17. The cultivation of the newer coniferæ in this country.
18. The barking of trees.
19. The maintenance of a stock of game along with the proper management of woods.

Section 1.—*The Importance of Plantations on an Estate.*

Woods and plantations are intimately connected with, and enhance the value of, landed estates to a greater extent than many seem to be aware of. The benefit conferred on agricultural lands by a judicious distribution of plantations may be laid down under three heads—

shelter, amenity, and a general improvement of the climate. Many persons are of opinion that plantations are injurious to agricultural lands, by causing them to be too much confined, and thus preventing the free circulation of air. There can be no doubt that there are extreme cases of this nature, and that too large an extent of woodland on some estates will be injurious to farms; and not only so, but also prejudicial to the health of the inhabitants of the district, and to the health of the animals grazing in the fields. This will be the case more especially in low-lying situations when too much confined by masses of woods.

On the other hand, a great many estates in this country are very much devoid of plantations, and would be vastly increased in productiveness, and consequently in value, by judicious planting. We know large tracts of country with very few plantations over its surface, where winds and storms sweep over it without being checked in any way, doing damage to farm crops, and causing colds and influenza among the live stock.

Not only are plantations a benefit to estates by giving shelter, but they are also the means of improving and equalising the temperature of the climate of the district. In districts devoid of masses of wood, we generally find that in the summer months the land gets dried up and parched from a want of moisture. No doubt, at certain seasons of the year, any land, even in the immediate neighbourhood of plantations, will get parched and dry; but I maintain that this is more likely to be the case where there are no plantations.

In some countries this has been experienced in a great degree. Certain districts of Greece and Palestine were at one time in possession of large masses of forests, and at that time those countries were rich and fertile. These forests have been all cut down or otherwise removed, and the consequence is, a general sterility over the face of the country. This is accounted for by the fact that where there is a district of country without any woods or plantations, as soon as rains fall, they are evaporated before they can sink into the ground and get to the roots of the plants, and in this way the fertile growth of vegetation is prevented. On the other hand, where there are masses of trees, when rains fall, the shade of the trees prevents the sun's rays from drying up the moisture which has fallen in the plantations. The rains thus get time to enter the soil and sink to certain depths, when they reappear again in the form of springs, which again form streams of water, thus keeping vegetation fresh and encouraging general fertility.

Portions of Canada have been entirely cleared of timber, the settlers having cut down the forest before them without leaving any trees, and without any consideration of the consequences. In these districts the want of moisture in the summer season is now being very much felt. Showers of rain are indeed frequent, but from the want of the shade of trees to keep the rays of the sun from drying the surface, the water is evaporated at once without producing any lasting benefit to vegetation or to the soil. In clearing these primeval forests, to be converted into agricultural lands, large masses of them should be left on judiciously-chosen sites, with the view of giving shelter, and also to be the means of retaining moisture in the districts, and generally equalising the climate, as there can be no doubt that the entire clearing of forests is a great evil, and this is more especially the case in hilly districts.

At the present time there is a large tract of country in the immediate neighbourhood of Cape Town which is very much dried up from a want of moisture, and this is attributed to a general want of trees in the district. Dr Brown of Haddington, late Colonial Botanist at Cape Town, called attention to this fact in a report to the Colonial Government in 1863, in which he states :—

I have found everywhere in the course of my tour, in the physical geography of the country, what seems to me to be indications that at a period not very remote this must have been a land well watered everywhere ; and I have also found that within the memory of the present occupants of the land there has been a remarkable change in the aridity both of limited and of extensive districts. I have satisfied myself that this is not a mere fancy, to be classed with the common saying in ancient and modern times, that the former days were better than these. The fact is well attested ; and I can refer to places both in the eastern and the western provinces where the change was observed to follow immediately the destruction of bush, which is only in accordance with what I would have expected.

There is a widespread opinion that forests attract rain. I shall afterwards have occasion to give a different account of the fact upon which this opinion is rested. At present I rest satisfied with stating that what is done by forests on a large scale, is done on a smaller scale by the bush, herbage, and grass of the veldt. If they do not attract rain, they at least retain moisture; and the destruction of them allows that moisture to be carried off.

As I deem it of importance to produce a thorough conviction of this fact, which, it appears, is not generally known, I may be allowed to enter at some length upon the subject.

It is well known that if a wet cloth be exposed in the air, it soon becomes dry; or if a quantity of water be left exposed in a basin, it soon disappears if the air be hot and dry. Even the large reservoirs of water, if not replenished, dry up in the course of time. In all these cases the water passes off in a state of vapour. This vapour is transparent ; it is not like the cloud or mist, which consists of water in minute drops suspended in the air. It is in a state of gas, and is as invisible as the air itself. In accordance with the law of gaseous diffusion, which admits of unlimited diffusion of one gas through another, the atmosphere is permeated with this vapour, which may be found everywhere—on the summit of the highest hills and at the bottom of the deepest mines—alike. It may have been observed that a glass of iced water is immediately covered on the outside with dew-drops of moisture; whence come these? Not through the glass from the water within, but from the atmosphere without—a proof that the moisture was there though unseen.

It may have been observed that the hotter an iron plate may be, the more quickly is any water spilt upon it converted into vapour. The reason is, the more rapidly does it impart the heat necessary to the vaporisation of the fluid. So is it with the soil; the hotter the soil may be, the more rapidly is moisture evaporated.

There is always a difference in the temperature of soil exposed to the direct rays of the sun and the temperature of soil in the shade, whether that shade be afforded by roof, rock, tree, or bush, or even by the grass.

Thus can we in part account for what has been seen to follow the destruction of bush, whether it be for a supply of fuel, or in connection with the burning of the veldt as a means of securing pasturage, desired for flocks or herds. The principle involved is equally applicable to the destruction of trees.

Such are the opinions of Dr Brown, and those who may have given some attention to the subject will agree with him. It is an important fact that the denudation of a country has been followed by an increase of heat and drought from the destruction of forests of trees and bush; and there can be no doubt that if portions of those countries which I refer to were judiciously clothed with plantations, consisting of kinds of trees suited to the soil and climate, they would ere long be very much improved, in respect to a better supply of water and the fertility of vegetation.

We have ample proof from geology that Syria and Persia were at one time covered with masses of wood, and that there were streams flowing throughout these countries, which are now completely dried up. Portions of these countries were once thickly populated, but now, from the want of water, the inhabitants are much fewer in number.

In Jamaica the clearing of forests has been followed by a diminution of water.

The great missionary Moffat tells us, in reference to his settlement at Latakoo, that the natives used to speak of the floods of ancient times, and the incessant showers which clothed the very rocks with verdure, and the extensive forests, consisting of giant trees, which once studded the brows of the hills. They spoke with rapture of the large rivers, with their impassable torrents, in which the hippopotami amused themselves, while herds of other animals walked to their necks in luxuriant grass, filling their *makukas* (milk-sacks) with milk, making all their hearts to sing with joy. The remains of these large forests were found in numbers of large stumps of the *Acacia giraffe*; but at the time of Mr Moffat's settlement there was hardly one of the kind to be found, while the hills and ancient beds of rivers plainly told that they were covered at a former period with a more luxuriant herbage than now clothes them, the whole country north of the Orange river, lying east of the Kalagaie desert, looking like a worn-out field or garden. Mr Moffat further states that the inhabitants built their houses of timber, and their fences of branches and shrubs, and that they cut the trees down without any regard to economy. When they fix on a site for a town, they choose one near to a thicket of trees or bushes, and very soon all is levelled; and that when they clear the ground for cultivation, they burn the trees down by keeping a fire at their roots. Thus large forests which once existed show no remains excepting perhaps a few old stumps. The natives also burn the dry grass, which often destroys large masses of forest; and to this system, Mr Moffat states, "may be attributed the long succession of dry seasons, and to the same cause may be traced the diminution of fountains, and the entire failure of some which formerly afforded a copious supply, such as Griqua Town, Campbell, and a great number of others which might be mentioned."

It has been remarked that since the accidental destruction of whole plains of the *Olea similes* (wild olive) by fire, near Griqua Town, as well as the diminishing of large shrubs on the neighbouring heights, a gradual decrease of rain has followed in that region.

These facts show us that man may ruin a climate considerably; and, on the other hand, there can be no doubt that countries which are now denuded of timber, and where there is a great want of moisture to increase vegetation and give a plentiful supply of water, may be very much improved in this respect by judicious planting. There is, as I have already stated, such a thing as a country being overstocked with timber, where there is a want of a free circulation of air, and the consequence is injurious to the health of both man and animals.

But what I want to point out more particularly is, that there are large tracts of country in many parts of Great Britain which are so devoid of plantations that the winter storms sweep across the country with full force; and in the summer season the land is parched and dried up from want of moisture, and is freely exposed to the fierce rays of the sun. If well laid-out plantations were formed in such districts, choosing those sites likely to give the most shelter, the local climate would be made more genial, by the plantations retaining the moisture in the summer season, and checking the cold winds in the winter.

There has generally been found larger rainfalls where there are large masses of plantations than where such do not exist. It is generally thought that woods have the power of attracting rain-clouds; however, there are other opinions in regard to this. Dr Brown is of opinion that, from the shade given by the trees, the temperature of the earth under them, and also of the atmosphere, is lower; and indeed is lower amidst abundant vegetation of any kind, than in barren and sterile districts. In consequence of this, if a hot wind blow over a district in which there are trees, it will be cooled down; and therefore its power of holding water in a state of vapour is diminished, in a geometrical ratio, with every fall of temperature, and the consequence is a deposit of moisture in the form of dew, mist, or rain.

Again, Dr Brown states * that whatever moisture has been taken by the tree from the soil is all, excepting what is required in the structure of the plant, returned to the atmosphere by the stomates on the back of the leaf. This operation is effected by different kinds of trees in various degrees, and in this way the air around trees is saturated in a higher degree with moisture than the air on an open treeless country.

One thing is certain, that where rains fall, that which lies in the soil under trees is retained there for a length of time, as the shade of the trees prevents evaporation; while, on the other hand, that which is deposited on an arid plain is very soon evaporated by the heat of the sun, and also by the heat of the soil itself.

It must therefore be of great importance to those who are owners of large estates, partly consisting of tracts of country without any plantations, to know that they can improve their properties very much, with benefit to themselves and to the occupiers of the land, by having breadths of plantations formed on sites suitable for the growth of timber. These plantations would not only be the means of retaining the moisture in dry seasons, but would also give a large amount of shelter to the farm-lands, and increase the value of the estates to a considerable degree. Many intelligent farmers know the benefit derived from the presence of plantations, and will always give a higher rent for land judiciously sheltered by plantations than otherwise. Estates with a proper outline of plantations have a rich warm look about them, and this has a tendency to influence both purchasers of landed property and tenants more than may at first be supposed.

Experience has shown that estates studded with well-formed plantations, extended to a certain point, but not more, have increased in annual value very much. I know estates in the north of Scotland which at one time were comparatively tracts of waste land, and thought at the time unfit for anything but grazing a few head of sheep and moor-birds. These tracts were laid out with plantations, by planting the greater part of the hilly portions and the most exposed parts. The lands left unplanted have gradually increased in value from the shelter given by the plantations; and estates which sixty years ago were worth from 1s. to 2s. per acre per annum on the average, are now let to

* Report of Colonial Botanist, 1863—Cape of Good Hope.

substantial tenants at rents varying from 10s. to 25s. per acre. Besides the increase in value of the agricultural lands, there is also a large amount of valuable timber on them, which produces a handsome yearly income from the thinnings taken from the plantations. With good treatment, there is no reason why all high-lying exposed estates should not be so improved.

Where the proportion of wood on an estate is too large, it confines the fields and prevents the crops from being ripened and dried in due season. I am aware that many farmers object to plantations on their farms, but this is not so much from any supposed injury done by the plantations themselves, as it is from the amount of game which is usually reared in connection with them. The loss, in some seasons, of sheep, and more especially lambs, in exposed districts of the country, is sometimes very great. It is well known that deaths of stock are much fewer where the grazings are properly sheltered by plantations. Even cattle in low-lying districts always take to the shelter of plantations in a storm; and cattle so situated improve much faster than where they are exposed to the full force of the wind. It is also well known that cattle require more food in a cold exposed situation than in a warm one. Many intelligent farmers have remarked to me that shelter and warmth were a good part of the feeding of their stock.

Grasses grow much quicker and in greater abundance in sheltered than in unsheltered situations.

Bad soils are improved by planting trees on them, by the annual fall of leaves, which decompose and form a rich soil.

The value of landed estates is very much enhanced prospectively by having an extent of well-arranged and healthy plantations. Such estates, when brought into the market, bring an extra price, not only for the saleable value of the timber at the time, but also for what may be expected from the timber when it has arrived at perfection. Presuming the growing timber on an estate to be worth at the time of the sale, say, £5000, I could state instances where £10,000 would have been given for the same, taking its prospective value into account. The far-seeing purchaser of an estate can look forward to the increase in value arising from the growth of trees until they come to maturity.

I scarcely know of any better way of laying out money to good interest than by the formation of plantations on high-lying and exposed districts of the country. It is capital laid out at compound interest, and on the very best security.

SECTION 2.—*The general System of Managing Plantations.*

The general system of managing plantations, from their first formation to the time they come to maturity, is, at the very least, antiquated and defective. There are many estates in this country where the woodlands are properly attended to and managed as they ought to be, and these cases are becoming more plentiful every year; but taking the science of arboriculture as a whole, we cannot consider ourselves as being so far advanced in it as in that of agriculture and horticulture. From a very early date the sister branches of agriculture and horticulture have been making rapid progress, while that of arboriculture has only made very slow progress compared with the others. There are many reasons why arboriculture has not kept pace with the sister branches. One reason is, the length of time that has to pass before any direct pecuniary returns are received for timber. Landed proprietors generally consider that if they plant, they are doing so for the benefit of the next generation, and with no immediate benefit to themselves. This, no doubt, is true to a certain extent, as it falls to the lot of very few to reap the full benefit from a crop of trees which they have planted themselves; and yet the generality of landed proprietors enter to their estates with a certain amount of old timber on them, from which they reap a profit where they did not plant, and it therefore becomes every landed proprietor to plant a reasonable extent of their estates with trees, to keep up the succession.

Another reason why a large extent of our woods and plantations is neglected, is the preservation of game. A great many proprietors who are strict game-preservers—and of course all gamekeepers think that they cannot keep up a good stock of game where the woods are attended to in the way of thinning, &c.—in fact, many landed gentlemen—have stated to me that they know their plantations were not kept in such a profitable state as they would wish to see them; but, on the other hand, they considered that, if they ever attempted to improve the plantations, then the cover would be completely spoiled. This, in my opinion, is a mistake, as I shall show in the section of this chapter on the maintaining of a stock of game along with the proper management of woods.

Another drawback to the advancement of arboriculture is the employment of men who know little or nothing about the management of woods and plantations. I know that some landed proprietors have stated that their woods and plantations are not remunerative, and consequently they consider it a useless expense to give a really good man a fair salary to look after their woods; but this is just the very reason why the woods and plantations do not pay. If a well-qualified person were employed to attend to the plantations, who knew how, when, and where to conduct the several operations of forestry, the plantations would soon be found to produce a fair proportion of the annual income of the estate.

Forestry is a department of landed estate management which requires as much forethought, study, and ability in its management as any other branch. A farm-bailiff is not usually engaged unless he has been trained in the cultivation of land, and in the rearing and disposing of stock, and is otherwise qualified for the place; neither is the management of the garden usually intrusted to any but men properly trained in their profession.

But how often do we find the woods placed in the hands of men who never have been trained to the work!—men who can perhaps cut a tree down when required, and can probably find out its contents in feet, and can insert a plant in the soil, but who know nothing of the true and proper system of planting, thinning, and draining operations connected therewith. Would it be likely that a farm would pay if put under the control of a mechanic? or would a garden thrive and remain an object of beauty if placed under the same management? How can it then be expected that woods and plantations can pay where there is not the right man in the right place? The very thinning of woods and plantations is an intricate and responsible operation by itself, and should never be intrusted to any but men who have had experience in the work. The thinning of plantations, judiciously carried out, results in the welfare of the remaining crop; but when this operation is carried out by men who go to work at random, and who know not whether trees are healthy or unhealthy, or what trees will grow to most profit in the soil, the result will be the certain ruin of the plantation.

The blunders and mismanagement of a farm-bailiff or gardener can be renovated in one or two years' time at most, but the blunders committed in the management of plantations cannot be remedied for a number of years, and probably not in a lifetime.

Another point of very great importance to the advancement of arboriculture is the planting of trees in soils suitable to their growth. We often find young plantations which are not making much progress, the trees in a short time becoming diseased and stunted in their growth, arising either from the soil not being in a suitable state for the reception of the plants, or from the trees not being suited to the kind of soil. Some kinds of trees will of course grow better on certain soils than others, and consequently this must be taken into consideration before the formation of the plantation, if success is desired. Wheat prefers one soil, barley another; and farmers generally keep this in remembrance in sowing their crops; and the same consideration should be given to trees.

SECTION 3.—*The Qualifications necessary in a Forester.*

Woods and plantations, as a department of a landed estate, should, as I shall afterwards show, produce an important share of the annual income, according to their extent and character; but this will not be the case if they are not attended to by a competent and well-qualified forester. The plantations on an estate should be placed under the care of some one who thoroughly understands the management of woodlands. If they are of any considerable extent, there will be full employment for one man to superintend and carry out the several operations connected with that department; but if of only small acreage, they can be attended to by any other person on the estate holding another position, but who should have a competent knowledge of trees and their management.

Any one desirous of following out the profession of a forester should receive an efficient and careful training, as much as a farm-bailiff or gardener.

It is very necessary, indeed, that any one trusted with the management of extensive and valuable woodlands should be properly educated for his trust, and that he should be active, shrewd, and conscientious in everything he does.

He should have received a good education in the common branches usually taught in our schools. He should be able to measure land, so that he may take correct plans of plantations and their acreage. He should have a fair knowledge of botany, so that he may be able to describe trees when required. He should also know the different qualities of soils, so that he will know what soils suit one kind of tree and what another.

Vegetable physiology is the science which gives an account of all that takes place in the growth of plants. Every one desirous to become a thorough forester should know something of this science.

It is not necessary that foresters should be professors of these sciences, but they should have a fair knowledge of them, so that they may be able to apply them in dealing with the different operations in their business.

Besides the theoretical knowledge stated, it is still more necessary that a forester should be trained in the practice of his profession in the woods of some landed proprietor where there is a thoroughly good forester. I could name several estates, both in England and in Scotland, where for the last twenty years the woods have been under the superintendence of highly-qualified men, and where numbers of good foresters have been trained. I hope the time is close at hand when some of our chief agricultural or arboricultural societies will give diplomas and certificates to foresters on examination.

On the estates already mentioned, where the woods have been under the management of well-qualified foresters, the result is a large increase in the value of the existing plantations; and at the present time these are paying a larger net income per acre per annum than the land they occupy would have paid if it had been kept as part of a farm.

Section 4.—*The Kinds of Trees adapted to different Soils and Situations.*

In fixing upon any portion of an estate with the view of growing timber for the purpose of giving shelter or profit, it must be considered that the soil, of whatever kind it may consist, will grow some species of tree much better than it will do others; and, at the same time, the local climate must be taken into consideration.

To judge a soil correctly, its chemical properties must be known in order to arrive at its qualities and abilities and adaptation for any kind of plants; but practice enables an intelligent man to judge of it very correctly on inspection.

It is just of as much importance for the healthy growth of trees to put them in a soil suitable to their nature, as it is to select certain soils for wheat, barley, or oats.

The Oak comes to its greatest perfection on a clay soil or loam, and does well on a light sandy loam.

The Ash prefers a good rich loamy soil.

The Elm is seen growing to a large size upon a light gravelly soil. It is also found growing healthy on clay soils and loams, but a good sandy loam suits it better than any other. It is frequently found of large dimensions on the sides of steep glens, and in soil composed of the debris of rock. Either the English or Scotch elm thrives well near a stream where there is a constant supply of fresh water; but they will not do so near stagnant water, or where the soil is wet from the same cause.

The Beech is a hardy tree, and will grow on exposed situations. I have seen it of large dimensions in sandy soil on the coast of Yorkshire; and in the north of Scotland it grows well on the sea-coast, where the Scots pine and larch have failed. In a recent inspection of an estate on the coast of Lancashire, I found very large beech-trees growing in a light sandy soil with a gravelly bottom. On our English chalk soils the beech grows to perfection, instances of which I have found on the Yorkshire wolds south from Malton.

The Sycamore is another hardy tree. It is found growing from two thousand five hundred to three thousand feet above sea-level in Switzerland. It thrives best in a light sandy loam, and lives to a great age. There is one in the park near Scone Palace, Perthshire, which is said to be upwards of three hundred years old, having been planted by Queen Mary.

The Maple delights in a free sandy loam, and I have found it growing well on very poor soils.

The Poplars are rapid-growing trees, and attain large dimensions when found growing on soils suited to their nature. I lately valued black Italian poplars growing on a light loamy soil of rather a moist description. The trees averaged sixty solid feet of wood, and were not over forty years old. I have also met with them growing on light sandy soils, where they arrived at a large size.

There are some black Italian poplars now growing on the Lofthouse estate, the property of the Earl of Zetland, on the Yorkshire coast, which contain over sixty feet of timber in each tree, and they are not over forty years of age. We have cut down coppice-wood of the black Italian poplar which at ten years of age was thick enough to make rails for fencing. It was growing from old stocks on a damp loamy soil.

There are some fine specimens of Lombardy poplar on the estate of Myton Hall in Yorkshire, the seat of Major Stapylton. They are about forty years old, and have attained a height of nearly sixty feet on an average. The soil is a light loam, and moist.

The Willow attains a considerable size when planted in a situation agreeable to its nature, and this is in a loam, or sandy loam, with moisture. A dry soil does not suit it well. It grows well in any low-lying sheltered situation where there is plenty of moisture.

The Alder.—This tree is usually found growing along the line of our streams and rivers, and in wet swampy places. If the soil is poor, it does not attain a large size; but when found growing in a good loamy soil, with plenty of moisture, it comes to considerable dimensions. It grows naturally on almost any kind of soil, provided there is sufficient moisture. Large numbers of this tree are found along the line of the old coach-road from Perth to Inverness, and there we find them growing generally in swampy places and along the edges of the rivers.

The Horse-Chestnut.—To grow this tree successfully it must be planted in good rich loamy soil and in a sheltered situation.

The Spanish Chestnut.—This is a tree which comes to large dimensions when grown in a good loamy soil and in a sheltered situation.

The Birch, or that variety which is a true native of this country, forms forests of considerable extent in the north of Scotland; and there it is found growing on the sides of the hills, in light soils formed by the decayed rock. It is a very hardy tree, and is found at an elevation of more than three thousand feet above the level of the sea. It generally prefers light dry soils, but I have met with it in Lancashire growing to very fair timber dimensions in a wet soil.

The Lime-Tree.—This is a tree which attains a large size and lives a long time when planted in situations suitable to its nature. There are some very large trees of this kind on the estate of Arniston, Mid-Lothian, growing on a deep rich loamy soil. There is also an avenue of very large trees on the estate of Thirkleby Park, near Thirsk, growing in a deep loamy soil, and rather moist. It always does best in a sheltered situation.

The Hornbeam is a tree capable of being grown to large dimensions, although this is not usually the case. It sometimes attains a height of from forty to fifty feet when reared in a good loamy soil.

The Walnut-Tree.—This tree attains very large dimensions when grown in deep loamy soil, and dry. It will grow in a damp soil, but the quality of the timber is inferior in that case.

The Thorn is found growing naturally in a dry loamy soil. I have also seen it thrive very well in exposed situations on a light dry sandy soil. It does not do well on wet or moorland soils.

The Holly.—This grows best in a light dry loam. There are some beautiful specimens on the estate of Wass growing on a light loamy soil; and on the side of a hill where there is good natural drainage some of these have attained the height of thirty feet and upwards.

The Mountain-Ash finds a home for itself in our rocky glens, stretching out its roots between the rocks, and thrives well in such situations. I have seen several in the county of Inverness, and on the hills and mountains above Ballahulish, on the west coast of Scotland, which had attained a very fair size, and growing in light soils formed by decayed rock.

The Scots Pine is a tree found in many different situations, and grows well in several of them; but the quality of the timber is much influenced by the situation and soil in which it is grown. In the natural Scots pine forests of Invercauld, Abernethy, Duthill, and Rothiemurchus, in the north of Scotland, the trees are of slower growth on the high-lying portions of the forests, where the soil is dry and gravelly; but there the timber is of the best quality, and superior to the best quality of larch in the south. They grow faster on the lower portions of the forests, but the quality of the timber is not so good. I have measured and sold Scots pine-trees from the Duthill forest that were from six to seven feet in circumference at the base. In England it is generally considered that the Scots pine is a worthless tree. This is accounted for by the quality of the timber being soft from having been grown on strong land in low-lying situations. The best quality of timber of this tree is always found growing on gravelly soils and rather exposed situations.

The Larch.—The soil and situation suited for this tree may be pretty correctly known when we consider that it grows naturally in the mountainous regions of North America, Europe, and Asia. It is also found growing to perfection in the mountains of Switzerland and Germany. The European or common larch grows well in almost any situation in this country, provided the soil is not too stiff, or wet with stagnant water. I have seen it growing healthily to a large size on the estate of Lofthouse, the property of the Earl of Zetland, although the trees were standing in a wet soil; the water, however, was not stagnant, but fresh and pure, there being a constant stream through the site. In all cases, the soil for the healthy growth of this important tree should be well drained. It grows best on the slopes of hills and glens, where there is a good natural drainage.

The Silver Fir.—This is a tree which ought to be more extensively cultivated in our plantations than it is. I have seen it growing to large dimensions in a dry sandy loam fully one thousand feet above sea-level. Good specimens are also to be met with on our clay soils. It will grow well on almost any soil, provided the subsoil is not wet and sour from stagnant water.

The Norway Spruce Fir.—This tree grows well in a damp soil, and prefers a sheltered situation. It is found thriving on clay loams, sandy loams, and even on peaty soils, provided the soils are moist, but not full of sour stagnant water.

Having thus briefly stated the kinds of soils suited to the growth of the most common of our forest-trees, I may further add that all trees of the pine tribe thrive better on high and exposed situations than the hardwood trees. The latter require a richer soil and more sheltered situations. I have frequently, in the formation of plantations on the sides of hills, endeavoured to imitate the natural distribution of trees, by planting the pine tribe alone on the higher portions, and having a mixture of the hardwoods on the lower grounds. In the formation of a plantation some six years ago, on the estate of Wass, the elevation ranged from three hundred to eight hundred and fifty feet above sea-level, in which the lower portions were a clay loam, the middle portions were a loam, and the higher portions a light gravelly soil resting on rock. We planted the lower part with a mixture of oak, elm, and ash at fifteen feet apart, and filled up with larch to five feet over all. The middle parts were planted with oak and sycamore at sixteen feet apart, and larch amongst them at four feet. The higher parts were planted with Scots pine at about seven feet apart, with larch at three and a half feet amongst the pines.

The result of this plantation is successful. All the plants have grown well, and promise to continue in a thriving state.

In laying out any portion of ground with the view of planting, the first thing is to ascertain the character of the soil and subsoil. In many enclosures we find a diversity of soils. All the clay soils, clay loams, and loams will grow the oak, ash, elm, and sycamore; and if a mixed plantation is desired, the hardwood should be put in at such distances as will admit of them to stand as the permanent crop.

Thus, presuming that oak, ash, elm, and sycamore were planted at sixteen feet apart, and the ground filled up with larch between these at four feet apart, the larch would afterwards come gradually out as thinnings when required, and in the course of time the hardwoods would stand alone as the crop.

All high-lying parts of an estate where the soils may be light, or breadths of moorland with a poor sandy soil, should be planted with coniferous trees alone. The best plan in cases of this kind is to plant Scots pine at such distances that it will afterwards come to stand as the permanent crop, filling up with larch amongst them, to act as nurses to the pines, and come out as thinnings when necessary.

In the formation recently of another large plantation on the estate of Wass, the elevation ranged from seven hundred to nine hundred feet above sea-level. We planted the lower portions to the extent of one-half of the enclosure with Scots pine at twelve feet apart, and filled up with larch to four feet over all. The higher portions were planted with Scots pine at seven feet apart, and with larch amongst the pines to three and a half feet apart. We also mixed numbers of pinaster amongst the Scots pine on the higher grounds. This plantation is succeeding well, there being not above one per cent of failures all over it.

On very high-lying and exposed parts of estates where the soil is very poor and thin, Scots pine alone should be planted; but if it is thought that the pine will not succeed well by itself, there should be mixed an equal proportion of birch along with the pine. If the pine fail, the birch will grow and make some shelter.

A great want is felt in this country in getting trees to grow for shelter along our coasts. There are many thriving plantations along the west coast of Great Britain, but on the east coast there is a greater difficulty experienced in this respect. For such situations the pinaster, or cluster pine, is admirably adapted. It is to be seen growing luxuriantly along the coast of the Firth of Forth, and on the coasts of Ayrshire and Wigtownshire. I examined a forest of pinaster in the summer of 1867 on the coast of France south from Boulogne. The trees were thriving admirably, having made a growth of fully sixteen inches the previous season. The soil was pure sand, as usually seen on our shores, and the subsoil was a sandy clay. I do not anticipate that we shall be able to grow the pinaster to any valuable timber dimensions on our east coast, or indeed on any of our coasts; but they could be raised to a sufficient height to give shelter, and when that is attained, other kinds of trees would grow much better immediately behind the pinaster plantation.

There is no doubt that every kind of tree will grow to a certain extent in every kind of soil under any ordinary circumstances; but to grow trees to perfection, they require to be planted in suitable soils and climates. I have endeavoured to show the soils suited to the common kinds of our forest-trees usually grown in Great Britain; but it must be kept in view that although the soils named are suited to the different kinds of trees, yet, on the other hand, the climate must also be taken into consideration. Soils suitable to the growth of any particular tree may be found at an elevation and in a climate where the trees would not succeed well. For instance, although I state that the different kinds of hardwood trees prefer a richer soil than the coniferous trees, and a more sheltered situation, yet it is quite possible that a good soil suitable for hardwood may be found in a situation too much exposed to give the tree any chance of succeeding well. This, therefore, must be taken into consideration in selecting a crop of trees for any particular soil.

The trees which succeed best on the higher regions of our islands are, the Scots pine, pinaster, larch, birch, and mountain-ash. At a lower elevation, the oak, sycamore, beech, ash, elm, maple, chestnut, lime, and poplar thrive to great perfection.

SECTION 5.—*Estate Nurseries.*

On landed estates where there is any considerable amount of planting operations going on each year, there should be a portion of ground laid out for the purpose of rearing trees for the plantations. I do not think it necessary or advisable for a landed proprietor to rear all the plants he may require for forest operations, unless the number be very small. Where the woods and plantations are extensive, a forester will have quite sufficient to attend to in his forest duties without entering into the details of a nursery establishment; but still I consider it economical and a part of good management to have a small extent of ground kept under certain kinds of trees for the use of the estate. One great advantage in having such a home-nursery is, that when good large plants are wanted for any particular purpose, they can be reared in the nursery to any required height, and then removed to their final situation. Public nurserymen do not usually give forest-trees much space in their grounds, either between the plants or between the rows; and in consequence the plants are often drawn up to a height which makes them extremely slender for their age, and their roots want that amount of fibre which is necessary for their success.

This, therefore, can be avoided in a home-nursery; as the plants can be given ample space in the rows and also between the rows, when they will grow strong and bushy with good roots.

A home-nursery is also the best place for rearing specimen trees previous to such being planted out in the plantations. We have reared and transplanted many thousands of the rare pines from our home-nursery with very marked success. They have generally been removed when of a large size, and when it would have been dangerous to have done so from a public nursery at a distance.

We have also found a home-nursery highly useful in rearing plants to a large size for filling up blanks or empty spaces in plantations; and on several occasions we have been able to make small plantations to give immediate effect by removing large-sized plants from the nursery. This is often wanted on landed estates; and it will be found very useful, indeed, to have a number of large-sized, well-shaped, and good-rooted plants at command when required.

As an example of the utility of a home-nursery, I will mention one instance. In the summer of 1866, a small clump of trees on the Wass estate, consisting of hardwoods and larch, was nearly destroyed by rabbits. The larch, especially, were eaten over. As it lay close to one of the drives, and was an eyesore in its dilapidated state, we had a number of good larch-plants removed from the home-nursery, in the month of August. We chose a moist day for the planting, and lifted each plant with as great a ball of earth as possible. The plants were attended to for a few days, by watering them; and the result was, we had not a single death amongst them, and they have grown well since.

The extent of land required for a home-nursery must of course vary with the extent of the existing plantations, and also, chiefly, with the extent of land intended to be planted within a given time. I shall endeavour to show what extent will be required for a given number of acres planted annually.

Presuming that it is intended to plant two hundred acres annually for a number of years; we have therefore to consider the numbers of the different kinds of plants that will be required to plant the two hundred acres annually, and the extent of ground it will take to rear the necessary quantities.

But before entering into any such detailed statement, a site for the intended nursery has to be chosen. This should not be far from the principal extent of the land to be planted, if a good site can be got there; if not, another part must be chosen. The soil should not be of a stiff nature, but rather open and free. The chief thing wanted in rearing young plants for removal into plantations is to encourage as much as possible the growth of fibrous roots. There is little fear of plants succeeding if they are well supplied with small rootlets; and to encourage this, a loam or light loam soil should be fixed upon for the nursery, as stiff soils—either stiff clay or loam—rather encourage tap-roots. A light soil, therefore, should be chosen, even should the site be at some distance from the intended planting operations.

Another point to consider is the climate of the locality in which it is proposed to make the nursery. It should not be too much sheltered, as then the plants will have a tendency to be too much drawn up in a soft and tender state, and will not make valuable plants for high-lying and exposed parts of the estate. Not only the land itself, but the land around the site, should be thoroughly drained, otherwise the wet land will encourage frosts in spring, and most likely kill the young shoots on the plants. It should, on the other hand, not be too much exposed. The part chosen should be a medium district, not too much sheltered or exposed, with a dry light soil and a southern exposure.

Having, therefore, fixed upon a likely place for a nursery, we shall now consider the number of plants required annually, in order to get at the extent of land required. As I have already stated, we will suppose that it is intended to plant two hundred acres annually, and presume that one hundred acres are to be planted on the estate annually with hardwood and larch, and one hundred acres with pine and larch alone; the former, we shall suppose, being on the lower part of the estate, and the latter on the higher lands.

To plant one hundred acres annually with hardwoods and larch, will require, therefore, per annum—

30,000 hardwoods.
242,000 larch as nurses.

And to plant the high-lying hundred acres, will require, say—

150,000 larch.
150,000 Scots pine.

I have calculated the hardwood at twelve feet apart, with larch mixed amongst them to four feet apart; and the larch and Scots pine are also taken at four feet apart. This will therefore require, in all—

30,000 hardwood,
392 000 larch, and
150,000 Scots pine

to be produced, and to come from the nursery annually; being a total of 572,000 plants annually. These plants will occupy nursery-land as follows:—

	Acres.	Roods.
30,000 hardwood,	0	2
say 400,000 larch,	2	2
150,000 pine,	1	0
	4	0

Four acres is therefore the extent of land required to furnish each year's planting of two hundred acres; but then we have to consider that the larch and Scots pine require to stand two years in the nursery before they can be fit to plant out into the plantations. Instead, therefore, of three acres and two roods being required for this, it will take one acre more—that is, it will take in all, for larch and pines, four and a half acres. This extra acre is required for the rearing of seedlings as a succession of crop. This is the plan we have usually taken, and it does very well. We purchase the seedlings from some respectable nurseryman, and plant or lay them out at such distances as to stand one year only. We then remove these seedlings after being in the ground one year, when they are of the age termed one-year seedling one year transplanted, and put them out, and give them more room between the rows, and in the rows amongst themselves.

Then in regard to the hardwoods, they will have to stand three years in the nursery before they can be removed to the plantations; this will therefore require three successive crops of hardwood trees to be constantly in the nursery—that is to say, 30,000 one-year seedlings, 30,000 two years old, and 30,000 three years old, the latter to come out each year. Each succession of hardwoods will require two roods to give them ample room; this will give one and a half acre under hardwood trees in each year. Besides the quantity of land already stated as being required both for the hardwood trees and the larch and Scots pine, there ought to be a portion of the nursery under green crop in each year, to keep it clean and in good condition; and this should be done in rotation, as each portion of the old plants is removed. One-fourth of an acre may be allowed for the seed-beds of the hardwoods, a similar extent for manure-heaps and compost, and an additional acre for borders and other ground under other trees—such as specimen pines and shrubs—and, say, a quarter of an acre under roads and walks. This, together, will therefore give, in each year—

	Acres.	Roods.
Under one-year hardwood, . . .	0	2
„ two-year-transplanted hardwood, .	0	2
„ three-year-transplanted hardwood, .	0	2
„ seedling larch and pine, . . .	1	0
„ transplanted larch and pine, . .	3	2
„ green crop, ...	2	0
„ seed-beds, ...	0	1
„ manure-heaps, ...	0	1
„ borders, &c., ...	1	0
„ roads and walks, ...	0	1
	9	3

or, say, a total of ten acres required for planting out two hundred acres of plantation annually. I have not taken into account any land required for the seed-beds of larch or Scots pine, as we have always found it best to purchase the seedlings from a nurseryman. Public nurserymen will consider this a very large extent of land for rearing the number of trees required, but this is just the great advantage of having an estate nursery. Ample space is given to each plant; and this secures a healthy well-rooted plant, with plenty of fibrous roots, and the new plantations are formed with satisfactory results. In public nurseries, and especially where they are in the neighbourhood of large towns, the plants are usually too much crowded, which tends to draw the plants up weak and soft, and with bad roots.

If the high-lying land of an estate is very much exposed, a smaller size of plants will suit better for planting; and in that case a less extent of nursery-ground will answer the purpose. Thus the larch and pines may be large enough when of the age called one-year seedling one year transplanted, when of course they would be removed, and the extent of land stated as being under one-year seedling two years transplanted would not be required. That being fully more than one-half the land stated as being required for larch and pine, this would give nearly two acres less.

Having arranged as to the extent of land required, the next thing is to have it thoroughly drained. This is an important operation for the success of the nursery, and should be well done. The depth and distance of the drains must be regulated by the character of the subsoil. The next operation is to have the ground trenched, and this should not be less than two feet in depth. All the stones should be removed, if any, and used in the draining, and in building stone walls round the nursery as a fence, and in making roads and walks. During the operation of trenching, the land should be made as level as possible.

The fencing should next be attended to. This, as I have stated, may be done with any stones which may come from the land, or with a neat upright paling fence—at all events, the fence should be rabbit-proof. A hedge is not a good fence for a nursery, as it is not rabbit or hare proof, and therefore requires another fence along with it to protect the nursery. Where a hedge is desirable, wire netting can be used along the bottom of it as a protection against vermin. I prefer a good stone fence or wall for the protection of nursery grounds; it keeps out hares and rabbits, and gives a certain amount of shelter.

Having drained, trenched, and enclosed the nursery-land, it will be necessary to put the whole under a green crop for the first year, and to apply a liberal manuring to the site, after which it will be in a proper condition for the reception of the young trees.

The cost of the formation of a nursery ten acres in extent will probably stand as follows:—

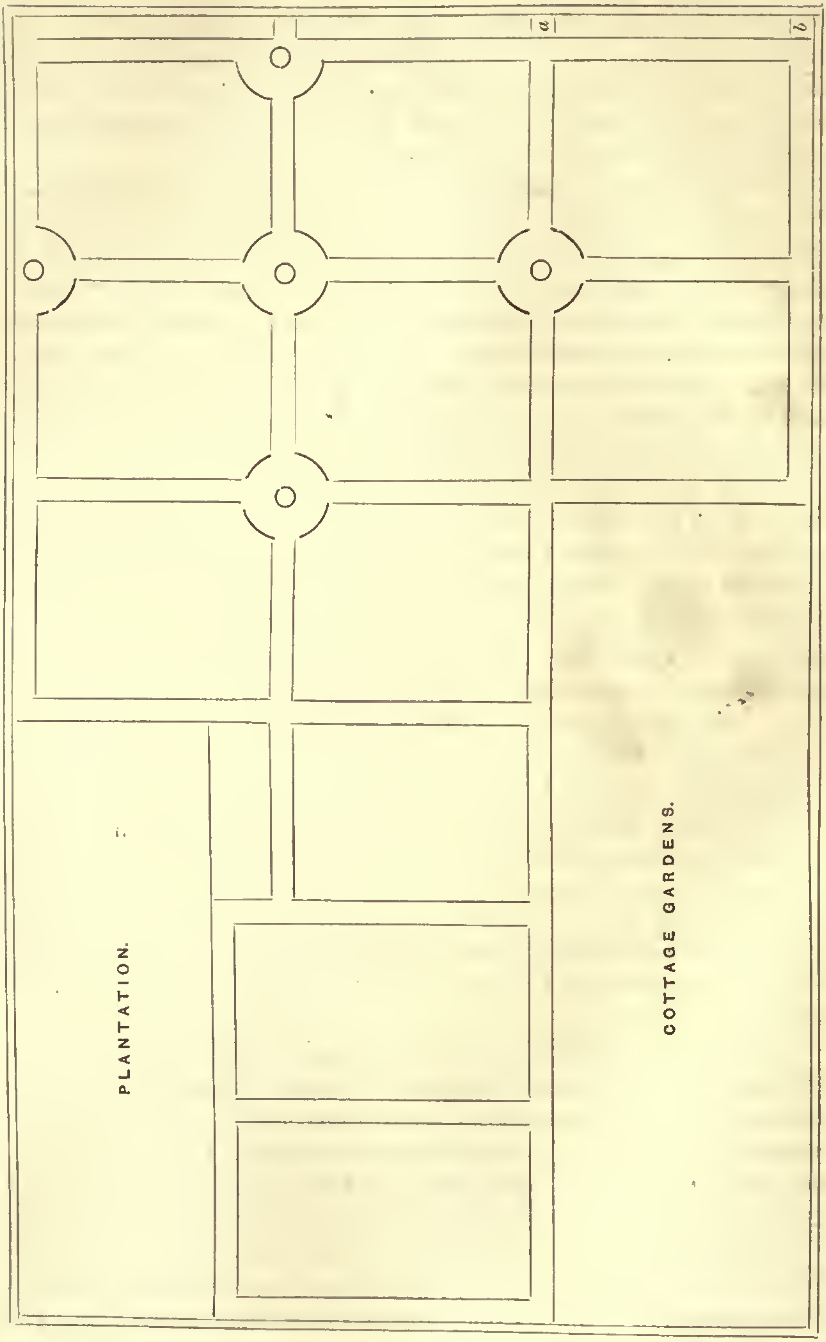
Draining 10 acres of land, say 4 feet deep and 25 feet apart, with pipes, at, say, £6, 10s. per acre, ...	£65	0	0
Trenching 10 acres, say 2 feet deep, at £8 per acre, . .	80	0	0
Removing stones at £1 per acre, ...	10	0	0
Ploughing and levelling land, say	10	0	0
Fencing with stone wall 100 roods of 7 yards, at 12s. per rood,	60	0	0
Forming roads and walks, say	30	0	0
	£255	0	0

I have not allowed anything for manuring and laying under green crop, as I calculate the value of the crop will pay for the outlay in connection with it.

In forming the walks, they should be formed in the way described in the chapter on Road-making, under "Walks." They will, however, require an edging of some sort. Privet was used in the formation of a large nursery on the Abernethy estate, the property of the Earl of Seafield, in Inverness-shire. It has answered the purpose very well. In a small nursery formed on the estate of Wass we have used box as edging.

The nursery should be made either in the form of a square or a parallelogram, so as to keep the two opposite sides of equal length and parallel to each other; this enables the plants to be laid more regularly, and to have the whole nursery laid out in squares or parallel breaks.

Fig. 112.



Form of the Nursery on the Estate of Wass, the Property of Major Stapylton.

The preceding diagram, fig. 112, shows the manner in which our Wass nursery is laid out. It extends to about four acres, and we can plant eighty acres annually from it. We do not rear many hardwood trees, as the chief extent of land to plant on the estate is high lying and exposed, consequently we plant a greater proportion of larch and Scots pine. The nursery consists of a variety of soils, the greater portion being a free open light loam ; there is also a portion of heavy land suitable for the growth of hardwood trees. The part marked *a* is a small house for keeping tools required in the nursery, and *b* is a water-tank sunk down in the line of a main drain, from which a good supply of water can at all times be got for the nursery when necessary.

Strictly speaking, no ground should be chosen for a nursery site unless there is a good and constant supply of water. In some large nurseries there are underground runs leading to all the principal parts of the grounds, so that in dry weather of any duration a jet can at once be obtained for those parts of the ground requiring it.

SECTION 6.—*Planting and Expense of Forming new Plantations.*

Where extensive planting operations have to be carried out on an estate, the work is generally commenced about the end of October or beginning of November, and continued, when the weather permits, to the beginning of April. On many estates where the extent to be planted is small, the planting operations are confined to the months of February, March, and April. For my own part, I am in favour of planting in the autumn months, especially when dealing with hardwood trees. I have always found both hardwood and coniferous trees do best when planted in the months of October, November, and December. There is no doubt that the character and state of the soil have a considerable influence in this respect. I should prefer planting in dry sandy or gravelly soils in the autumn months, and planting in moist soils in the spring months. However, as already stated, it is necessary to take advantage of the whole season when a large extent has to be done, as then time is precious. It will not even do to employ a large number of workmen, as it is not every labourer who can plant properly ; and if every unskilled workman who presents himself is employed, the consequences may be serious. Of course, by close attention on the part of the forester, these men in the course of a few weeks learn to know how to plant well; but I consider it better policy to do the work well as far as we go, and rather plant over the whole of the season with a few skilled workmen, than have the work done hurriedly in a short time with a large number of inexperienced hands.

In the best weather I put the men to plant on the high-lying and exposed parts of the ground, and in cold weather they remove to the more sheltered places.

In frosty weather, and at other times when they cannot plant, they are employed in making drains, roads, fences, and pits; so in this way they are never idle, unless, indeed, in very stormy weather.

There are two methods of planting practised in this country—one is by making pits or holes, and the other is by notching or slitting. Pits should be made for all Scots pine, larch, and spruce that are above three years old, and for all hardwood trees of any age; and also some soils should be pitted even if small plants are to be used—this is where the soil is of a hard nature, and where the subsoil is hard. Some of the moorlands in this country have a hard seam between the soil and subsoil, commonly called moor-band pan. It is necessary to have this broken up, or the plants will not thrive well. I advocate the pitting system in general where there is sufficient soil to admit of it being done. It is almost impossible to pit on hilly ground where the soil is thin and lying near the rock. In such situations the notching system must be adopted.

Pits for the hardwood trees should be made about fifteen inches on the side of the square, and about the same depth, first taking off the thin turf or sod from the top and laying it to one side, then removing all the soil to the required depth, and laying it to the opposite side. When planting the trees, they should be held in the middle of the pit by a woman or boy, and the earth put in before any firming of it takes place. It is customary with may planters to put in a little soil and then firm it, then add some more soil, and so on till the pit is full; but this is injurious to the plants, as the roots are packed too close, and are thus injured. I always adopt the plan of firming only when the pit is full of soil, then the plant is securely fixed in its place by pressing the soil about the neck of the plant with the foot.

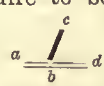
Pits for the hardwood trees, as I have described, have cost us from 8s. to 15s. per thousand, according to the nature of the soil and situation, and we always endeavour to have them done by contract. If the land is very stony, and a pick has to be used in making the pits, they will cost more.

Hardwoods are often put into the pits by placing the stem of the plant against the side of the pit. In exposed situations this is a good plan, as the plant can be made firmer in this position than when placed in the centre.

In planting one-year seedling two-years-transplanted larch, we have usually made pits in soils which would admit of this being done about nine inches square and one foot deep. These pits have cost us from

10d. to 1s. 3d. per hundred by contract. When inserting the larch into these pits, we cause them to be placed against one of the sides of the pit, and not more than three-fourths of an inch deeper than they had been standing in the nursery lines. This is easily known by the mark on the bark. If the larch-plants are inserted in the soil deeper than what I have stated, they will not grow vigorously, as none of the coniferous tribe do well if planted too deep, or if any of the branches are covered by the soil. In order to prevent too deep planting with larch or Scots pine, and to assist otherwise in securing good planting, a woman or boy should go along with each man and hold the plants in the pits while the man puts in the soil, and they should be instructed as follows: 1st, Hold the plants between the forefinger and thumb at a point on the stem three-fourths of an inch above the part to which they had been planted in the nursery rows; generally this point will be found to be about two inches above the part where the uppermost roots come out from the stem. 2d, Hold that part exactly level with the surface of the soil on one side of the pit, and hold it in that position until the man has put the earth in about the roots of the plant. And, 3d, while keeping it in that position all the branches should be kept back by the hand.

The part round the plant, after having all the soil put in, should be firmly pressed with the foot. If the natural growth on the surface is grass, the part round the plant should be left bare; for if the turf is replaced, the herbage will grow up and choke the plant, especially in strong soils. In pitting on moorland where the heath is short, I think it judicious to have the turf replaced; but it should be cut into four quarters, and beat in about the plants. I consider this necessary on moorland, as, if the soil is left bare, it is much exposed to the heat of the sun in summer, and gets very dry and opens out, and thus allows the dry air to get to the roots of the plants, which kills them.

In planting small-sized larch and Scots pine on high-lying and exposed parts of the country where the soil is thin, they require to be inserted by means of the notch, making two cuts in form thus, 

The spade is first inserted as shown in the line *b c*, then a cut is made in the opposite direction, as shown at *a d*, and the spade is bent down, which makes an opening where the cut has been made. The plant is then inserted and drawn in to the point at *c*. These notches are often made with a planting-mattock, but I find nothing better than the common spade, and all the better if the spade should be somewhat worn.

Another form of notch is made by cutting two cross lines instead of one, thus, 

The plant is drawn up to the point *a* at the crossing of the lines. After the spade is withdrawn, the turf should be firmly pressed down with the feet and with the heel, to fix the plant well in its position.

The distance at which plants should be put from each other in a plantation must of course vary with the altitude, situation, and exposure of the site of the plantation.

On high-lying and exposed parts of the country I have generally planted the trees at from three to three and a half feet from each other. Many foresters think this too close, as the first thinnings do not come to any value; but the great object in such situations is shelter, and by planting at the distances named, the trees ere long shelter one another and grow much faster.

On situations at a lower level, or those parts of the country which are a medium between very high-lying land and the lowest levels, I usually plant at four feet apart. There is not any necessity for planting closer in such situations; and to put them any wider apart will only tend to expose the plants all the more, and check them from growing so fast.

On the lower levels of the country, and in sheltered situations, the distance apart of the first planting of trees should be regulated by the demand for small thinnings in the district. Supposing that a good market can be got for small thinnings, I would advise that all the low-lying and sheltered sites to be planted on an estate should be done at three to three and a half feet apart; the first thinning can then be taken out earlier than if the trees were put in at wider distances, and sold for whatever purpose there is a demand. If, however, there is no demand for small thinnings, then we should plant the trees at five feet apart; this will enable them to stand together without being injured until they come to be some useful size. I do not consider it a part of good management to plant at much wider distances than that last stated, as, in plantations formed with the trees at seven, eight, or nine feet apart, a few deaths make large gaps and holes in the plantation. Of course the dead plants could be replaced, but filling up never gives such a satisfactory plantation as one which gets away altogether; and besides, no income would be received for a long period of years from plantations formed at wide distances.

Before proceeding to plant, the trees have to be purchased from a public nurseryman—that is, when no home-nursery is kept. In purchasing from public nurseries, it is always a good plan for the forester to visit the nursery and examine the plants, and choose what may be wanted for the season's planting operations ; and in doing so he should attend to the following :—

1st, The plants should be quite healthy and free from insects. I often meet with larch-trees very much infested with the white scale or bug. This spreads very much in a plantation, and should be guarded against.

2d, The bark should be of a perfectly healthy character, and the leaves entire and well formed; if otherwise, the plants are in degree unhealthy, and therefore should be rejected.

3d, The plants should not be too much drawn up, for tall slender plants seldom do well.

4th, There should be plenty of fibrous roots ; this is a very important point to attend to. Long tap-rooted plants generally make great failures when planted out, and are very backward in starting to grow.

5th, Plants for exposed situations should be short and hardy, and of the size called one-year seedling two years transplanted.

6th, If the plants are wanted for low-lying, warm, and sheltered places, good tall well-rooted ones should be chosen.

Of course the size of the plants required must vary with the situation where the plants are to be put. Many, in choosing plants, look at the appearance of the trees above the soil, and not at the roots. They consider that if they have been making fine long growths, that is all that is required. If the trees have been standing in the rows for some years, and not been transplanted since removal from the seed-bed, they will no doubt show fine growths, but in all likelihood the roots will be very poor. If the plants have been regularly transplanted, there will be a mass of fibrous roots, and this is what is wanted in young trees intended for removal to plantations. It is through the fibrous roots that the plants live; and consequently the more of these they have, the more likely will the result be successful.

In purchasing specimen plants of any kind, and more especially of the pine tribe, care should be taken to see that they have been transplanted, and well supplied with fibrous roots.

The following table shows the number of trees required per acre at different distances apart:—

PLANTER'S TABLE, showing the Number of PLANTS required per IMPERIAL, SCOTCH, and IRISH ACRE, from one to thirty feet distance.

IMPERIAL ACRE.				SCOTCH ACRE.				IRISH ACRE.			
1	43,560	12	302	1	54,760	12	380	1	70,560	12	490
1½	19,360	12½	270	1½	24,338	12½	350	1½	31,360	12½	452
2	10,890	13	257	2	13,690	13	324	2	17,640	13	417
2½	6,987	13½	239	2½	8,761	13½	300	2½	11,209	13½	385
3	4,840	14	222	3	6,084	14	279	3	7,840	14	360
3½	3,556	14½	207	3½	4,470	14½	260	3½	5,760	14½	335
4	2,722	15	193	4	3,422	15	243	4	4,410	15	316
4½	2,151	15½	181	4½	2,704	15½	228	4½	3,484	15½	292
5	1,742	16	170	5	2,190	16	214	5	2,822	16	275
5½	1,440	16½	164	5½	1,810	16½	201	5½	2,332	16½	260
6	1,210	17	150	6	1,521	17	189	6	1,960	17	244
6½	1,031	17½	142	6½	1,296	17½	178	6½	1,670	17½	234
7	889	18	134	7	1,117	18	169	7	1,440	18	217
7½	774	18½	127	7½	973	18½	160	7½	1,254	18½	206
8	680	19	120	8	855	19	151	8	1,102	19	195
8½	603	19½	114	8½	758	19½	143	8½	976	19½	185
9	537	20	108	9	675	20	137	9	871	20	176
9½	482	22	90	9½	606	22	113	9½	782	22	146
10	435	24	75	10	547	24	95	10	705	24	123
10½	395	26	64	10½	496	26	81	10½	640	26	105
11	360	28	55	11	452	28	70	11	583	28	90
11½	329	30	48	11½	414	30	60	11½	533	30	79

In proceeding with planting operations, the great object should be to have it done well, and in such a manner as will insure a successful result. Many planters hurry the work over, paying little regard to the way in which the plants are inserted, and then of course they are able to state that their planting cost a small sum per acre; but the result is not generally successful. The object should be to have the work well executed, and the result will be a greater certainty. This can only be done by a sharp supervision over the workmen, and the examination of the plants put in. The forester should be in close attendance on the men during the planting season.

In some parts of the west of Scotland, where the surface is very rocky and thin of soil, and where it is impossible to rear trees by planting them, a system of rearing plantations by sowing seeds of the trees has been adopted, and successfully carried out. In doing this, small plots of earth are prepared in the hollows of rocks for the reception of the seed. Generally speaking, there is a sufficient quantity of earth existing in the hollows for this purpose; but when this is not the case, earth is carted and laid in these places, and two or more seeds put in.

The oak, birch, and Scots pine are the best adapted for such situations, but more especially the birch. The acorns of the oak may be put in the most sheltered sites, and covered with about two inches of soil. The birch-seeds will do to be covered very slightly, just sufficient to keep them from being blown away; but the seed of the pines requires half an inch of covering. In the course of two or three years the patches should be looked over, and all the rubbish and weeds taken out; and if more than one plant is found growing in one place, only one should be left and the others taken out. Those thinned out can be used in filling up any failures which may have occurred elsewhere.

Pits should always be made one or two months previous to planting, and more especially on soils which are stiff, or where the subsoil may be hard. This gives time for the weather to moulder down and open out the soil, both that taken out of the pit and the sides of the pit itself; and the young trees generally do better afterwards.

It is always desirable to avoid planting young trees amongst old ones, as I have never found them to do well, as, from the close confinement amongst the older trees, they are generally drawn up and grow weakly. However, should it be found necessary to do so, the plants should not be planted too close, and not less than five feet from the drip of the standard trees. If the old trees extend their branches a long way over, so as to cover a large space of the surface of the land, these long branches should be pruned in, so as to give more room for the young trees.

Planting is often done by contract, many proprietors being in favour of contracting with some nurseryman for the whole work of supplying the plants and putting them in the soil. As a rule, it is not a good plan to do this, as the plants are often of such a character that they would be rejected by a regular forester, being frequently the refuse of the nursery, drawn up, weak, and badly rooted. Along with this, the plants are hardly if ever so well planted. Of course the more quickly that the nurseryman gets over the work the better for himself. Planting never should be done except by the regular forester and the regular workmen. There are, however, instances in which it may be necessary to resort to this plan—as on an estate where no regular forester is kept, or where there are no regular workmen employed who are able to plant. When this is the case, specifications must be drawn out with the view of taking in offers for the work from nurserymen; but we should always prefer giving a respectable nurseryman—one with whom we are acquainted, and know that he will do the work well—a higher price per acre for the work than to any who would most likely wish to have the work finished as soon and as cheap as possible, irrespective of the consequences.

The following is a copy of specifications which I drew out in 1865 for the formation of a plantation in the county of Northumberland:—

Specification of the Plants and Manner of Planting the Wood, lying on the Estate of , County of Northumberland.

The land to be planted extends to two hundred and thirty acres or thereby. The surface is undulating, and covered with heath, with low-lying portions of grass.

The soil is generally of a sandy gravelly loam. On the grassy spots the soil is a light loam. The plants to be used on the gravelly sandy loam are Scots pine and larch, with hardwood in the lower spots, and are to be put in according to the following quantities and ages:—

Three thousand five hundred and fifty-six plants per acre, three and a half feet apart—one-half to be Scots pine and the other half larch. The Scots pine to be strong well-rooted plants, and to be of the age called one-year seedling two years transplanted.

The larch to be strong and well rooted, and of the size called one-year seedling one year transplanted.

The Scots pine and the larch to be put in by the notch; care to be taken to have the roots properly covered, the spade-cuts closely pressed together, and the plants all firmly fixed.

Hardwood plants of oak, sycamore, and ash, of sizes about two feet high, to be planted in the hollow grassy spots in pits made fifteen inches square and one foot deep. The turf or sod to be laid on with the grass surface down.

All the plants supplied to be well grown, healthy, and with plenty of fibrous roots, and none to be sunk in the ground beyond the nursery mark.

The contractors to be at all expenses of supplying the plants, carriage of plants to the plantation, and the planting of them.

And also the contractors to keep up the plantation for two years from the date of finishing it—that is to say, all deaths and blanks will be filled up by them at their sole expense, and with the kinds of trees described.

The plants to be furnished, and all the work to be conducted and completed, to the approval of of , whose decision shall be binding on all parties in case of any differences arising either as to the terms of agreement or as to the work to be executed. The work to be commenced by the 27th day of October 1865, and completed by the 20th day of March 1866.

Estimates will be received per imperial acre, including the cost of plants and all other expenses.

The cost of the formation of plantations must of course vary much with the character of the soil, situations, and many other advantages and disadvantages of different localities, so that no example which I might give can be a criterion. The first cost of fencing must be taken into consideration, and this may vary much with the kind of fence it is desirable to erect. If stones are plentiful, a dyke or wall built of them will make the most substantial fence, although costly at first. If there is an extent of older plantations, it may be the most judicious system to fence the young plantations with a wooden paling, or with a wire fence erected on wooden posts.

Local circumstances must decide the question of fencing.

Again, if there is a considerable extent of wet land within the enclosure, the expense of drainage will add to the total expenditure; but drainage should not in any case be left undone when it is required, as the improved growth of the trees will amply repay the outlay.

The mode of planting also makes a difference in the expense, pitting being more expensive than notching; but where the soil or subsoil is at all stiff or hard, pitting will enable the plants to grow faster and more healthy, and consequently must pay the extra outlay.

If the land is covered with any brushwood, whins, brambles, or other rubbish, this should be cleared off, which of course adds to the expense.

It may, however, be of use to some to state the expense incurred in the actual formation of several young plantations during the last few years, both in England and Scotland.

I shall therefore give statements of two or more plantations now in existence, stating their altitudes, sites, climate of the district, kind of soil and subsoil, and the cost of formation. The account given of the plantations No. 1 and No. 2 is taken from the prize essay written by me 'On the Formation and Management of Young Plantations,' for which the Highland and Agricultural Society awarded their gold medal in 1867.

No. 1.—Talquhonie Plantation. Extent, five hundred and fifty acres imperial.

This plantation is the property of Lord Seafield, in the district of Duthill, in the county of Inverness.

Exposure.—The site of the plantation is elevated, forming part of a range of hills running from east to west. The chief portion of the plantation has a southern aspect.

Altitude.—The altitude of this plantation ranges from eight hundred to twelve hundred feet above the sea-level.

Climate.—The climate of the district may be said to be moist. In the winter season the frosts are severe, and there are generally heavy falls of snow, sometimes lying eighteen inches deep for a period of six to eight weeks.

Character and Condition of the Soil and Subsoil.—The soil is chiefly a sandy peat lying on a debris of the granite rock of the district. There are, however, different heights and hollows embraced in its extent, which vary much in character of soil. On some places it is sandy, on others gravelly and peaty, while a considerable portion is a sandy loam; and there are a few acres of the character of peat-moss. With the exception of the portion of the latter character, the land is naturally dry. This plantation is remarkable for what may be termed insular beds of good soil in the hollows between the rising grounds.

Fencing.—The plantation was enclosed partly by a four-barred paling, and partly by a turf wall with a two-barred paling on the top of it. The wooden paling was made of old and matured Scots pine timber, and made similar as described in the chapter on Fencing in this work.

The turf wall was made similar to that which is described under "Fences," with a paling on the top of it.

Drainage.—On one side of the hill there was a considerable extent of wet peat or moss; this was drained by making parallel open cuts at thirty feet apart, thirty-six inches broad at top, thirty inches deep, and sloped on the sides to nine inches broad at the bottom.

The Mode of Planting adopted.—All the plants used were put in the soil by the system of notching. One portion of the plantation was planted in 1857, another in 1858, and the other and remaining portion in the year following. The weather during the time the planting operations were going on was varied, as, from the large extent of land to be planted, the operation extended over the autumn and spring of each year referred to. There were generally sharp frosts in the mornings, which prevented the planting being done when this occurred. The workmen in these cases were put to draining operations, and as soon as the soil was sufficiently soft, planting was proceeded with.

The Kind of Trees planted.—The trees planted were larch, Scots pine, and spruce. On the highest portions of the plantation, where the soil was thin and the position exposed, Scots pine alone were planted at three and a half feet apart, or at the rate of three thousand five hundred per acre. On the lower portions, where there was a greater depth of earth, and of better quality, Scots pine were inserted at eight feet apart, and filled up with larch to four feet apart over all, or at the rate of two thousand seven hundred per acre. Where the soil was peat, a mixture of spruce fir and Scots pine was used.

Expenses in the Formation of Talquhonie Plantation.

Fencing—						
1112 yards of four-barred paling, at 9¾d. per yard,	£45	3	6			
5685 yards of turf dyke with paling on top, at 5¾d. per yard,	136	8	2			
				£181	11	8
Drainage—18,129 yards, at 1½d. per yard,				113	6	1
Plants—						
Scots pine, 1,446,150, at 4s. 6d. per 1000,	£325	7	8			
Larch, 223,420, at 6s. per 1000,	67	0	6			
Spruce, 54,220, at 12s. per 1000,	32	10	6			
				424	18	8
Planting—						
Workmen's wages planting the whole,	£254	3	4			
Cartage of plants from home-nursery to plantation,	15	1	6			
				269	4	10
Total cost of plantation at first formation,				£989	1	3

Cost of management and general maintenance from the year of planting—1857 to 1867 (ten years)—			
Scouring and cleaning drains,	£8	15	2
General repairs of fence, looking over enclosure, clearing snow from turf wall,	76	4	10
	£85	0	0

The cost of the plants per thousand may seem very low, but they did not cost the proprietor any more, as they were raised in the home-nursery on the estate.

By the foregoing table of expenditure it is brought out that the different works are at the following rates per acre:—

Fencing,	£0	6	7	
Draining,	0	4	0	
Plants and planting,	1	5	2½	
Maintenance,	0	0	3¾	per annum.

The State of the Plantation at this Date, with relative Progress of each Kind of Tree.—The plantation at the present date (October 1867) is in a very healthy and satisfactory condition, excepting on the very high, dry, and exposed parts, where the trees have not made much progress. On the lower and middle ground, the larch are now, on the average, five feet high, several having grown as high as nine feet. The Scots pine will average two feet high. The larch, Scots pine, and spruce have made the most progress on a light sandy soil with a gravelly bottom.

The expenses for the last ten years, in the general maintenance of the plantation, have amounted to £85, or nearly at the rate of 3¾d. per acre annually. This expenditure has been for fencing, cleaning drains, and looking over the plantation; but does not include forester's wages, or the value of the timber used in repairing the fence.

No. 2.—Hollen Bank Plantation. Extent, twenty acres.

This plantation is on the estate of Wass, county of York, and the property of Major Stapylton.

Exposure.—The side forms part of the north side of a hill running from east to west, and therefore the whole of the plantation has a northern aspect.

Altitude.—The altitude ranges from three hundred to six hundred feet above sea-level.

Climate.—The climate of the district is mild, and comparatively moist.

Character and Condition of the Soil and Subsoil.—The soil on the lower portions of the district occupied by this plantation is a light clay loam resting on a subsoil of sandy clay. Previous to planting, a portion of this was very wet, and was drained in the way described under the head of "Drainage." On the middle portion, half-way up the hill, the soil is light loam lying on the debris of underlying rock; while the upper and higher portions of the district have a soil of light sandy loam, very thin, and lying on the rock. The geological formation of the hill is what is termed "calcareous grit."

State of the District previous to Planting.—Previous to planting, the site of this plantation was occupied by a patchy crop of oak, elm, ash, and alder, with hazel underwood intermixed on the middle and lower portions of it. The upper portion was pastured. This old and partial crop of hardwood and hazel was cut and removed from the ground, taking care that the stools of the trees were properly dressed, to insure their throwing out shoots to form coppice afterwards.

Fencing.—Before planting, the ground was enclosed on three sides by a thorn hedge, one side being without any fence, and on this we erected a wire fence. The straining-posts used were wood and iron. We fixed a wooden post at the end of each length that was strained, and an iron straining-pillar at the opposite end of each length, so that the iron straining-pillar might strain between itself and the wooden one. These posts were according to those already described under the chapter on Fencing. The wires used were the galvanised cable strand. Intermediate posts were put up five feet apart, the material used being the root-ends of larch and Scots pine thinnings cut six feet long; and, upon the average, they were three inches in diameter at the small end, or the top of post. These were pointed at the root end, and driven into their sites by a wooden mallet, leaving about two inches of the post above the top wire when finished; and the top of the posts were sawn in a sloping direction, to throw the water off, which is a great preventive against rotting, and should always be done. The wires were fixed to the posts by means of staples in the usual way.

Draining.—The draining done in this plantation was performed in a similar manner to that described in regard to No. 1.

The Kinds of Trees used.—On the middle and lower portions of this plantation—where there was a growth of oak—ash, elm, and alder shoots sprang up at the date of planting. Larch was used in filling up between them, with a mixture of spruce and black Italian poplar on the drained places. The spruce and black Italian poplar were put in at about fifteen feet apart, and the larch filled in between them and the shoots to nearly five feet apart over all.

On the higher portions Scots pine were planted at nine feet apart, and filled up with larch to four and a half feet apart over all. A proportion of pinaster were put in along with the Scots pine.

The ages of the different kinds of trees were as follows:—

Larch, one-year seedling two years transplanted.
Scots pine, one year bedded one year transplanted.
Pinaster, four inches high.
Black Italian poplar, three feet high.
Spruce, eighteen inches high.

The Mode of Planting adopted.—The larch, spruce, and black Italian poplar were planted in pits made twelve inches deep and twelve inches on the side of the square. The Scots pine, pinaster, and larch, on the higher grounds, were inserted in the soil by the usual notching system.

The Expense of the Formation of No. 2.

Clearing and burning rubbish previous to planting,		£14 9 9
Fencing—		
Repairing existing hedges,	£2 3 9	
Cost of wire, 800 yards, six deep, at 7d.,	23 6 8	
Erecting wire fence, 800 yards, at 1½d.,	5 0 0	
Staples,	0 16 0	
Cost of two gates,	1 0 0	
Hanging gates and painting,	0 10 0	
		32 16 5
Draining,		4 13 11
Pitting,		8 1 7
Planting,		21 8 6
Carry forward,		£81 10 2

Brought forward,		£81 10 2
1,500 spruce, 18 inches, 25s. per 1000, ...	£1 17 6	
500 black Italian poplar, 3 feet, at 40s. per 1000,	1 0 0	
50,000 larch, one-year seedling two years transplanted, at 18s. per 1000, ...	45 0 0	
5,000 Scots pine, one year bedded one year transplanted, at 15s. per 1000, ...	3 15 0	
500 pinaster, 4 inches, at 15s. per 1000, . .	0 7 6	
		52 0 0
Total cost of formation, ...		£133 10 2
Management and general maintenance from 1863 to 1867 (four years)—		
Fencing, general repairs, ...	£4 7 6	
Draining, cleaning drains, ...	1 5 0	
Planting, filling up deaths and plants eaten by rabbits, ...	5 12 0	
Cost of plants used in filling up, ...	11 0 0	
Cost of maintenance to date, . .		22 4 6
Total cost of maintenance to date, ...		£155 14 8

Present Condition.—The plantation has made rapid progress since it was planted. On the lower portions of it the larch are fully eight feet high on an average, the spruce three and a half to four feet high, and the black Italian poplar ten to twelve feet high. On the middle portion the larch average four to five feet high; and on the highest part they are three to four feet high, while the Scots pine are from eighteen inches to two feet. The pinasters have not done equally well, the greater portion having died from a continuation of cold frosty winds for some days after planting. A few, however, remain, and are making fair progress. The oak, ash, elm, alder, and hazel copse has grown very fast, averaging from five to ten feet high at the present time (1868); and, on the whole, there is an excellent and promising crop on the ground.

We have just completed the first thinning of the copse.

No. 3.—Wass Moor Enclosure. Extent, four hundred acres.

This plantation is on the estate of Wass, in the county of York, and is the property of Major Stapylton.

Exposure.—The site of this plantation is elevated, although pretty flat and level. It forms part of the Hambleton plateau.

Altitude.—The altitude of this plantation ranges from five hundred to seven hundred feet above the level of the sea. The chief portion of it will range from six hundred to seven hundred feet; but there are narrow flats running through it which fall down to about five hundred feet above the sea-level.

Climate.—In the winter season, from the exposed position of the district, the climate is cold and severe. In the summer the lands are parched and dried up by the heat of the sun. There are farms on three sides of this enclosure, and in each of these, and in many others in the same district, there is generally felt a great want of water in the summer season. In fact, at any season of the year there is no water supply excepting what is collected from off the roofs of houses, and into ponds for the cattle from the surface of the fields in heavy showers, there being no springs or streams on the plateau. Previous to 1862 there were no plantations of any extent in the higher portions of the district. Since then nearly nine hundred acres of plantations have been formed on sites deemed suitable for giving shelter. I am inclined to believe that in the course of time, when these plantations have arrived at such a growth as to cover the surface of the enclosures, the moisture and rains falling on the surface will be there retained; and the probability is that there will be a plentiful supply of water in the district by the formation of springs caused by the accumulation of moisture in the soil. The rainfall in the district is considerable.

Character and Condition of Soil and Subsoil.—The soil over the greater portion of the enclosure is a sandy peat, with a subsoil of a sandy nature, and between the soil and subsoil there is more or less of a hard pan. This pan, or, as it is sometimes called, moor-band pan, is not over one inch thick.

There are many tracts of land of this description in the north of England and Scotland, the soils of which are of a light sandy nature, the subsoil being a hard pan. Where such a pan exists in the subsoil, trees do not in general thrive well unless the district is either systematically drained, so as to open out this pan to the action of the air, or unless the pan is otherwise broken up and made free and open. If the pan is not broken through, the trees never attain to such a size as they will do when the roots are allowed to penetrate the soil.

In winter, and wet weather generally, the water that falls on such land does not pass through the pan, in consequence of its hard nature, but lies stagnant about the roots of the plants, and thus in a short time they become diseased at a very early stage of their growth. On the contrary, in dry weather, and especially when rain has not fallen for some length of time, the roots are prevented by the pan from drawing moisture from the suboil.

As I have already stated, drainage is a good cure for this pan, and also by having it broken up, as I shall afterwards show when treating of the mode of planting the enclosure under notice.

In the lower levels and hollows of this enclosure the soil is a light loam, with a similar subsoil.

State of the Enclosure previous to Planting. — Previous to being planted, this enclosure was covered with heath of from three to six inches in height. Some portions of the enclosure were wet, especially in the hollows.

Fencing.—Before planting the district under notice, it was enclosed on one side by a stone wall, which formed the boundary of some adjoining fields. Part of the other sides was fenced with wire, using wooden posts and six wires deep, the same as described under the chapter on Fencing. A portion of one side was enclosed with a dry-stone wall five feet high, and the copestones laid on with lime. A small portion has also been enclosed by a turf wall, with two wires on wooden posts on the top.

Draining.—The drainage of this enclosure has not been completed. What has been done has been dried by open cuts made as described in reference to the other plantations already mentioned.

The Kinds of Trees used.—Over the greater portion of this enclosure, with the soil a light sandy peat, we planted Scots pine at about ten and a half feet apart, and filled up with larch to three and a half feet apart. In the hollows we planted sycamore at sixteen feet asunder, and mixed Scots pine and a few spruce amongst them at a distance of eight feet, filling up with larch to four feet apart over all.

The ages of the different kinds of trees used were as follows:—

Larch, one-year seedling one year transplanted.
Scots pine, one year bedded one year transplanted.
Spruce, twelve to fifteen inches high.
Sycamore, eighteen inches high.

The Mode of Planting adopted.—All the trees were planted in pits. These pits were made in the following manner: One set of men went first and took off a thin turf from the top about fourteen inches square. This was laid to one side; then the soil was taken out down to the pan and laid to the opposite side of the pit. The first set of men proceeded on in this way, and behind them came more men with common picks, with which they picked up and opened out the pan and subsoil in the bottom of the pit, also sending down the picks into the sides of the pit. The picks were sent down and turned into the sides of the pits through the pan. This broke the pan over a greater surface than by merely taking it down with the square of the pit.

The plants were inserted into the centre of the pit and fixed there, and the turf was laid on the top with its natural surface down, excepting in the case of the Scots pine, which were not turfed round, as they were small, and the heath might grow and choke them up if put close to them.

We did not burn the heath off, as is often done, as we considered that it produced shelter to the plants in the winter season, and assisted in retaining an amount of moisture in the soil in the dry summer weather.

Expenses in the Formation of this Plantation.—There is a portion of this enclosure to finish yet, but from what has been done, the result is at the following rates per acre :—

Fencing, ...	£0	4	0
Draining, ...	0	3	0
Pitting, ...	1	5	0
Planting, and cost of plants, ...	2	1	6
Carriage of plants from nursery, ...	0	0	6

The drainage in this case is but a small sum per acre, as only the very wet portions were done. The pitting is a heavy expenditure. Many planters would have done this at one-half the expenditure, but the result would not have been so satisfactory as it will be in the way in which the subsoil has been opened out; indeed, it has already shown itself to be a success.

Present Condition of Plantation No. 3.—About one hundred acres of this enclosure were planted in the season 1865-66. Another hundred acres were planted in the season 1866-67, and about the same extent was planted last season (1867-68). The first portion is therefore now three years old, and the second two years old. The whole of the plants put in have made good growths. There have not been many deaths in the enclosure—not more than one per cent over the whole—and the plantation is in a very promising condition at the present date.

Many other instances could be given of the actual cost incurred in the formation of plantations in different parts of the kingdom. The foregoing cases may give, however, an idea of the first cost in different localities; but these, of course, cannot be taken as a rule in forming others, as much depends upon the site of the enclosure, the mode of fencing adopted, the extent of drainage necessary, the character of the soil and subsoil, with the mode of planting, and the size and kinds of plants used.

SECTION 7.—*The different Kinds of hardy Deciduous Trees, and their Uses.*

I have already given a statement of the soils suited to the different common forest-trees grown in this country. I now propose to give a short statement of each hardy deciduous tree, with the uses to which the timber is applicable.

The Oak (*Quercus robur pedunculata*).—This well-known tree is a native of Britain. It is a slow grower, but it is one of the most ornamental of our timber-trees, and in the course of time attains very large dimensions. The timber is used in shipbuilding, and in almost every other purpose to which timber can be applied. The bark is valuable, and is used extensively for tanning purposes.

Many other substances are now used for tanning leather, such as *Terra, Japonica,* and *Veronica;* but they do not answer the purpose so well as good oak-bark, which produces a better colour and quality of leather than the aforementioned.

The Oak (*Quercus robur sessiliflora*).—This grows quicker than the *pedunculata,* but generally does not attain such a great age. The *sessiliflora* may be said to grow with a cleaner stem than the other, and with a less spreading head of branches, but the quality of the timber is not considered so good.

The Turkey Oak (*Quercus cerris*).—This tree has finer-grained timber than the others, but the quality is not much inferior. It is of more rapid growth than either of the former.

The quality of all oak timber depends much upon the nature of the soil and subsoil in which it is grown. Those trees which are grown on grounds of moderate elevation, and in a light loam soil, produce the best timber.

Evergreen Oak (*Quercus ilex*).—This is a native of Italy, Spain, France, and the south of Europe. It grows slowly in this country, and cannot be said to attain the size of a useful timber-tree, but it has an ornamental effect.

The Ash (*Fraxinus excelsior,* Linnæus).—This is one of the most useful of our timber-trees. It is a native of this country. The quality of the timber is very tough and elastic. It is very useful for general country purposes, even from an early stage of its growth.

Mountain-Ash (*Pyrus aucuparia*).—This is a tree which does not attain a great height. It is very hardy, and will grow in exposed situations. The timber is fine grained, of a hard quality when matured, and can be highly polished. It is a very ornamental tree, as it produces clusters of red berries in a season of the year when there is not much to enliven pleasure-grounds and woodland walks.

The Beech (*Fagus sylvatica,* Linnæus).—This tree is found over all the temperate parts of Europe, and also in Asia. It is a magnificent tree when arrived at considerable age, and equals in dimensions the oak and ash. There are some very fine ornamental varieties, such as the weeping-beech and the purple-leaved. The common beech is greatly used now as a hedge plant. The timber is very hard, and extensively used in coach-building, turning, and cabinet-making.

The Scotch or Wych Elm (*Ulmus montana*).—This is a native of Scotland, and is a fine ornamental tree when of a large size. It forms a large head, with strong drooping branches. It may be known from its English neighbour by its heavy large branches, which are also of a rougher nature. The timber is very tough, and the quality is good. It is used for general country and agricultural purposes.

The English Elm (*Ulmus campestris*, Linnæus).—This is found growing naturally in England, France, and some parts of the south of Europe. It makes a fine park tree. The timber is hard and the quality good. It is used in making blocks for wheels.

The Horse-Chestnut (*Æsculus hippocastanum*).—This forms a large ornamental tree. It is a native of North America and Asia, and is a beautiful tree for parks and pleasure-grounds. The quality of the timber is soft and brittle, and of a white colour. It cannot be recommended as a timber-tree, but it is very ornamental.

The Spanish or *Sweet Chestnut* (*Castanea vesca*).—This is cultivated to a considerable extent in the south of Europe. It forms a magnificent tree, and may be often seen in this country attaining a height of from eighty to ninety feet. It forms a fine park tree, and the timber is very durable. Some fine trees of this description may be seen on the estate of Lofthouse, in Yorkshire, growing on a deep light loam. They have been allowed ample room to develop themselves, and are now fine specimens.

The Lime-Tree (*Tilia Europæa*, Linnæus).—This is indigenous to Europe, and grows to a height of from eighty to ninety feet. It is a very ornamental tree, having sweet-scented flowers. It is admirably adapted for avenues, pleasure-grounds, and parks. The timber is close grained, but soft, and is used in turning-work and in the manufacture of musical instruments. The bass ropes and mats which we use in this country are made from the inner bark of this tree.

The Walnut (*Juglans regia*, Linnæus).—This is a native of Persia, is valuable for its fruit, and forms a very large ornamental tree. The timber is used extensively in turning, cabinet-making, gun-stocking, &c.

The Sycamore (*Acer pseudo-platanus*, Linnæus).—This tree is indigenous to Europe, is a rapid grower, and very hardy. Its timber is much sought after, and is one of the most useful of our timber-trees. The timber is very close grained and easily worked. It is much used in making machinery and furniture.

The Norway Maple (*Acer platanoides*, Linnæus).—This tree grows well in this country. The timber is soft, but close in the grain, and can be highly polished. It is hardy, and succeeds in exposed situations.

The English Maple (*Acer campestris*, Linnæus).—This is a native of Britain, and is planted in this country as an ornamental tree.

The Birch (*Betula alba*, Linnæus).—This tree is distributed over Europe generally. It is a very graceful tree, and very hardy. It is a great ornament to Highland scenery. The timber is of a fair quality, and is used for domestic purposes, although not very durable. The bark is used for tanning purposes, and the timber is sold to be converted into charcoal for the manufacture of gunpowder.

The Weeping-Birch (*Betula alba pendula*).—This has all the properties of the former tree, but is more ornamental, in producing large pendulous branches. This is a beautiful tree for lawn and pleasure-grounds.

The Common Elder (*Sambucus nigra*, Linnæus).—This is a native of the greater part of the European continent. The wood is hard, and can be highly polished. The tree is ornamental, and very showy when in flower, and especially so when it is mixed in a woodland walk with trees of a darker foliage.

The Alder (*Alnus glutinosa*).—A common tree found growing in moist places over Europe. The timber is soft, but very durable under water, and is used in the manufacture of gunpowder and in chemical works.

The Thorn Acacia or *Locust-Tree* (*Robinia pseudo-acacia*, Linnæus).—This is a native of North America. It is a very ornamental tree. The timber is hard and durable, but as it generally grows with a very crooked stem, it is not much used.

The Black Italian Poplar (*Populus monilifera*, Aitchison) is a native of North America. It attains very large dimensions in this country, and ought to be more grown than it is at present. It is the most rapid growing of all the poplars, and sometimes attains the height of one hundred feet in this country. Its timber is used for cartwright purposes, turner-work, &c.

The Balsam Poplar or *Tacamahac-Tree* (*Populus balsamifera*, Linnæus) is also a native of North America, and attains a height of from forty to fifty feet in this country. The timber is soft and light.

The Lombardy Poplar (*Populus fastigiata*).—This is a native of Persia and Italy. It is a rapid grower, especially when planted near water. It grows in a tall upright form, and is easily distinguished from the other poplars. The timber is not valuable, but the tree has a very ornamental effect, and is a fine contrast with other trees in a park or pleasure-ground. An avenue of this kind of tree, planted in the village of Wass, has made an average growth of three feet per annum.

The Ontario Poplar (*Populus candicans*, Aitchison).—This is very like the balsam poplar; it is also a native of North America, and grows to a height of from fifty to sixty feet in this country. The buds in spring give out a pleasant balsamic odour, and when the leaves come out they have a yellowish colour. The leaves are large.

The Aspen Poplar (*Populus tremula*).—This is not a good timber-tree, but it is ornamental, and has a fine effect, from the trembling motion of its leaves. It makes very good copsewood.

The White Poplar (*Populus alba*, Linnæus) is a native of Europe, and is a fast grower, with a straight upright stem. It attains a height of fully eighty feet in this country, and makes a fine contrast amongst other trees, from the whiteness of its leaves. The timber is white and soft.

The Black Poplar (*Populus nigra*).—This is a native of Europe and Africa. It is a rapid-growing tree, and attains large dimensions in this country. It is used for the same purposes as the black Italian poplar.

The Grey Poplar (*Populus canescens*).—In good situations this tree comes to a large size in this country. Its timber is used for cooper-work and machinery purposes. It is very hardy and ornamental. When grown as coppice, it pays well, and is used for crate-wood and hampers, and is a fast grower.

The Service-Tree (*Pyrus sorbus*).—This is a native of Europe. It is not planted in this country with the view of producing timber, but for ornament. It grows to a height of from forty to sixty feet. The timber is hard, and takes a fine polish.

The Sloe or *Black Thorn* (*Prunus spinosa*, Linnæus).—This is a native tree of small size and of a coarse rambling nature, but useful as under-wood.

The Gean or *Wild Cherry* (*Cerasus sylvestris*) is a native of this country. The timber is close grained and firm. It is hardy, and grown for ornament chiefly.

The Common Hazel (*Corylus avellana*, Linnæus).—This assumes more the form of a bush than a tree in this country. It is indigenous to Europe, and very common as copsewood, and it is profitable to grow as such, being in much request for the making of crates, hampers, broom-handles, &c.

The Hornbeam (*Carpinus betulus*).—This is a native of Britain and Europe, and when cultivated in a good soil attains a height of from fifty to sixty feet. The timber is close grained and hard. It makes a good hedge plant. It resembles the beech, but may be distinguished from it by the feathery appearance of the leaves.

The Laburnum (*Cytisus Laburnum*).—This is a native of Europe, and is a slow-growing tree. The timber is very hard. It is, however, chiefly grown for the fine effect of the large clusters of yellow flowers which it throws out in a drooping form.

The Common Thorn (*Cratægus oxyacantha*).—This does not come to any considerable timber dimensions in this country; it is more of an ornamental bush. Its greatest use is in forming hedges, and for this purpose it is invaluable. If trained in a park or pleasure-ground, it is a fine-looking plant. Its flowers are sweet scented, and in the autumn its berries are very pretty.

The Huntingdon Willow (*Salix alba,* Linnæus).—This is a native of Europe, is easily cultivated, and grows to a height of from fifty to sixty feet. It grows very rapidly. Its timber is in much request, and is used for the same purpose as the poplar. It is a very graceful and ornamental tree.

The Bedford Willow.—A native of Britain. Is a rapid grower. It is found at from sixty to eighty feet in height in this country, and is worthy of being grown for its timber qualities.

The Osier Willow.—This is common, and is grown very profitably for the making of baskets, hampers, &c.

The Tulip-Tree (*Liriodendron tulipifera*).—This is a native of North America, and attains a considerable height in the south of England. Its timber has not been found to be very durable. It is cultivated in this country as an ornamental tree—having a bushy growth and curiously-shaped leaves, which give a fine contrast when mixed with other trees.

The Holly (*Ilex aquifolium*).—This plant attains a considerable size when grown in a good soil suitable to it. The timber is firm and close, and of a white colour. It is much used by cabinetmakers, turners, and engineers.

Section 8.—*The Thinning of Plantations.*

The leaves of trees are indispensable to their growth. Professor Lindley, in his 'Introduction to Botany,' states that "leaves are at once organs of respiration, digestion, and nutrition. They elaborate the crude sap impelled into them from the stem, decomposing its water, adding to its carbon, and exposing the whole to the action of the air; and while they supply the necessary food to the young tissue that passes downward from them and from the buds, in the form of alburnum and liber, they also furnish nutriment to all the parts immediately above and beneath them. There are many experiments to show that such is the purpose of the leaves. If a number of rings of bark are separated by spaces without bark, those which have leaves upon them will live much longer than those which are destitute of leaves. If leaves are stripped from a plant before the fruit has commenced ripening, the fruit will fall off and not ripen. If a branch is deprived of leaves for a whole summer, it will either die or not increase in size perceptibly."

Since this is the case, it must be very wrong to keep trees crowded amongst themselves, so as to prevent the leaves from growing. If we examine any plantation where the trees are all of an equal size and age, and growing on similar soil, we are almost certain to find that the largest trees are those which are situated on the outside of the plantation, or where they have had ample room to spread out their branches; and in a case of this kind it will be found that any trees which have had ample space to develop themselves will contain much more timber than those in the heart of the plantation, which, from being kept in a crowded state, are tall, drawn-up poles, with a few branches at the top. I consider it just as impossible for a tree deprived of the greater portion of its leaves to grow healthy and fast as for any person to undergo much exertion with a portion of his lungs gone.

It is a great error in the management of our woods and plantations to have them so generally kept in a crowded condition; and yet, after all that is known and taught us by vegetable physiology, we still find the greater portion of the woods and plantations in this country kept much crowded. There is no doubt that the larch disease is, if not caused by close crowding, at all events accelerated by confinement.

But, laying aside these considerations altogether, it is surprising that the increased growth in a properly-thinned plantation does not induce the proprietors of crowded plantations to have them properly attended to; and there is, besides, the value received for the thinnings to be taken into account.

As an instance of the importance of thinning plantations, I may mention two cases, in one of which two hundred and seventy acres of plantation, consisting of a crop of mixed hardwoods, was in 1861 valued at £4473. The trees were thinned in 1862, again in 1864, and again in 1866, when they were again valued in 1867, and the valuation amounted to £7694. The crop had thus made an increase in value, independent of the thinnings, of £3221; and the thinnings taken from the plantation during the years named amounted to nearly £3 per acre per annum.

In the other case, one hundred and forty-three acres of oak timber were valued at the sum of £4000 in the spring of 1863. The crop was thinned the same year, and again in 1866, and in the autumn of 1867 the standing crop was valued at the sum of £5801. These valuations were done at both times by two disinterested parties, and show the importance of attending to plantations regularly.

Young plantations of larch and pine, under ordinary circumstances, should be ready for a first thinning when from six to ten years old. This depends entirely upon the soil and situation in which they are grown. If the locality is warm and sheltered, and the soil good, the trees will of course grow faster, and will crowd upon each other sooner than when the situation is exposed, so that no time can be laid down beforehand as to the precise year in which any plantation will require thinning. This should be done whenever the trees begin to indicate a tendency to interfere with each other.

We very often find young plantations left unthinned until the trees are so crowded that all the side branches are completely dead, and then a pretty severe thinning is given; but instead of being thinned gradually, a great number are taken out at a time, and at long intervals; and the consequence is, that the trees receive a sudden check, from which they do not recover afterwards, and the growth made by them is very small.

The only way to keep plantations in thorough good condition, and to take the greatest income from them over the whole period of their existence, and at the same time to leave the greatest amount of value of crop on the ground, is to commence thinning them whenever they may appear to require this,—and that period is whenever the trees indicate that they are interfering with one another too much. I say *too much*, as in my experience I find there is a certain amount of crowding required to check the trees from growing too freely to branches. It is necessary to keep them at a certain distance, so as to check the branches from overgrowth, but not so crowded as to kill them. If the branches are allowed to grow freely and without being checked in any way, the result will be that the tree will grow larger in branches and not so much in stem as would be the case if the growth of the branches had been checked.

It is a difficult thing to state the exact distance at which trees should be kept; it must be learned by practice and experience.

At each thinning it should be kept in mind to leave as much as possible the strongest plants on the ground, and to remove the weaker ones.

In fact, in thinning any plantation, this should be done on the principle of removing gradually and from time to time the weaker portion of the crop and the least promising trees, and of leaving at each time of thinning the strongest and healthiest, and those which are most likely to become valuable on the ground, keeping them at such distances apart as will not overcrowd the trees.

If plantations are not attended to in the way of thinning, the trees become tall, weak, drawn-up poles, and are matured before they are of any useful size. When plantations are allowed to go on from year to year for a long period without being thinned, they become in such a state of closeness that it is almost impossible to improve them. When this is the case, and an attempt is made to thin the plantation by taking a few trees out, the first storm that occurs is almost certain to do a large amount of damage, until ultimately the wood becomes a complete wreck. Where the trees have reached a period when it is almost impossible to improve them, the most profitable way, therefore, is to have the entire crop removed and the ground replanted. This is especially the case where a crop of larch and Scots pine has become drawn up, and left in a neglected state for a length of time.

There is a better chance of improving a mixed plantation of hardwoods which has been neglected; but even in that case, when they have been kept long crowded and uncared for, they become matured at an early age, and cannot be materially improved.

When hardwood trees are planted along with larch or other trees for nurses, with the view of the hardwoods becoming the standard crop and the larch taken out as thinnings, the former should not be kept too much confined, as is frequently done. We often meet with plantations which have been for some time in existence, where the crop consists of hardwood trees standing at distances varying from fifteen to twenty feet apart, and larch amongst them. In cases of this kind, many foresters allow the hardwood trees to be crushed, and more attention is paid to the larch; but the hardwoods should have sufficient space to grow, as they are intended to stand after all the larch have been removed.

In thinning plantations composed solely of a crop of mixed hardwoods, the principle of thinning should be to take out gradually, and from time to time, the weakest trees, and those which are likely to make the least progress, leaving those which are likely to come to the most value in the shortest space of time as the crop.

Many landed proprietors desire to keep their plantations thick and crowded, from an idea that they give the most shelter in that state. For a few years they no doubt afford a great shelter when kept thick; but, from their crowded condition, the branches very soon become dead for fully more than half-way up the tree, and then there is less shelter afforded than if the trees had been allowed proper space. When plantations have been judiciously thinned, and the trees allowed to spread their branches out to a certain extent, so as to meet each other, but no more, they give a larger amount of shelter than if they had been allowed to become tall, drawn-up, branchless poles.

In thinning out plantations or clumps, the ultimate crop of which is to form park trees—or in pleasure-grounds, or in any case in which the trees are wished for ornament only—they should be constantly kept quite free of each other, so as to allow each specimen to develop itself fully.

The extent of thinning to be carried out in any plantation must depend in a great measure upon its situation and exposure, and also upon the character of the soil, and the nature and character of the crop.

In a case of thinning neglected plantations, it will often be found impossible to leave the trees at regular distances. Some years ago I received the management of a considerable extent of mixed hardwood plantations in the county of York. The crop was copsewood, grown from the old stocks. At the time I commenced operations the trees were about twenty-five years old; and during the whole period from the time of their first year's growth till they were twenty-five years old, very little had been done to them in the way of thinning. Some portions had been certainly thinned where the timber could be easily got at, but this had been overdone, as large gaps had been left in the wood. Over the greater portion of the plantations there would be an average of four trees on each stock. The crop consisted chiefly of oak, ash, elm, and sycamore. In the course of the first thinning, I took only the very smallest, weakest, and most unhealthy of the crop, still leaving a large thick crop on the ground; but in this case the trees had been crowded, and were drawn up, and consequently great caution had to be used at first in thinning them, so that instead of taking a large number out at one time, I decided upon taking out only a few at each thinning, and to thin at short intervals. Accordingly I thinned them again in two years from the time the first thinning had been carried out. On the next occasion, I thinned the shoots amongst themselves, taking out the weakest and those most likely to make the least progress; and, generally speaking, the ash and elm were taken out in preference to the oak and sycamore on the lowest portions of the plantations, and where the soil was of the best quality. On the higher grounds, and where the soil was not so good, I preferred leaving the ash, elm, and sycamore as the crop, and took out the oak instead.

These plantations were again thinned in three years from the time the second operation was conducted, and were done on the same principle as already stated in reference to the second thinning leaving at each thinning the trees just touching each other, but no more.

These plantations have yielded a large income since the thinning operations have been commenced; and the result at the present time is, that the crops now are worth fully double the value they were in the year when the first thinnings were made, and they are in a healthy growing state, and will continue to give a large annual income for many years to come.

The thinning of plantations on all estates should be carried out in a regular systematic way. Like everything else on a landed estate, the management of the woods and plantations should be reduced to a system; and if this is done, the different operations will be carried out more economically, and with greater advantage to the crops, than if they were done at random. With a view to this, the plantations should be divided into different classes, according to their ages, and these classes divided into equal portions, and a portion taken in hand and operated upon in each year. We shall, for instance, suppose that there are two hundred and twenty-five acres of plantations on an estate, varying in age from ten to twenty years; then we should divide that extent into three equal portions, and let one portion be taken in hand and thinned and otherwise improved in each year. Presuming one portion was dealt with in 1868, a second would come in to be operated on in 1869, and the third in 1870. Then the first portion that was dealt with in 1868 would again come to be further improved in 1871.

Again, presuming that there are three hundred and sixty acres of plantations on an estate, varying in age from twenty to thirty-five years, we should divide this extent into four equal portions, and take ninety acres of it to be dealt with in each year, and carried out in the same manner as already described in the preceding paragraph.

If there should be any considerable extent of woods varying from thirty-five to fifty years old, we should divide this class into five equal portions, and take one portion to be thinned and otherwise dealt with in each year,—and so on. As the ages of the wood increase, they will not require to be thinned so frequently, as the older the trees get, they are the less inclined to grow branches, and therefore will take a longer time to meet each other.

All thinning operations should be carried out in the spring of the year, as the remaining crop has the full year to improve before the winter blasts come. If thinned in the autumn, the crop is at once exposed to the cold winds and storms before it has had any time to recover itself.

Plantations which are kept thick and crowded prevent a free circulation of air in the districts in which they are situated; and when there are large masses of such, I believe that they are also prejudicial to the health of the population. Where thinnings are systematically carried out, the health of the district is improved. This is shown in the following paper, on Arboriculture as a Science, which was read before the British Association at Dundee in 1867, by Mr William Brown, factor to Colonel Farquharson of Invercauld:—

I have yet to learn that this Association, or any other with similar objects in view, has ever taken up in a right way those points in the scientific culture of trees, the elucidation of which are so much wanted to guide and assist the practical forester; or those influences, good or bad, which trees are found to possess over the soil and climate, and hence over the health of other vegetation, besides animals.

There has not, perhaps, been occasion for such a notice of what some may consider as merely a branch of agriculture, and who may therefore object to giving arboriculture any independent standing; but I wish now to remove this objection, and to claim for it that position which I hope to show its importance deserves. I leave it to the critical assorter of scientific subdivisions to say under what particular heading my subject should be placed. All I want is its proper recognition as a science—on what grounds, a few facts will suffice to show.

The area of Great Britain is about 57,000,000 acres, of which it is estimated 2,600,000, or 1-22d part, are under a crop of wood of all kinds and ages; or, more particularly, the whole surface may be divided into five grand divisions, thus:—

	Acres.
Corn crops,	9,300,000
Green crops,	3,500,000
Grass,	15,800,000
Wood,	2,600,000
Uncultivated,	25,800,000
	57,000,000

There is, then, in our island, one acre in every twenty-two covered by trees, or only one-third less than what is under green crops. To every eleven acres of cultivated land there is one of wood, and one to every sixteen of uncultivated. Had this wood acreage no existence, the other figures would have a different appearance, as trees, as a whole, being almost disconnected from the main body of the uncultivated, the crops and grass would probably not show half what they now do; and in place of 26,000,000, the uncultivated would stand about 40,000,000.

Without its timber, Britain—and more especially other countries, less favourably situated as regards latitude and sea influences—would, it may be safely said, never have attained its present eminence, either politically or agriculturally. The gross land rental of Britain being about £53,000,000, or 18s. 6d. per acre overhead, but 30s. when confined to the cultivated; and as a wood crop is found to return as much, on an average, as arable, we find the annual value thereof to be no less than £2,500,000—a financial fact to tell in favour of the object of this paper.

While trees regulate a climate, it is also a fact that injudicious clearing or over-planting respectively cause aridity and humidity. Most calamitous effects could be instanced, especially in foreign countries, from the reckless sweeping away of forests, whereby destructive inundations are frequent, and the country around has become a waste.

The want of a due proportion of a country under a tree crop is certain to cause irregularity of temperature, violent storms, and dryness.

On the other hand, a country may be overclothed with wood, so as to bring about just the opposite effects, which, besides their more immediate results, are well known as generators of disease. Upon the grounds of these few facts, then, it is evident that a climate may be *made*, or at least regulated, by man, to suit different crops and districts. This is a power in our hands which seems to have been overlooked, and surely it is one of invaluable importance. As a certain body of trees do influence, one way or another, the climate of its neighbourhood—just on the same sort of principle, though in a different manner, as hills or large surfaces of water are found to do—it really results that, by a proper distribution of variously-sized plantations, man may come to suit in degree the climate to the plant, and not so much the plant to the climate, as he must do in present circumstances.

As illustrative of the effects of trees on the health of the population, I would refer to the districts of Grantown and Abernethy in Strathspey, which before 1856 were covered with some 15,000 acres of nearly continuously close masses of plantation and natural forest. After 1856, and to this date, a regular system of thinnings and clearings have taken place. The population of these districts in 1861 was 5871, and the extent embraced is some 90,000 acres—thus showing one acre of wood to every six of other crops or waste land, being double the average of the kingdom.

The Registration Act not having come into operation previous to 1855, prevents the possibility of getting reliable information as to the percentage of deaths when the country lay under a close mass of wood; but as from that date to 1861 is sufficient to allow for any change of climate brought about by the thinning and clearing, we can ascertain in what way it has become perceptible.

The following table shows the deaths for the four years ended 1865 :—

Districts.	Population, 1861.	1862.		1863.		1864.		1865.	
		Deaths.	Percentage to Population.	Deaths.	Percentage to Population.	Deaths.	Percentage to Population.	Deaths.	Percentage to Population.
Grantown, ...	3943	77	1.95	73	1.85	66	1.67	63	1.34
Abernethy, ...	1928	39	2.02	38	1.97	28	1.45	18	0.95

We find, then, that the deaths have decreased gradually every year, from 77 to 63 in the one district, and from 39 to 18 in the other. In figures, the difference of 0.85 per cent over the whole may seem small, but it really represents 49 deaths a-year, which is a very large decrease in a rural population, and more especially as the bad influences of too much wood in Highland inland districts such as these must be counteracted by altitude and the surrounding mountains.

Of course it is almost impossible that a yearly decrease should continue; and besides, it may be that previous to 1855 the deaths were some years as low, if not less, than any of those given. (Since writing these notes, I learn that the deaths in 1866 were 70, which is just the average of the four preceding years.) There are invariably fluctuations in all districts ; but no epidemics having occurred, we are led, without doubt, I think, to attribute the great and gradual decrease of deaths in that part of Strathspey mainly, if not altogether, to the wood surface having been brought down to a more healthy proportion.

A similar plan of improvements among the woods is in progress in the district in which I reside, and it will be to me very interesting to note the effects.

Some still say that nature is the best forester in the sense of thinning or regulating the number of trees on the ground ; but neither in this nor in the extent with which we are provided with them *naturally*, does it suit, as we have seen, to allow things to have their own way. Yet I am to take advantage of the fact of nature's bounty, and to say that the great importance of arboriculture is more manifest from the early care which she takes in covering the surface of countries with trees.

It may be safely said that civilisation cannot advance without trees, and that those must be the most civilised people who cultivate them on scientific principles.

Purely practical men may say they want nothing more to guide them as to which trees are suitable to various soils, elevations, and exposures ; and securing these, the results or effects produced must, as a natural consequence, be of the most satisfactory and of one kind—namely, healthiness ; but while quite sufficient so far, it cannot subserve the purposes of science as to the health of the people, and other influences.

Practical forestry has made great strides during the last thirty years. It has been slow but sure ; and from this I would fain predict that so sure will be the ultimate success of arboriculture as a standing science in our country. I can well see that to *know a tree*, in every sense of the word, will yet become the aspiration of every sound-thinking man.

But to attain to this, and to bring arboriculture, as a science for everyday use, within the grasp of not only the practical woodman, but the majority of landed proprietors, it is necessary that some system for guidance as to observations or other information should be established by a body of scientific men. It is no doubt a wide field, out of which much more may issue than the few indications I have briefly sketched. I have barely introduced the subject, but this is not the time to go into detail ; and if I do not succeed in gaining for arboriculture such a position in science as I think its importance deserves, I hope I have suggested as much as will lead to at least a careful consideration of it, which in its turn will, I trust, result in encouragement to go the length of your giving—as you say yourselves—a systematic direction to scientific inquiry on the subject.

Much gratification was expressed at this subject having been brought before the Section, and Mr Brown was greatly complimented for his interesting paper.

SECTION 9.—*The Pruning of Forest-Trees.*

There are great differences of opinion existing amongst practical foresters as to the pruning of forest-trees. Some think pruning not only unnecessary, but prejudicial to the health of the plants, and also that certain modes of pruning injuriously affect the quality of the timber afterwards. On the other hand, there are those who approve and adopt pruning to a moderate extent, while others prune largely. I must acknowledge myself to be amongst those who adopt pruning moderately. We know that the leaves of a tree are essential to its growth ; and if pruning is carried out extensively, a large amount of leaf-bearing surface is removed, and therefore must be prejudicial to the growth of the tree.

If trees, after being planted, are kept at proper distances from each other, there will not be much occasion for pruning, at least in the side branches of the trees, as nature will be her own pruner. There are instances, however, which occur amongst trees in plantations, which require some attention in the way of pruning. As a rule, I would say, "Prune not at all;" but, as I have already stated, there are instances where pruning, applied judiciously, is of great advantage. If it be properly carried out in such cases, the trees so treated will be much improved; but, on the other hand, if pruning is carried too far, or be ill directed, the result will be mischievous.

The object of pruning, or indeed of any other attention to trees, is to increase the quantity of timber. When pruning is necessary, this should be done before the branches have attained any considerable size, as a great amount of harm is done by removing large branches from the trunk, it being always found that the timber round the part cut is injured, and proves worthless. No branch over three or four inches in diameter at the part to be cut should be removed from a tree close to the stem. In such cases I would prefer shortening the branch merely, as where any strong branches interfere with the growth of the main trunk, all that is necessary is to check the growth of these branches —it is not necessary to remove them.

It is a common practice amongst foresters to take off the greater portion of the side branches of young hardwood trees previous to being planted, and also after they are planted. It may have been observed that where those cuts have been made there are usually a number of small shoots which spring out from the cut or round about it, thus showing that the sap has been attracted to these points, or been stopped in its upward course. I have also frequently observed that where young trees have been severely pruned of their side branches, the sap was so much checked in its upward course that the top died out.

All the pruning that is necessary for young forest-trees may be done in the nursery previous to their being removed into the plantations, and this should be done by removing any very small branches or buds found growing very low down on the stem, and those are better removed by the finger and thumb than by using a knife; and we should also check any branches in the top of the tree which may be getting too strong, so as to interfere with and get the mastery of the leading shoot. Where any branches of that kind are found, it would be acting injudiciously to remove them close to the stem, as this would remove a great number of leaves, and consequently of so many mouths which feed the plant; but the branches should be cut through about half-way from the trunk, or from that to two-thirds of their entire length from the stem. In such cases, what is wanted is not the removal of the branch, but the checking of it so that it may not interfere with the growth of the main stem.

While a tree is young, the branches should be so checked and regulated as to give the leading shoot full advantage; and where this is done in time, it will not often be found necessary afterwards to use the knife.

There are many cases, however, where trees have been long neglected, and by throwing out strong side branches, interfere with the tree's growth to timber. Where this is the case, we should prune up the side branches of the trees from about four to five feet from the ground—that is, supposing the trees to be from fifteen to twenty feet high, or more; and we should also check any strong side branches which might be getting too much ahead of the others; and where there were two or more leading shoots, let them be reduced to one, choosing in all cases the strongest and best in every respect as the shoot to carry on the stem of the plant.

We have lately pruned a number of young oak-trees on the estate of Wass. They averaged about seven feet high. The trees were healthy, and very much given to throw out strong side branches. In pruning these, we first cut off all the side branches close to the stem that were not more than one inch in diameter, and these were removed to a little over two feet in height up the stem. Where there were any branches exceeding one inch in diameter at their base, we did not remove these, but shortened them; and any large branches in the top which were growing too fast, and likely to interfere with the leading shoot, we cut off at about half their length; but in several instances we found two shoots leading, and in those cases we removed the weakest close to the stem. In about two or three years after this, we shall go over this plantation again, and remove close by the stem those low branches which we have foreshortened. The reason why we prefer shortening the branches previous to cutting them close off is, that by doing so the flow of sap is checked in the branches, and the shortened part which remains is weakened, and can be afterwards removed with less danger than if it had been taken off all at once.

Pruning is at all times against nature, and therefore I advocate as little of it as possible. Where it is chiefly wanted, is to check strong branches, or in the removal of one leader where two or more exist.

This operation should be done in the months of May and June, as then the wounds have time to heal before winter. Any pruning after these months will be comparatively fresh when frosts set in, and the plants will suffer accordingly.

Coniferous trees should not be operated upon with the knife, as the wound made by it seldom heals up satisfactorily, but keeps breaking out each year as the sap comes.

With this class of trees, where a branch is inclined to get too strong, or a top shoot is seemingly taking advantage of the leading shoot, I have always advocated and adopted the plan of checking these branches by pinching a small portion off the end with the finger and thumb.

During the summer of 1867 I had a number of *Wellingtonia sequoia* in my garden from a foot to five feet high. Many of these I found, in the month of May, with two, three, or four shoots striving for the lead. Some I checked by pinching off about half an inch from the top, others I cut off altogether with a knife, and left a few untouched. I examined them from time to time during the summer, and in the month of October I found those which had been shortened by pinching the shoots had made an average growth of sixteen inches; those which had been cut with the knife had made an average growth of seven inches, and the cuts were partly fresh; while those which had been left untouched had all grown slowly together, and had not on the average made more than four inches,—thus proving in favour of the plan of pinching with the finger and thumb.

Coniferous trees should, however, be pruned of all dead branches on their stems. We very often find larch and Scots pine trees especially growing with a number of dead branches on their stems, which the bark and growing timber gradually cover into the trunk of the tree, and thus spoil the quality of the timber. All these dead branches should be removed as they die, and the result will be an improvement of the timber.

The implements we employ for pruning operations are the pruning-knife, saws, and chisel.

The knife which I use is that made by Saynor, and it is found very useful in cutting off the lower branches, such as a man can reach.

In cutting off a branch at the stem with a knife, the pruner takes hold of the branch in his left hand and slightly lifts it up. Where the tree is not large, the pruner stands with the stem of the tree in front of him, having the branch which is to be cut on the opposite side, and at the same time he lifts the branch with the left hand; then he cuts it across with the knife in the other, entering the knife on the low side of the branch, and cutting upwards, taking care not to enter the stem of the tree, but merely to get the branch off without making a larger wound on the stem than the base of the root of the branch covers.

Fig. 113.

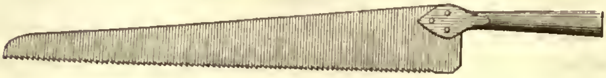
Branches which are too large to be cut with the knife will require a hand-saw such as is represented in fig. 113. This is useful for the operation while standing on the ground; but before sawing a branch with this, the under part should be cut about half an inch, to prevent splitting when the branch falls off.

When the pruner cannot reach a branch from the ground with his knife or hand-saw, then we use the chisel, fig. 114, or the pole-saw, fig. 115, as the case may require.

FIG. 114.

The chisel is used by holding it to the part to be cut, and

FIG. 115.



giving it a stroke on the end of the handle so as to drive it through the branch.

The pole-saw is useful in removing branches larger than can be safely cut with the chisel, and also in taking off any dead branches. Any length of pole can be attached to either chisel or pole-saw.

Fig. 116 is a form of pruning-shears we have had for some time, and which are very useful for cutting small branches in the tops of trees that require checking. They have handles attached of any length requisite.

FIG. 116.

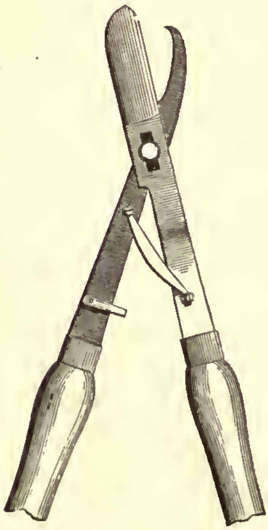


FIG. 117.

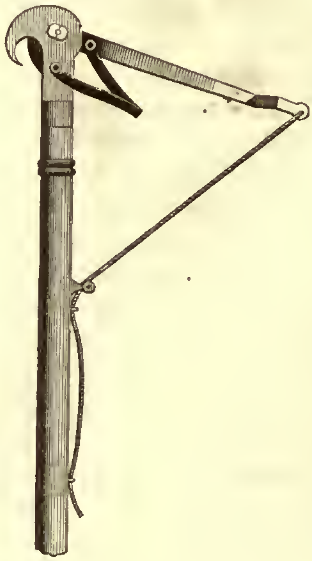


Fig. 117 is called the averuncator, from the Latin *averunco,* to prune. It consists of a double blade, the one being fixed and the other movable; these are attached to a handle of any requisite length. The movable blade is made to operate by a lever power, and this is done by means of a cord passing through a pulley, which the operator pulls. When pulled sharply, the cutting blades are brought together, and when a small branch is placed between them it then cuts it.

Section 10.—*The Disposing of Timber.*

There are three ways of selling timber—namely, by *private bargain*, by *tender*, and by *public auction*, all of which have their advantages, according to the amount of timber for sale.

Selling by private bargain should be done only where there is but a small quantity to be disposed of, unless a price per foot be agreed upon and every tree measured. This is a very safe system with measurable timber; but with small thinnings, or what may be called not measurable timber, these often sell to the best advantage by public auction, as there is generally a good competition amongst farmers and others for such sizes for fencing and other purposes.

When there is a large amount of timber to dispose of, it may be best in some instances to offer it by auction; but this may not answer the purpose well where the district is out of the way and inaccessible, which may keep timber-merchants from becoming purchasers.

Timber-merchants are very cautious about running risks, and they are very fond of reaping good profits, so that in disposing of timber a forester requires to be a good judge of its value, and the way in which to dispose of it.

The best time to dispose of all thinnings from which the bark is not to be removed is in the autumn and winter months.

Those which are to be barked—such as the oak and larch—must of course be cut in spring; and if to be sold standing, should be disposed of in February and March.

In cutting and felling the trees in plantations of large extent, it will be of advantage for the forester to mark the thinnings and then have the felling done by contract; and an agreement should be drawn out and signed by the contracting parties, containing the specifications of the work to be done—which should state the way in which the trees are to be cut, dressed, and lotted, and the length of time specified for the completion of the work. The mode of cutting and lotting must be guided by the size of the thinnings. As a rule, I prefer throwing all trees with the cross-cut saw that stand six inches in diameter, and any other trees that may be under that size with the axe. Previous to felling a tree with the saw, it should be slightly notched in with the axe on the side to which it is to fall.

Steady careful workmen should only be employed in the thinning of plantations, as, if they are not proficient and careful, great damage may be done to the standing trees from the falling of the others.

Each tree should be neatly pruned of its branches after it is felled, and left in its full length and not cut across. Timber-merchants generally prefer purchasing trees which are not cut into lengths, as they can then turn them to any purpose that may suit them.

In preparing thinnings for sale, all the trees should be taken to the roadsides and put into lots, each kind by themselves, and each size and quality separately ; that is to say, inferior trees should be lotted by themselves, and where it can be done conveniently, the trees in a lot should be all of a size. The lot will look better in this way, and a higher price will be got for it, as it will then be laid out according to the probable wants of the purchasers.

In preparing in this way for public sale, all the lots should be numbered. I usually do this with red paint. After the whole is done, the forester should commence at No. 1 of the lots, and go over the whole and value them, entering the number of the lot, the number of trees in each lot, and the kind of timber, in a book, along with the valuation of the same. The following statement will illustrate the way in which I have generally done this :—

THINNINGS lotted for SALE on the ESTATE of WASS, 2d April 186 .

Name of Plantation.	No. of Lot.	No. of Trees in each Lot.	Description of Timber.	Forester's Valuation.	Name and Address of Purchasers.	Sum sold for at Sale.
				£ s. d.		£ s. d.
Abbey Bank, . .	1	8	Ash.	1 4 0	William Frank, Helmsley.	1 2 6
do. . .	2	11	Elm.	0 13 0	John Smith, Coxwold.	0 14 6
do. . .	3	9	Ash.	1 12 6	William Frank.	1 11 6
do. . .	4	12	Sycamore.	2 8 0	do.	2 6 0
do. . .	5	14	do.	3 0 0	do.	3 3 0
Hollen Bank, .	6	2	Larch.	0 19 0	do.	1 0 0
do. . .	7	1	do.	0 9 0	James Robson, Thirsk.	0 10 0
do. . .	8	1	do.	0 10 6	do.	0 10 0
Tower Wood, . .	9	9	Beech.	2 5 6	Wm. Smith, for N.E. Railway Co.	2 7 0
do. . .	10	7	Ash.	1 1 0	do.	1 0 0
do. . .	11	6	Firewood.	0 4 6	Thomas Beetham, Wass.	0 4 0
do. . .	12	13	Elm.	3 2 6	William Frank.	3 2 0
Duckendale Plot,	13	8	Ash.	2 17 0	do.	2 17 0
do.	14	8	do.	2 19 0	do.	3 0 0
		109		£23 5 6		£23 7 6

The foregoing shows the method of entering in my note-book the lots, numbers, valuations, and result of a small public sale. Extensive sales are conducted in a different way, as will be afterwards shown. With such a statement taken previous to the day of sale, the forester will be prepared to see how the sale goes on, and whether he is receiving the full value of the thinnings, provided his own valuation has been carefully taken.

The first five columns will of course be filled in before the sale, the remaining two as the sale goes on.

Having got all the lots in order, the sale will then have to be brought under the notice of the public; and this is usually done by advertising in any local or other papers where the notice is likely to be brought most prominently before parties for whom the timber is suitable, and also by putting up handbills in public places.

Where there is only a small quantity of timber for disposal, the demand will most probably be local, and therefore local notices will suffice; but where there is an extensive sale, purchasers will be induced to come from a distance, and therefore a more extended notice must be given.

Previous to the day of sale, the conditions under which the timber is sold must be drawn out, which will be read to the company present by the auctioneer.

The following is a copy of the conditions of sales on this estate when sold by public auction:—

CONDITIONS of SALE of WOOD to be sold by Auction on Wednesday the day of 18 .

1. The highest bidder to be the purchaser, with the exception that if the last or best bidding shall be considered by the forester to be below the real value of the said lot, then the same shall be reserved to the proprietor.

2. Should any dispute arise between two or more bidders, the lot in dispute to be immediately put up again and resold.

3. All the wood to be removed and every other expense performed by the purchaser, and to be at his own risk after each lot has been knocked down by the auctioneer.

4. In its removal from the ground, or any way on the estates through which it has to pass, the purchaser must at all times be under the control of Major Stapylton's forester.

5. Purchasers will be allowed until the of to remove their purchases from the estate. Any timber found on the ground after that date will belong to the proprietor of the soil.

6. Any damage done to standing timber, or other trees, lands, crops, gates, or fences, shall be paid for by the purchaser, who must at once pay the amount on its being ascertained by the forester, whose decision shall be final on such matters.

7. Payment of the purchases to be made to the forester within six days. In the event of a settlement not being made by that time, the timber will again become the

property of the proprietor of the soil, and it shall be optional for him to re-expose the same for sale, or otherwise, as the forester shall think proper.

8. The purchaser shall sign the conditions of sale, thereby becoming bound to fulfil the same.

The foregoing conditions are suitable for a small sale of timber, and where there is only a local demand.

In conducting large sales of timber by public auction, it is always best to sell the trees standing, as then a good price can be got for them before they are sold. I have known instances in which large lots of timber were cut down before offering it for sale, and it had to be sold at a low price at last, as it was beginning to spoil.

The thinnings and clearings should therefore be marked and laid out in distinct lots, and a valuation of the whole should be taken in something like the following form :—

ALLOTMENT and VALUATION of PINE TIMBER standing marked in the Forest of , as proposed to be sold in the on Wednesday the day of 18 .

Name of District.	No. of Lot.	No. of Trees in each Lot.	Rate per Tree.	Valuation.	Not to be sold under	Sold at	Name of Purchaser.	Remarks.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.		
Cavour, . . .	1	2,100	0 3 8	405 0 0	384 0 0			Last bidding, £350 ; not sold, by
do. . . .	2	2,197	0 3 8	422 15 8	400 0 0		Peter M'Anish.	
do. . . .	3	2,200	0 3 8	423 6 8	405 0 0		do.	
do. . . .	4	2,163	0 4 8	504 14 0	480 0 0		John Duncan.	
do. . . .	5	1,000	0 4 8	466 13 4	443 0 0		do.	
do. . . .	6	1,800	0 3 8	330 0 0	315 0 0			Not sold—no offerers.
Grenash, . . .	7	116	0 6 6	38 0 0	36 0 0			Not sold ; last bidding, £25.
Syngarie, . . .	8	600	0 6 8	200 0 0	190 0 0		Peter Grant.	
Davroick, . . .	9	4,509	0 2 8	600 0 0	570 0 0		Andrew Oswald.	
		17,685		£3390 9 ·8	£3223 0 0			

An advertisement should next be inserted in some of the most widely circulated papers.

The trees in each lot should all be marked, and their value taken when marking them. In doing this, the forester should go along with two men. One man takes a chip off the side of the tree with an axe, and deep enough to take off the bark into the hard wood; and he goes on in this way from tree to tree, as they are pointed out to him by the forester. The other man comes behind the first with a paint-pot and brush, and numbers the trees, putting two numbers on the tree—one at the top, showing the number of the lot; and the other number at the bottom, showing the number of the tree in the lot. Thus the first tree in the first lot would be numbered $\frac{1}{1}$, the second tree $\frac{1}{2}$, the third tree $\frac{1}{3}$, and the fourth tree $\frac{1}{4}$—and so on. While the men proceed in this way, the forester points out those trees which are to be marked, and also enters their value—that is, of each tree—in his note-book.

Previous to the sale, the conditions under which the lots are to be sold will require to be drawn out, and this must be done in more particular terms than in the case of a small sale. The following is a copy of conditions of sale under which we have sold large lots. With some slight alterations, it is applicable for the sale of any description of timber:—

CONDITIONS of SALE of PINE TIMBER in the FOREST of , the property of , to be sold by Auction at the instance of , Agent, for and in behoof of , the Proprietor, within the , this day of eighteen hundred and .

1. The highest bidder to be the purchaser, with the exception that if the last or best bidding shall be considered below the real value of the lot, then the same shall be reserved for the proprietor. And should any dispute arise between two or more bidders, the lot in dispute to be immediately put up again and resold. The sale to be conducted in the presence of the officers of the estate.

2. In bidding for the timber, no person shall advance less than £1 at each bidding when under £50, and £2 when above £50 and under £100, and £5 when above £100, and no bidder to retract his bidding.

3. The purchasers to pay down immediately into the hands of the auctioneer a deposit of £20 per cent in part payment of each lot, and sign agreements for the remainder of the purchase-money by approved bills at three months, payable at a banker's in , such bills to be drawn by the purchaser and accepted by some person or persons to be approved by the , and no part of the timber to be taken away until such bills are accepted, approved, and delivered to the said ; but should the purchaser be desirous of making a prompt payment, a discount of 2½ per cent will be allowed upon the payment of the balance of such purchase-money if paid within one week of the day of sale.

4. The timber to be cut and removed at the expense of the purchaser before the day of 18 next, doing no injury to the standing timber, and the same to be taken by the purchasers without any claim for compensation whatever for any

defects which may then or thereafter be discovered. If any wilful damage should be done to the standing timber or other trees, the amount thereof to be estimated by the agent of the estates, which shall be final and binding; and the amount thereof, together with the expenses of such settlement, to be borne and paid by the purchaser of the lot or lots in question.

5. The lots after the sale to be at the risk of the purchasers, and not of the proprietor; and no lot shall be removed without delivery thereof by the proper officer of the estate, and any person presuming to remove any lot without such delivery, will be considered a wilful trespasser, and prosecuted accordingly.

6. The trees constituting each lot are believed to be correctly numbered, marked, and described; and the purchasers are to take the same as being correctly numbered, marked, and described, without being entitled to any compensation or abatement from their purchase-money by reason or on account of any deficiency or mistake, or alleged deficiency or mistake, in quantity, quality, number, or description. And should any dispute arise between any of the purchasers as to any tree or trees, mark or marks, number or numbers, belonging to any lot or lots, the same shall be referred to a person appointed by the agent in charge of the estate, whose decision shall be binding and conclusive upon all parties.

7. Should the purchaser or purchasers fail to comply with any of the above conditions, the deposit-money shall be forfeited, the vendor shall be at full liberty to resell the said lot or lots, either by private sale or public auction, and the deficiency (if any) by such second sale, together with all charges attending the same, shall be made good by the defaulter or defaulters at this present sale.

8. The proprietor, the said   , his heirs and executors, always retaining and reserving to himself and heirs aforesaid a right of lien or hypothec, and prior and preferable to all other parties whatever, over the timber sold in the forest until the purchaser's bills or purchase-prices are duly paid; and any person failing to clear the forest of his purchase within the time prescribed, shall forfeit and lose whatever timber belongs to him that may be found in the forest after the expiry of the time allowed for removal, and the same shall revert to the said proprietor, or his heirs or executors.

9. Purchasers may erect saw-mills or other means of manufacturing the timber in such sites and situations as the agent shall point out.

Such conditions must of course be drawn out on stamped paper sufficient for the value of the sale, and signed by the proper parties connected with it, by the purchaser, and by witnesses to each signature.

In the summer of 1867, I was called upon by the managers of an estate in Lancashire, which was in the hands of the Court of Chancery, to inspect and report upon the woodland on the estate. I marked and valued a large number of oak, ash, elm, pine, sycamore, alder, willow, poplar, birch, lime, chestnut, and beech trees, and described and divided them into lots which I thought would be suitable for purchasers. The lots were sold by auction, pursuant to an order of the High Court of Chancery, and with the approbation of the judge of the court.

The estate is intersected by good roads, and the lots lay contiguous to the Leeds and Liverpool Canal, and there are two stations of the London and North-Western Railway on the property.

I assisted in drawing out the conditions of the sale, the following of which is a copy, and it may be useful to many foresters:—

Conditions of Sale.

1. The highest approved bidder shall be the purchaser, and should any dispute arise between two or more bidders, the lot in dispute shall be put up again and resold.

2. The sale is subject to a reserved bidding for each lot, which has been fixed by the direction of the judge to whose court these causes are attached. No person shall advance less at any bidding than the sum named by the auctioneer previous to the sale, and no bidding shall be retracted.

3. The purchasers shall pay down immediately after the sale into the hands of R—— T——, Esq. of , Leeds, the receiver appointed in the above-named suits, or of some person authorised by him, a deposit of 20 per cent in part payment of their purchase-money, and sign the agreement at the end hereof, and pay the remainder of their purchase-money to the said R—— T——, less 2½ per cent discount thereon, within fourteen days; or the said R—— T—— may take from any purchaser a bill or bills for the unpaid purchase-money drawn by some party and accepted by the purchaser or some other security with approved sureties payable to the said R—— T—— on or before the 25th day of March 1868, or such other day as the said R—— T—— may fix; but this condition is not to be considered as obligatory on the vendors. Tuesday the 7th day of January 1868, at twelve o'clock noon, at the chambers of the said judge at No. 11 Old Square, Lincoln's Inn, is fixed for the certificate as to the result of such sale.

4. The whole of the timber shall be felled by and at the expense of the purchaser, under the direction and in the manner to be prescribed by Mr F——, or the agent of the vendors upon the estate for the time being, so far as practicable at the time of the sale; and the same shall be axe-fallen, stub-fallen, or sawn as he may direct, in a workmanlike manner; and the bark of each oak-tree shall be hatcheted round the root before it is felled; and the wood and timber purchased shall be taken by the purchaser without any claim for compensation whatever for any defects which may then or thereafter be discovered.

5. The purchaser shall at his own expense clear the ground of all the wood and timber purchased by him before the 1st day of September 1868, under the penalty of forfeiting the whole of the wood and timber then remaining on the ground to the vendors, who may either sell the same and pay the proceeds thereof to the said receiver, or the same may be retained without proceeding to a sale for estate purposes; and this forfeiture shall not prevent the vendor from having any action for damages, or the other remedies in that behalf.

6. The purchaser shall clear the ground of and carry away all top branches and bark, and all rubbish occasioned by the falling of the said timber and wood, on or before the 1st day of September 1868.

7. That the timber, bark, tops, and lops shall not in any way be unnecessarily or improperly dispersed over the woods or fields; and the purchasers shall use all possible caution to prevent damage to the lands, fences, hedges, and gates, and to the standing timber, in the felling or removing of the wood and timber, and the lop,

top, and bark thereof purchased by them; and the purchasers, or their servants or workmen, shall not take any dogs into the woods. All injury or damage arising from any breach or disregard of this or any other of these conditions, or any other wilful, unnecessary, or negligent damage by any of the purchasers, or their respective agents, workmen, and labourers, horses and other cattle, to the lands, or other standing timber and trees, on the estate, or to the tenants, their stocks or crops, or to the fences, walls, gates, and stiles upon the said estate, by the fall or removal of the timber and trees hereby proposed to be sold, or in anywise relating thereto, shall be forthwith made good and paid by the purchaser thereof. The amount of such injury or damage to be settled by the judge to whose court the causes of are attached, in case the parties differ about the same; and all questions of compensation to be paid or received by the purchasers shall, in case the parties differ about the same, be settled by thesaid judge.

8. If the purchaser shall fail to comply with the two last preceding articles hereof, or any part thereof, it shall be lawful for the vendors to repair the said damage, and remove the said tops, branches, bark, and rubbish mentioned in such preceding conditions at the purchaser's expense, and to charge the purchaser with the amount so expended; or they may, in lieu of that remedy, have the damages occasioned by the purchaser's non-compliance with the said last-mentioned article settled by the said judge, as therein provided; and immediately thereupon the purchaser shall pay the amount thereof, as liquidated damages, to the said R—— T——, together with all expenses occasioned by his, the purchaser's, default.

9. No timber-tree shall be felled in the wood without first taking off the arms, or on failure or neglect to comply with this condition, the purchaser shall pay to the said receiver £2 for each tree felled contrary to this condition.

10. The lots after the sale shall be at the risk of the purchasers, not of the vendors; and no lot shall be cut until the same is paid for or security given as aforesaid; and no lot shall be removed without the sanction of the receiver or the said agent for the estate.

11. The purchaser shall not pass over the lands of the vendors or the tenants of the said estate otherwise than by such road or roads as the agent of the said estate shall point out, and any purchaser shall not employ any workmen objected to by the vendors.

12. That no tree, pole, or teller which is not included in the present sale shall be cut, under a penalty of £5 for each tree, pole, or teller so cut over and above the value thereof, to be recovered as liquidated damages.

13. If the purchaser shall fail or refuse to pay his deposit-money, or sign the agreement at the end hereof, or pay the purchase-money, or the residue thereof, or give the bills or other security as aforesaid, or in any other manner to perform or comply with these conditions, or any of them, his deposit-money (if any has been paid) shall be absolutely forfeited to the vendors, who shall be at liberty to resell, either by public auction or private contract, the wood and timber purchased by such purchaser without notice to him, and that either at this sale or at any time afterwards; and any deficiency in price on such resale, together with all expenses attending the same, shall be forthwith paid to the vendors by the defaulter at this sale; and in case of non-payment, the whole or the unpaid part of such deficiency shall be recoverable by the vendors from such defaulter as liquidated debt and damages.

AGREEMENT.

do hereby acknowledge that have become the purchaser of lot in the annexed particular, at the sum of £ , on the terms of the foregoing conditions, which hereby engage to abide by and perform in every respect.

Witness hand this day of 1868.

Purchase-money, . . .	£	:	:
Deposit paid, . . .		:	:
Remainder unpaid, .	£	:	:

We have frequently adopted the system of selling the thinnings by tender on this estate, and in some instances it was found to answer very well. We mark the trees, and sell them standing before having them cut.

For this purpose we have printed forms made out, which we fill in with a statement of the lots for sale, and send a notice to timber-merchants and others who we think are likely to offer for the lots. The following is a copy of the notice sent to the merchants:—

SIR,—I beg to inform you that there will be sold by tender, on the estate of Oldstead, on the 30th April 1868, the following kinds and quantities of very superior timber, namely:—

Name of Wood.	Oak.	Ash.	Elm.	Sycamore.	Alder.		TOTAL.
Tower Wood,							

The timber now exposed for sale is of large dimensions, of first-rate quality, and well worthy of your attention.

The lots will be shown previous to and on the day of sale, on application to me, when I shall be glad to give you all particulars.

You will oblige by sealing the tender, and marking it outside—"Tender for Wood." The tenders will be opened in the Stapylton Arms Inn, Wass, at two o'clock, on 20th April 1868.

The proprietor does not bind himself to accept the highest or any offer.

Wass is one and a half miles from the Coxwold station on the Thirsk and Malton branch of the North-Eastern Railway.

A conveyance will wait the forenoon trains at the Coxwold station on the 30th April 1868, to convey intending purchasers to Wass.—I am, sir, your obedient servant,

ROBERT E. BROWN.

ESTATE OFFICE, WASS, *4th April* 1868.

The following is a copy of the conditions of sale for the timber sold by tender, and which is signed by the parties offering:—

Conditions of Sale of Wood on the Estate of , by , on the 186 , the Property of Major Stapylton.

1. The timber now exposed for sale is all marked and numbered, and believed to be correctly stated, as under, in the following plantations, viz. :—

No. of Lot.	Name of Plantation.	Oak.	Ash and Elm.	Sycamore.	Larch.	Scotch Fir and Spruce.	Bobbin-Wood, &c.		Total No. in each Lot.	Amount.
										£ s. d.
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

2. All the above wood to be cut and every other expense performed by the purchaser, and at his own risk hereafter.

3. In its removal from the ground, or any way on the estates through which it has to pass, the purchaser must at all times be under the control of Major Stapylton's forester.

4. The above must be removed from the plantation named on or before the 1st of . Any timber found on the ground after this date will belong to the proprietor, and will be sold to defray damages thereafter.

5. Payment of the purchase must be made within six days of sale to the forester in cash. In the event of not being settled, it will again become the property of the proprietor, and shall be optional to re-expose the same for sale or otherwise, as the forester shall think proper.

6. Previous to payment the purchaser is requested to satisfy himself as to quantity, number, or quality, or any alleged error whatever, as no deduction will be made on any account thereafter.

7. In the event of damage being done to woods, lands, crops, or tenants on the estates in the removal, the purchaser must at once pay the amount on being ascertained by the forester, whose decision shall be final in such matters.

8. The purchaser must annex his offer and signature under this condition of sale, thereby becoming bound to fulfil the same under a penalty of £ : : .

Tender.

I hereby agree to give the sum of £ : : for the above quantity of wood, subject to this condition of sale.

In selling timber by private bargain, which has to be measured in the usual way by the tape, certain deductions have to be made in the girth of a tree as an allowance for the thickness of the bark. This varies much with the kind and the age of the tree. It will also be observed that the bark is much thinner where the trees stand thickly together. There is always a large produce of bark from oak-trees which are attended to in thinning. Therefore, considering these different circumstances, it is difficult to lay down any rule as to what should be allowed for the bark in measuring timber. I have found very often that for a tree measuring about thirty inches in circumference at the girthing place, half an inch should be allowed on the side of the square; for a tree measuring sixty inches in circumference, three-fourths of an inch will be found sufficient; for a tree eighty to eighty-five inches in circumference, one inch deduction will be necessary; and for a tree from one hundred to one hundred and ten inches in circumference, one and a quarter inch will require to be deducted. These, as I have already stated, cannot be set down as a rule, as local circumstances and the kind of tree will have to be considered.

SECTION 11.—*The Management and Sale of Underwood.*

What I mean by the term underwood in this section is the copse-growth of hazel, alder, ash, and other shoots growing from old stocks. Over a great extent of the woodlands in England, and more especially in the southern counties, there are masses of underwood grown which is converted into fencing purposes, crate-wood, broom-handles, fagots, &c. &c.

On good soils this makes a rapid growth, and can be cut over once in every six or seven years. It should not be allowed to grow too high, as it interferes with the growth of other trees.

There is a considerable extent of hazel-copse upon the estate of Wass, which we cut over once in every six or seven years, and then it will average from six to eight feet high.

This we have used, in some instances, for fencing purposes, making hurdles, as described under the head of "Fences;" and we have also found it useful in protecting young specimen trees, by making a fence round them in the form of basket-work.

We have sometimes cut it out into the different sizes, and tied each kind up in bundles, when we have sold them by the hundred. The following list may be useful to some, showing what we have converted the underwood into, and the present selling prices in this district:—

		s.	*d.*
Pea-rods, per bundle of 20 sticks,		0	3
Dahlia-stakes,	per 100,	2	6
Scarlet-runner stakes,	,,	2	6

		s.	d.
Hollyhock-stakes,	per 100,	3	0
Fruit-tree stakes,	„	10	0
Flower-stakes (for pots),	„	0	6
Fence-stakes,	„	2	6
Yeathers for fence-stakes,	„	2	6
Stack-rods,	„	1	0
Broom-handles,	„	2	0
Punch-rods,	„	1	0

Hurdles, 1s. 4d. each, as described in chapter on Fencing.

We have also sold the underwood by *public auction.* The district where the underwood is growing is first laid out into lots of from two to three and four acres each, taking care, if possible, to have distinct boundaries for each lot—such as fences, roads, or drains—so that there may be no mistake afterwards. These lots are next numbered by driving in several strong stakes along their boundaries, and putting the number of the lot on each. Having had this done, we value each lot by first ascertaining as near as possible the average number of shoots per acre, and this we find by taking a few square yards in several places of each lot; and finding the average number of stakes on them, we calculate for the acre accordingly. The value of the copse depends much on its length and thickness—and it is much more valuable if straight.

We have always sold the underwood on the condition that the proprietor's workmen cut it down. We consider this the safest plan, as strangers would not care what they cut, and the stocks of the shoots might be spoiled for growing afterwards. The underwood ought to be cut during winter, and not later than the 1st of March; if cut when the sap is in full flow, a great many of the roots will die and others grow very weakly for some time afterwards.

It may be useful to give a copy of the conditions of sale under which large extents of underwood are sold in the south of England. The conditions which are here given are used on an extensive estate in Hampshire, where underwood of from eight to ten years' growth generally realises from £1 to £1, 5s. per acre:—

Conditions of Sale of Underwood on the Estate of S—— R—— Park, Hants.

1. The highest bidder to be the purchaser, and if any dispute arise between two or more bidders, the lot to be put up again.

2. That no person shall advance less than 2s. 6d. per statute acre at each bidding.

3. The vendor or his agent shall be at liberty to bid once for each lot.

4. The purchasers to have the underwood cut in a proper and workmanlike manner, two inches from the ground at most (wherever possible), by a slant cut upwards to prevent splitting, leaving all heirs, saplings, holly and all other ever-

greens, and all stemmers or young trees, now marked with red paint, and as many bushes and stakes as may be necessary to make good the fence round the coppice. And every infraction of this condition will subject the purchaser to a penalty of 20s.

5. That the respective purchaser or purchasers of each lot shall cause the said underwood to be cut on or before the day of 186 , or forfeit to the vendor what remains uncut at that time; and shall also cart or clear away the same by the day of 186 , or forfeit what remains uncleared at that period: and all damages in clearing out the said underwood to be made good by and at the expense of the purchaser on or before the day of 186 . And if any person shall be employed objectionable to the vendor or his agent, after being requested by notice from him or his agent to be discharged, the purchaser shall on demand pay to the vendor or his agent the sum of 20s. per day for every person so employed contrary to such notice aforesaid.

6. And no wilful or negligent damage to be done to the said timber, or timber-like trees, poplars, heirs, stemmers, and saplings, or to the corn or seed, in the cutting, converting, or carrying away the said underwood, on any account whatever, and in default thereof, shall pay for every deviation therefrom the sum of 20s. to the vendor or his agent; and that the said purchasers shall make good all bunneys, fences, gates, posts, and pales, that may be damaged by cutting or carrying away the said underwood.

7. Upon the fall of the hammer the several purchasers shall pay a deposit of £20 per cent in part of the purchase-money, and shall, within ten days from the day of sale, give to the agent approved security for the payment of the remainder of the purchase-money on the day of 186 , and no person to commence felling the underwood until such security be given and approved of.

8. That no purchaser shall be allowed to stack fagots, bunts, cordwood, or other wares, within two feet of any hedge or live fence belonging to the estate; and any violation of this condition shall be immediately followed by the forfeiture of all material so placed or stacked.

Lastly. Upon failure of complying with these conditions the deposit-money shall be forfeited to the vendor, who shall be at liberty to resell the lot or lots by public auction or private sale; and the deficiency, if any, attending such second sale, together with all expenses attending the same, shall be made good by the defaulter or defaulters at this present sale; and any person who has been a defaulter, or in arrear or arrears, at any previous sale, his or her bidding will not be accepted.

Agreement.

I do hereby acknowledge to have purchased lot comprised in the foregoing particulars, at the sum of per statute acre, and so in proportion for a less quantity, and have paid a deposit of , and do agree to pay the remainder of the purchase-money, and complete the purchase, according to the conditions of sale in every respect. As witness my hand this day of 186 .

Amount of purchase, ... £ : :
Deposit paid, ... : :

Remaining to pay, 186 . £

Section 12.—*The Transplanting of Forest-Trees.*

The transplanting of trees is at all times against nature, and they receive a check, more or less severe, even when the operation is successfully carried out. It is, however, often found desirable to remove large trees to sites devoid of timber—as, for instance, when a landed proprietor is about to erect, or has erected, a mansion on some commanding portion of an estate, and this site most probably has many good advantages to recommend it, but in the grounds around it there may be a want of large trees, which are indispensable to adorn the estate. The late Sir Henry Steuart of Allanton introduced a system of transplanting large trees, and carried it out very successfully in his own grounds at the time.

This was done by digging a trench round the roots of the tree, and allowing fibres to form for some years before the tree was removed. It was afterwards removed on a common janker, consisting of two large wheels on an axle, and having a long pole or shaft attached to the centre of the axle, upon which the tree was taken to the site in a recumbent position, with the branches on the ground.

Mr Mackay, gardener to Edward Strutt, Esq. of Kingston Hall, near Derby, built a tree-transplanting machine with four wheels, which raises the tree up in an upright position.

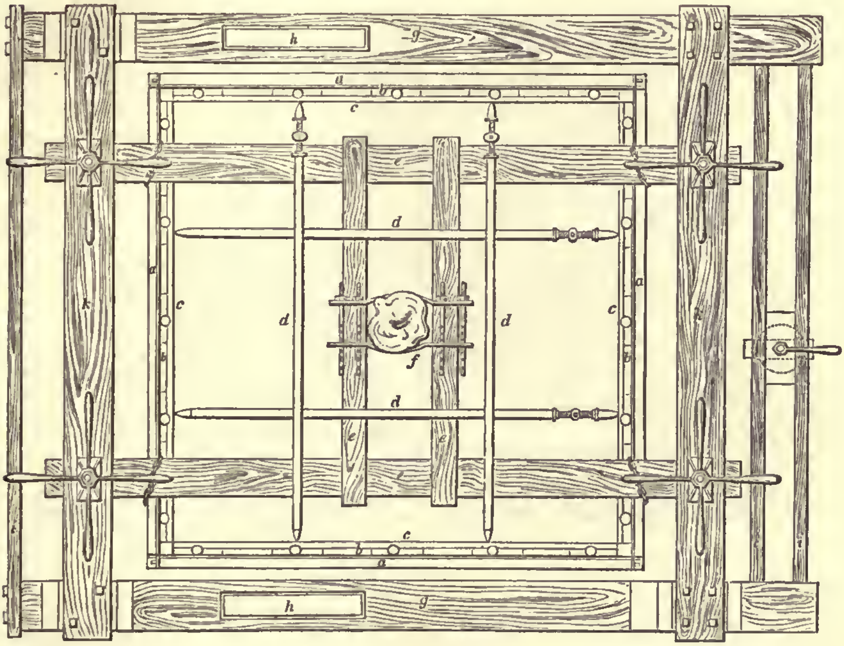
Mr M'Glashan of Edinburgh invented a transplanting machine, which in my opinion is a very useful apparatus, as the tree can be lifted with a large ball of earth attached to the roots, without much injury being done to it. A number of strong iron spades are first driven into the soil at a certain distance from the stem in proportion to the size of the tree. These spades work inside of an iron frame which lies on the surface. The upper portion of the spades is then so worked away from the stem of the plant as to throw a pressure on the lower portion of each towards each other. A strong wooden truck on wheels is then placed on the top over the spades, and the tree can be raised out of the earth with a large ball attached, as contained within the spades. It is raised by means of strong screws, which require a few men to work them.

With respect to Mr M'Glashan's machine, the 'Book of the Garden' says:—

"The most powerful and perfect of all such machines is, however, undoubtedly that invented and patented by Mr M'Glashan, who has favoured us with the following description and drawings of it, figs. 118, 119.

"The first part of Mr M'Glashan's process is to lay down a square frame of T iron *a*, in size equal to that of the ball to be removed. He then takes cutters *b*, made of malleable iron, and one foot broad, and three feet deep, or with head and neck four and a half feet, and with holes at different heights for a pin, which regulates their depth to be screwed in, so that they can be made, at very little trouble, to lift any depth of ball from one to three feet. These cutters are driven with wooden mallets into the soil to the depth required all round, and being inserted sloping inwards, they give to the enclosed mass the form of a square blunted wedge. A bar of angular iron *c* is then laid along the top of the four

FIG. 118.



rows of cutters, and extension-rods *d*, going across the frame, force the heads of the cutters apart as far as necessary, and consequently cause the points to converge at the bottom. Two parallel beams *e* are then laid across the frame, upon which are laid two cross-beams. A clasp or collar *f* lying hard on these two cross-beams is thus put round the trunk of the tree, which being made tight by screws, as shown in figure, serves to steady the tree and bear a portion of the weight when the lift is taken. The means of raising the mass are a carriage, which also serves the purpose of transplantation. It consists of two long beams *g*, which have an open space for wheels to run in, as shown in figure; the length of the axle is the same as the thickness of the beam, and is set in a *plumber box*, with a cast-metal seat *h*, that is bolted to the long beams which rest on it, and of course adds to the strength of them. The two long beams are bound together fore and aft by bars *i*, and cross-lifting beams, which are firmly bolted to them. There is a third wheel in front, which carries a portion of the weight, and, having a handle on the top, acts as a helm does to a ship, so that the carriage can be turned very quickly round a sharp corner, and easily governed through amongst trees. There are two bol-

Fig. 119.

sters *j*, raised up on the long beams at each end of the carriage, across which are laid two beams *k* (already alluded to in describing the binding of the long beams), for the screws to work upon; these serve to give height enough for the ball being raised to clear the ground. Horses can work at any end of the carriage by simply affixing the shafts to either of these extremities. The beauty of the construction of this carriage is, that it is as applicable for removing large shrubs as it is for forest-trees.

"The end bar *i* and cross-lifting beam *k* are taken off, and the carriage is moved back, enclosing the tree until it is exactly over the lift; the end bar and cross-lifting beams, which were taken off, are replaced and screwed on. The process of raising the mass is accomplished by screw power; the screws are two or four in number, as the case may require, and so arranged as to make the lift equal. They are made fast to the beams of the frame, and are worked by men. When the screws are put in motion, the frame and enclosed mass rise erectly upwards. In ordinary circumstances, a tree with a ball of ten feet, in about twenty minutes' working of the screws, should be completely raised from the pit. The propelling power, when the ground is soft, and horses cannot be used, or when it may be inconvenient to use them, is by a winch attached to the front of the carriage, and block and tackle made fast to some neighbouring tree, piles driven into the ground, or any other hold most convenient; but when the way is clear, and the road good, horses will do the work more expeditiously. It will be found necessary, when the ground is soft, to lay planks to prevent the wheels sinking, until they get on hard ground. The pit being already dug, the mass is moved directly over it, and the tree and ball are lowered into it on the same principle as it was raised; the earth is then filled in all round about, and the apparatus removed, and the operation is completed. The reader at first sight may be apt to think that the cutters which were put round the ball would sever the large roots; but if the operator has any desire to preserve them, which, Mr M'Glashan remarks, is still a very undecided question, it can be easily done by finding out their position with piercers, and driving a cutter on either side of them, and thus preserving them entire. Although ten feet is the size described here (as it has already been done), it can either be reduced or enlarged as the tree or operator may require."

The transplanting of very large trees involves great expense and risk, and should not be attempted, unless in rare cases, to give immediate effect where it is wanted. A tree of from ten to twelve feet high can be transplanted with greater safety and at less expense than one from fifteen to twenty feet high. The latter will remain stationary for some years, without making any progress; while the former will continue growing, and progresses at least after being one year in the new site.

The first great consideration in the transplanting of trees is the choice of good plants. The lime is a very safe subject to remove, and also the chestnut and sycamore. These three kinds are largely used in forming avenues along the new streets or Boulevards of Paris. I have also removed with success the oak, elm, walnut, birch, and holly.

The trees chosen may be taken from a plantation; but a slight drawn-up tree should not be fixed upon, or one which has been too much crowded upon by others. A very large head of branches is not desirable, as if so, it would not be in proportion to the roots when removed. A well-formed head is no doubt wanted, with a good supply of leaves; but a very large-branched tree should be avoided for the reason stated. A tree with very few branches is also to be rejected, as when this is the case it will have a short supply of roots also.

Some heavy-topped trees may be improved by a judicious pruning—as, for instance, when one or more branches have grown to such a degree as to give one or more sides of the tree a great weight, and out of proportion with the character of the tree. These branches should be cut across at such a point as the size of the top demands; thus, if we found such at about nine feet long, we should shorten them at about five or six feet from the stem.

I have generally transplanted trees by first preparing them in the following manner:—

1st, By opening out a trench round the trees about twenty inches broad, cutting it straight down and through all the roots which came in the way; cutting those roots carefully with a knife, and not with the spade, and deep enough to get below the main mass of the roots.

2d, This trench should be opened at a certain distance from the stem of the tree, in proportion to its size. Presuming the tree to be fifteen feet high, then I should cut the trench at a distance of four feet from the stem; and a tree twenty feet high, at a distance of five feet from the stem.

After having finished the trench, I next have the mass of roots undermined to a certain extent, and all the soil so removed thrown out of the openings.

I next fill in the trench to the surface with vegetable mould thoroughly rotten, and a quantity of it is spread over the surface of the ball of roots up to the stem, and then slightly covered over with some of the original soil previously removed.

I allow the tree to remain in this state for two years at least, when I open another trench round the tree just outside of the leaf-mould, and a little deeper than the one first opened; and then I undermine the whole mass of roots under the tree, and have it removed by whatever means it is thought desirable to do so.

The cost of preparing and removing in this manner has been on an average from 18s. to £1 each.

I consider that transplanting operations should be conducted in the winter months—say November, December, and January in the middle and south of England, and in the north of England and Scotland any time from November to March. After removal, the trees should be attended to in the way of watering and in keeping them properly staked to prevent the winds from shaking them. Trees, after being transplanted, very frequently throw out a quantity of young shoots on the lower portion of the stem. These should be removed with the finger and thumb before they get to any strength.

In the removal of pines from three to six feet high, and strong shrubs, we use a hand-barrow. The shafts are made six feet long, and of sufficient strength to bear the weight of what may be wanted. The boarding in the centre is made two feet six inches square. This places the shafts about two feet apart—sufficient to allow the men to walk between when carrying them. In removing plants in this way, a trench is opened out round the plant at a distance from the stem of about one-third the height of the tree; and when it is thoroughly undermined, the plant is then laid over on one side, and the hand-barrow placed underneath it as far as possible; and when the plant is brought back to its erect position, the roots will lie on the barrow, when it can be removed at once. I have in this way removed several kinds of rare pines from the home-nursery on this estate to the plantations, and in forming a pinetum. The plants average four feet high, and there has been only two deaths out of nearly one hundred and fifty so removed.

Mr Mackay of Kingston Hall has had a transplanting machine in use which has given great satisfaction in its operation. It is thus figured and described in 'The Forester,' third edition, p. 599:—

"Mr Mackay has two machines which he has used in the transplanting of his large trees at Kingston Hall, both of the same construction, but different in power; the one used for transplanting trees of twenty-five feet in height and under, and which may be capable of safely removing a weight of about five tons; the other he has used for transplanting trees from thirty to forty feet in height, which is capable of safely removing a weight of from ten to fifteen tons—that is, including the tree and its ball of earth attached. Trees of the latter weight Mr Mackay told me he had removed; and having examined these, I estimated that some of them would weigh about fifteen tons, including the ball of earth.

"Before entering into detail as to the manner of working the machine, I shall first give a statement as to the nature of its construction.

"It consists of two pairs of wheels, each pair working upon a strong axle of superior quality. In the largest machine as referred to above, each pair of wheels is about nine inches broad in the rings. The pair situated on the front part (see engraving at *b*, fig. 120) are about five and a half feet in diameter, and the pair situated on the hinder part (see engraving at *a*) are about seven feet in diameter, and distant from each other about fifteen feet; thus making the length of the machine, from the one axle to the other, fifteen feet. On each of the axles is placed a strong frame, in order to raise the horizontal bearers to a convenient height, and at the same time with the view of making the whole machine move in a workable manner. (See section of front frame *k*, fig. 122, and section of back frame *l*, fig. 123.) The front frame, I may also state, is made to turn upon a horizontal wheel, in the same manner as in the case of a carriage,

Fig. 120.

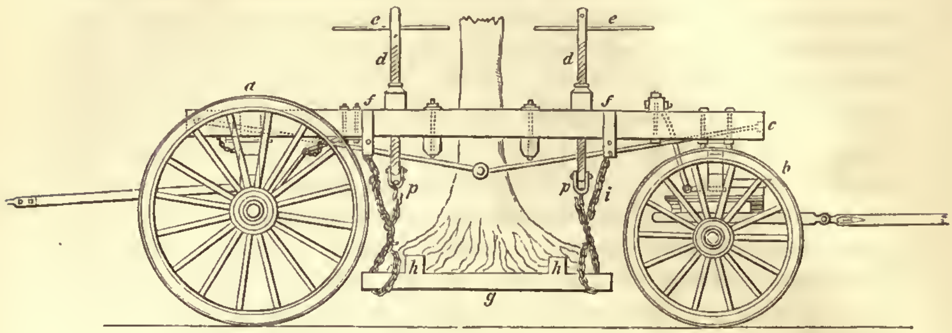


Fig. 121.

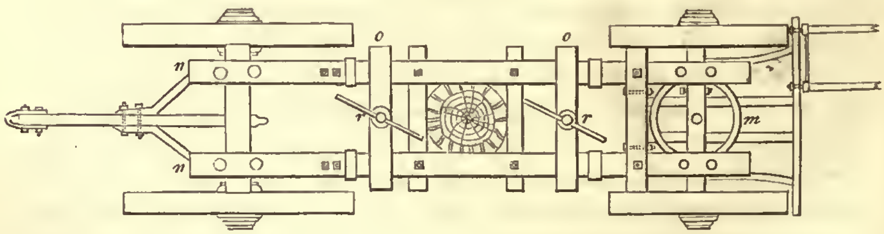


Fig. 122.

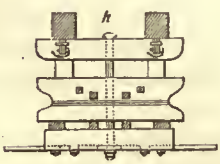
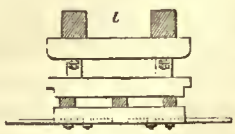


Fig. 123.



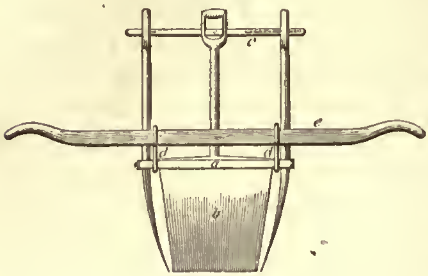
for the easy turning about of the machine in any required direction, as is represented in the ground-plan of the tree-lifter at *m*, fig. 121. Resting upon the frames, as is shown in the front and back sections, and parallel to each other at a distance of about two feet apart, are two strong beams of wood, about ten inches deep by six broad. (See side elevation of the tree-lifter at *c*, fig. 120, and also on the ground-plan at *n n*, fig. 121.) Those beams are fastened to the frames placed above the fore and aft axles by means of strong iron bolts, which can be unscrewed as occasion may require; and, placed upon those horizontal beams, again, are two others (see ground-plan at *o o*), into which the jack-screws are placed. The screws are also shown in their working state in side elevation *d d*, with their cross-handles for turning, *e e*, fig. 120. On the under part of those jack-screws, as passed through the cross beams, are attached the strong chains by means of which the tree is principally taken out of its place (see *p p*); and, as an assistant to them, there are side chains attached to strong iron rings fixed upon the beams (see *f f*). Those side chains are made to act along with the others attached to the screws, and are also found necessary to retain the weight of the tree and its ball of earth during the reversing of the screws for a new hold. The horizontal planks upon which the ball of earth rests, supported by the chains, are shown on side elevation at *g*; and the two cross planks, which are placed upon the horizontal ones for the better support of the ball, are also shown at *h h*. Those planks require to be made of the best oak wood, not less than four inches thick.

"Having now given a brief description of the construction of the machine as I examined it upon the spot, it remains to be stated how the operation of transplanting a large tree is accomplished by it.

"The work of transplanting a tree, with the machine above referred to, is perfectly simple and easily understood; and in describing it I could not do better than lay before my readers the manner of proceeding as detailed by Mr Marnock, who was editor of the Journal formerly referred to, who visited Kingston Hall, and saw the work performed. In the Journal of the 22d December 1849 he writes thus: 'In our last week's number we stated that we had seen some elm-trees at Kingston Hall, the seat of Edward Strutt, Esq., carried by the machine then represented, and replanted in another situation about three-quarters of a mile from the place where they had stood and grown for upwards of thirty years. We further stated that these trees were forty feet in height, and weighed each, including the ball of earth and the machine, upwards of ten tons, and that they were drawn by nine horses. We shall now, therefore, give the following details as to how this was accomplished. The trees to which we now allude were growing on the outskirt of a wood. The ground around the tree was cleared, and at four and a half feet from the stem of the tree a circular cutting was made to the depth of about three and a half or four feet, and about two and a half feet in width. This done, then on the most open side of the tree a sloped cutting was made, from the surface of the ground to the bottom of what may now be called the ball of earth, and a similar sloped opening was made on the opposite side of the tree. The first of these sloped cuttings was made for the purpose of drawing out the tree up this slight incline to the surface of the surrounding ground. The circular opening in the earth around the tree, and the two sloping roads on each side, being now prepared, the workmen commenced to undermine the ball of earth. This being done all around, four stout oak planks, long enough, were placed under this ball of earth in front and behind—that is, crossways to the direction of the machine; and under these two others were placed lengthways, with their ends in the direction to back and front of the machine. It will now be understood that these four oak planks under the ball of earth cross each other at their four extremities; and around their extremities, at each of the four corners, four sets of strong iron chains are fastened. A reference to the diagrams given will assist in explaining this. The first set of chains brought into play were those attached to the bottom of the jack-screws. Being made as tight as possible over the ball of earth, they were then hooked on the end of the jack. The two jacks were then turned by two or four men each, as the case may require, until the tree and the ball of earth were raised from the ground about six or ten inches. The jacks were then permitted to rest, and what is called the side chains were then put in requisition. These, as we have already stated, are fastened to the planks under the ball of earth, at the same point as the others, the opposite ends being made fast to the side beams, as shown in the engraving. This being done at the four corners, the jacks are then reversed, and the first set of chains slackened: the weight of the earth and tree is then sustained by the side chains. The first set of chains are again adjusted, and made as tight over the ball of earth as manual power can effect. The jack is again run down, and again attached to the chain at the lowest point it will reach. The jacks are once more applied, and run up till the end of the screw has been completely worked up to the under-side of the cross beam on which it rests. By this second lift the jacks have probably gained upon the six or ten inches which they made at the first lifting, and the bottom of the ball is now fifteen or twenty inches from the ground. The side chains, which are now quite slackened by the second lift of the jacks, are again made as tight as possible; this accomplished, and all securely and equally fastened to the side beams again, the jacks are gently reversed, till the weight is equally divided betwixt the side chains and the jack chains. The tree is now in a condition to be drawn out, unless it should be necessary to give it a third lift with the jacks, so as to raise it still higher from the ground; and if so, the side chains must always be attended to, as already described. They may be properly called the guard-chains, as they prevent accidents in the event of breakage of any of the jack-chains, when the former would take the weight of the tree, and prevent its falling. About ten or fifteen feet up the stem of the tree, four ropes extend from this point to the two front and two back corners of the machine; and this is all that experience has found necessary to preserve the tree in its perpendicular position during its transport on the machine to its future place of growth. The perpendicular position of the tree is, however, very greatly secured by the four side or guard chains. We have now to describe the mode of introducing the stem of the tree within the machine. This is effected in the following manner: The machine is drawn as near to the tree as circumstances will allow; it is then taken to pieces by unscrewing the different bolts—that is, the main horizontal beams are unfastened, and thrown over the wheels on either side. The larger hind-wheels are then placed in their proper position on the sloped cutting behind the tree, and the smaller fore-wheels on the sloped cutting before the tree; the large beams are then lifted on to their places, one on either side of the tree, and made secure with the iron bolts and the requisite fastenings. The tree then stands with its stem betwixt the side beams, and with a pair of wheels behind and another before. The chains and jacks are then applied as already described, and thus the process is complete. The next and only point deserving further allusion, is that of planting or placing the tree where it is ultimately to grow; and this is effected in the following way: The hole, sufficiently large to receive the ball of earth, is dug the necessary depth; then, on the opposite sides of the hole, a sloped cutting, wide enough to admit the machine to be drawn down and through it, is also provided. Into this cutting, therefore, the machine and tree are drawn, and through which the team of horses first pass. When the tree has reached the proper point, the machine is permitted to rest; props of brick or stones are then raised at the four corners immediately under the ends of the cross planks. These props may be three or five bricks in height; and when all is prepared in this way, the jacks are reversed, and the ball of earth gradually lowered down, till the ends of the cross planks rest upon the corner props, and the tree has taken its proper perpendicular position; and this is effected by the raising or lowering of these corner props. All being adjusted, any opening that may remain, betwixt the bottom of the ball of earth and the bottom of the hole provided for the tree, is filled up with earth; the whole being made firm around and under the roots of the tree. The brick or stone props are then struck out, and the planks removed—a process easily effected, as the tree now rests upon the earth which has been placed under and about it. These planks are, however, well ironed at each end, that, in case of any difficulty in their removal, a horse or horses may be readily yoked, and the planks withdrawn.' "

Mr M'Glashan of Edinburgh has invented several smaller transplanting machines on the same principle as shown in figs. 118 and 119—that is, by employing a number of strong iron spades, which are attached to a frame and driven into the ground surrounding the plant to be lifted, and at a certain distance from it, according to the size of the plant. A sketch of one size of these machines is shown in fig. 124, one of which I have in use. The frame *a* has a point at each corner. The frame is laid round the plant and fastened together; then four large spades *b* are placed inside the frame and driven into the soil, keeping them upright. When the spades have been put down as far as they can be put, two iron rods are passed through the handles of the spades, as shown at *c*. These rods have holes in them, into which pins are inserted. The heads of the spades are thrown back, and kept in that position by the pins. The object in throwing the heads of the spades back is to make the ball of earth narrower at the bottom than at the top. Two hooks *d* are placed on each side of the frame to receive the wooden handles *e*, when the plant can be lifted by two men, or more if it is large. The plant is carried in this way to its ultimate site.

FIG. 124.



These machines are made of different sizes, to suit the various dimensions of balls of trees to be operated on. The prices are—for an apparatus to lift a twenty-two-inch ball, £18, 5s.; for lifting a thirty-inch ball, £20; and one made capable of lifting either size costs £25.

In lifting trees with this apparatus, no previous preparation of the tree is required; no trench being dug round it, as in the case of other transplanters. The machine is set on the surface with the tree in its centre, and the spades are then driven down as far as they will go; they are then pressed outwards at the top, so as to cause the lower portions of the spades to move towards each other; this causes the ball to be narrower at the bottom than the top, and consequently in after operations it cannot slip from the machine. After this is done, the screws are worked, which gradually pull the tree, with a large ball, out of the earth; and in this way the whole is removed to its future site, and lowered by the screws into another pit previously prepared for it.

In the figures given of this description of machine (figs. 118 and 119) is shown one suitable for lifting trees with balls of earth of a size about five feet long by four feet wide. This is the best size for general transplanting, being suitable for trees varying from fifteen to thirty feet high. This size of machine has been extensively employed in the removal of trees from the Bois de Boulogne, near Paris, to form avenues along the Boulevards of that city.

SECTION 13.—*The Manufacture of Timber.*

Where there is any considerable extent of land under timber on an estate, it is advantageous to have some means of manufacturing it. Where there are large sales of timber, it may be necessary to have two or more saw-mills on the estate, as generally where these are erected and placed at the disposal of purchasers of timber, they will give more for it in many cases than they would if no means of manufacturing it on the spot existed.

During the time I was in connection with the management of the Strathspey forests in Inverness-shire and Morayshire, where there are many thousand acres under timber, there were twelve saw-mills in operation, the moving power being both steam and water. A few of these belonged to the proprietor, the Earl of Seafield, and were let out at an annual rent to the timber-merchants.

Saw-mills may be driven by either water or steam power. Where a constant supply of water can be got in any convenient place for timber, I should prefer taking advantage of such water-power; but where the supply of water is limited, or not conveniently situated for the timber likely to be cut down on an estate, then I should prefer taking advantage of steam-power.

Steam-power may be either got as a fixture or portable; and the adaptation of either kind to any particular property must be judged by local circumstances and the extent of the woodlands, as well as the size of the different plantations, and the distance apart they are from each other. The local circumstances which may influence the advisability of having either fixed or portable saw-mills are such as the supply of water throughout the woodlands for the use of an engine, and whether there are roads sufficient to get the apparatus into the woods.

Where a good supply of water can be got for the purpose of driving a saw-mill, it will certainly be the cheapest motive-power, and should be taken advantage of when such may be wanted. On the other hand, if an engine is required on an estate for the purpose of driving a thrashing-machine, pumping or stone-breaking apparatus, then in all likelihood the engine may be sufficient for all ordinary purposes. This is presuming that only an annual and limited amount of work is done; but of course if there be a constant amount of work in one or other of the departments of sawing, stone-breaking, &c., then an extra power will have to be got accordingly.

If the general mass of the timber lies somewhat close together, and there is not any necessity for the removal of the sawing power, then I should recommend the use of a fixed power. As a rule, a fixed steam-power can be erected at a much lower cost than a portable one, the horse-power being equal.

In a great many instances, however, it will be found advantageous to have a portable engine and sawing apparatus—the engine in this case to be a locomotive, as it is a great drawback to employ horses in the removal of it.

Where there is any considerable extent of land under wood, it will be of very great use to have an adequate sawing power on the estate. When the timber has to be removed and sent away to a distance in its rough state, there is a large amount of rough timber, bark, and outside slabs taken away at great expense in the carriage. This can be obviated by having the timber manufactured on the spot into whatever it may be suitable for, when all the unsaleable timber can be left and only the valuable and saleable timber sent; and besides, a great amount of small timber, which would be otherwise useless, can be turned to many useful purposes.

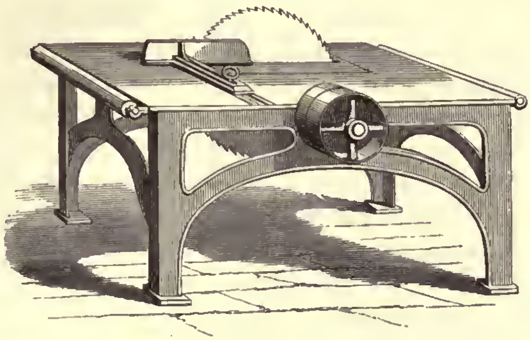
The cost of sawing apparatus, of course, varies with the kinds of power used and the strength of power required. The cost of fixing up a saw-mill, including sheds, machinery, saws, water-wheel, &c., will range from £300 to £800. One of fifteen-horse power may be erected under ordinary circumstances for £400; one of equal power, with steam-engine, will cost fully £150 more. It is taken for granted that good substantial sheds are erected; if temporary wooden sheds are put up, as is very often the case, then the cost at first will be less.

On many estates where the plantations are not extensive, and where it is often requisite to have the thinnings sawn up into fencing and other purposes for general estate use, it would be found advantageous to use a small saw-bench of the kind shown in fig. 125.

We have had one of these in use on this estate for some years, and find it very useful for the purposes named.

Being portable, we have a sleigh made for it to stand upon, when it can be removed to any part of the property by a single horse. As the motive-power for driving it, we usually employ an engine used in the district for thrashing purposes. This we get at a fixed rate per day, or at a certain rate per rail, post, or otherwise. The bench is strong, yet it is of small bulk. It takes a saw up to three feet in diameter. At each end is a roller to facilitate the moving of the trees.

FIG. 125.



The bench we have in use was manufactured by Messrs Clayton, Shuttleworth, & Co., engineers, Lincoln, and cost £20, fitted with a thirty-inch saw. The table is five feet long and two feet broad. That firm also manufactures larger benches, which take in much larger saws—up to four feet in diameter—and are therefore better for heavy timber. They are supplied with a self-acting feeding motion, which draws the timber up to the saw just quick enough for the saw working. They go through a great deal of work in a short time, and can be managed by any ordinary workman. A fence is erected to the left of the saw, which can be removed parallel to the saw, and at right angles to it. It can also be shifted to any angle required, thus making it very useful in cutting up weather-boarding, or in any case where feather-edge boarding is wanted. It is also supplied with a boring apparatus. The price of this complete is £65; but without the self-supplying motion and boring apparatus, £45.

SECTION 14.—*The Protection of Young Trees from Deer, Hares, and Rabbits.*

Deer, hares, and rabbits are often very destructive to young trees on an estate, and both landed proprietors and foresters are puzzled to know what should be done in the way of preventing these animals from destroying them.

Many proprietors are not fully aware of the loss they sustain in this way. I have known young plantations which have been repeatedly replanted and beat up with fresh plants every year, and yet they were eaten down each year in succession by either hares or rabbits, or both. The loss which thus takes place is not only the value of the plants themselves, but there is the labour which has been spent upon them in putting them into their places; and, what is of more value, there is a great loss sustained in the number of years which pass over; and there is nothing to see for the former outlay, as of course when the principal has been disposed of, there is no interest to receive afterwards. Presuming that a single acre has cost £4 at first, then, if left undisturbed by animals or other causes, that acre should be of some considerable value in a few years. The value of the crop upon it should not only give an increased yearly value equal to the rent of the land that it would be worth as pasture, but the crops should also give a further increase of value each year, equal to interest at the rate of, say, £5 per cent upon the rent which the land would have given in an agricultural state, and also the same upon the original outlay in the formation of the plantation, and upon this interest there will of course be compound interest to account for. Therefore, taking this into consideration, if the crop is at first destroyed, and then replanted and destroyed again, the loss sustained is very much larger than many would think.

How, then, can young trees in a plantation be preserved from the destructive habits of deer, hares, and rabbits?

If landed proprietors would look to their own interests, they would destroy all hares and rabbits on their estates. Not only would the saving of expense to themselves be immense, and the increased value of the young plantations be more satisfactory, but for the sake of their tenants on the property this deserves consideration.

Many proprietors, however, choose to attempt to rear young plantations, and at the same time keep up a large stock of hares and rabbits. In experience I have not found hares so destructive as rabbits.

Many mixtures have been tried applied to the stems and branches of the trees, but, generally speaking, they are ineffectual. Some very soon get washed off by rain, and others which remain on the plants injure their growth, and are about as destructive as the rabbits themselves. It is only reasonable to expect that, when all the pores of the bark and leaves of a plant are closed up by some mixture foreign to it, it cannot thrive well, and is entirely against nature.

The mixtures which have been tried as an application to young trees are hog's lard, train-oil, cow-dung, and soot; another, common tar, and also lime-and-water, and also paints. The hog's lard, train-oil, common tar, and paints injure the trees very much, and prevent their growth, especially when they are young. The cow-dung and soot, and lime-and-water, very soon get washed off by rains, and of course are of no use. Where trees have attained some size, certain of these mixtures may be applied without danger—as, for instance, in the case of trees of from four feet and upwards in height, and where deer, hares, and rabbits may be eating the bark from off the lower portion of the stem. I have applied Carson's lead-coloured paint largely in cases of this kind, and find it very effectual for a time.

This is a paint manufactured by Messrs Walter Carson & Sons of London, and costs 28s. per cwt. It is sent in the form of a powder, and has to be mixed with oil specially prepared for it, eight gallons of which are required for each cwt. of powder. It becomes a very cheap paint for many purposes. In applying it to young trees, I had it put on the bark of the stem only—not on the branches—to from twenty-four to thirty inches in height from the ground. Some which was applied three years ago still remains, and the plants do not show any symptoms of having suffered from the application. It will be found valuable in preventing deer from barking trees in parks; but it requires to be repeated, as it does not remain long on the bark, and these repeated applications become expensive.

Some years ago, several of the young plantations on this estate were very much infested with rabbits, and the crops were in many cases very much destroyed by them. I first tried some of the mixtures already named, but found they were not effectual; I therefore adopted the plan of protecting with wire-netting the young plantations from those sides where the rabbits chiefly came from. This I procured of the size called No. 19 wire, two-inch mesh, and was two feet high, and galvanised. This cost 4½d. per yard, delivered at our station. Where no fence existed, and we found that the rabbits came from older plantations to feed on the young trees adjoining, we erected the wire netting by driving light posts into the ground and tying the netting on with light wire about the thickness of bell-wire. These posts were cut three feet long and driven into the ground one foot, and were placed about six feet apart. Staples were at first used in fixing the netting to the posts; but I found that when the netting had to be removed when the trees were out of danger, there would be more trouble and expense in drawing the staples than there was in the simple untying of the small wire.

When the young plantations were thus protected from the outside by the wire netting, I next proceeded to have all the rabbits killed that were in the young plantation itself; and then I had all their burrows shut up, so that afterwards any fresh openings might be detected, and means taken to remove the intruders. I have found this a most effectual plan, as the plantations have not suffered since; and now they are getting to such a size as will enable us to remove the wire netting to some younger plantation, to protect it. This plan has in no way interfered with the other game on the estate, and therefore need not be objected to on that account.

SECTION 15.—*The Preservation of Timber.*

The very best quality of timber will begin to decay in a short time when exposed to the changes of the atmosphere. Timber, if kept constantly under water, will last a long time; and, on the other hand, if kept constantly dry, it will perhaps last nearly as long: but if exposed to the weather, where it becomes wet and dry alternately, it will soon decay. It therefore becomes a subject of great importance to know in what manner timber may be preserved in exposed situations.

Sulphate of copper is found to be a great preserver of wood. In the south of Spain there exists an ancient copper mine which is said to date from the first year of the Christian era. Some of the propwood which was used in upholding the roof is still there, and in a very fair state of preservation. It is charred by the crystallised sulphate of copper which exists in the mine.

When timber is decaying by *dry-rot,* it will be found to be connected with the growth of a small plant in the wood belonging to the tribe of *fungi.* It feeds upon the sap, and grows very fast; and by its rapid growth, and by removing all the sap from the wood, the timber very soon becomes brittle. This plant also spreads rapidly, and in a short time will go over all the woodwork of a building. A good free circulation of air generally prevents it from spreading. This, therefore, shows the necessity of providing some means of allowing a free passage of air into the roofs, floors, &c., of buildings.

Dry-rot may be prevented, and indeed checked in its progress, by boiling the wood in sulphate of iron for a few hours.

From an experiment made at Cherbourg, it was found that the woodwork of vessels could be prevented from being affected by dry-rot by subjecting the timber to a slight carbonisation with common coal-gas, the cost only amounting to ten cents per square yard of framing and planking.

The Kyanising system of preserving timber is to dissolve one lb. of blue vitriol (sulphate of copper) in boiling water, and then mix it with five gallons of water, and have the timber steeped in the mixture for a few days.

The system of creosoting is to subject the timber, along with dead oil, to a pressure varying from one hundred to two hundred lb. per square inch, for about ten or twelve hours. This is done in large iron tanks, and from ten to twelve lb. of the oil is thus pressed into each cubic foot of the timber. The cost of creosoting amounts to about 4d. per cubic foot.

The creosoting of railway-sleepers has of late years been generally adopted by railway companies in this country with more or less success. It is found that sleepers impregnated with dead oil decay much faster on lines where there is a large amount of traffic, but that on those railways where the traffic is limited the sleepers last longer. This may account for some of the railway surface superintendents affirming that creosoting is not of great value. I can only account for this peculiarity in the decay of the sleepers by considering that the frequent shaking on those lines where the traffic is large will tend to split and open out the fibres of the timber in the sleepers, and thus admit the action of the atmosphere upon them, and cause their decay sooner. There is also very good reason to think that the state of the timber previous to its being creosoted has much to do in its after preservation; for example, timber creosoted in a green state cannot take in the oil so effectually as that which has been previously properly seasoned.

From my own observations I am able to affirm that, if timber be properly seasoned previous to being creosoted, this system is well worth adopting. The odour of creosote is not pleasant when used on woodwork about dwellings, or near to them; but when used on fencing, sleepers, bridges, &c., it is found very efficient.

Some years ago I purchased a quantity of creosoted fencing from Messrs Lauder & Mellenby of West Hartlepool, a few posts of which we lifted some time ago, and found them quite as good as when they were first inserted in the soil.

All conditions being equal, the most resinous timbers resist decomposition the longest; also the older and more compact the grain of the timber, the longer it will last when exposed to atmospheric influences: therefore, in the first case, pine and larch timber lasts longer than non-resinous trees. The old Scots pine-trees in the Scotch forests of Ballochbuie, Abernethy, Duthill, and Rothiemurchus—many of which are three hundred years old—are quite full of resin—so much so, that pieces of them will burn like a candle, and are used by the natives as such. I have known fencing made of this old pine which has lasted thirty years.

An experiment is now being tried on one of the railways in the north of Scotland to test the qualities of sleepers made from the pine timber from the forest of Ballochbuie, the property of Colonel Farquharson, and sleepers made of foreign timber and creosoted. The

Scots pine-timber sleepers are laid on the railway in their natural state without any preparation, and the foreign sleepers are creosoted in the way mentioned. Both kinds of sleepers are mixed together on the line. The sleepers have not yet lain sufficiently long to test the experiment thoroughly, but I should say that, from the amount of resin in the Scots pine, it will last longer than the foreign timber creosoted. The experiment is being carried out by Messrs Richard Connon & Co. of Aberdeen.

The kinds of trees already mentioned last much better than the ash, poplar, beech, &c.; and in this case the heart-wood of trees is more durable than the sap-wood. Taking these two things, therefore, into consideration, if we try to get these two qualities into the timber, we will succeed to a certain degree.

Oil is a first-class article in filling up the pores of timber. This lasting effect is shown in the case of oil-casks, and also whaling-ships. Dead oil or pitch possesses the qualities of resin. According to Professor Letheby, "dead oil first coagulates albuminous substances; second, absorbs and appropriates the oxygen in the pores, and so protects from cremacausis; third, resinifies in the pores of the wood, and thus shuts out both air and moisture; and, fourth, acts as a poison to the lower forms of animal and vegetable life, and so protects the wood from all parasites. All these properties specially fit it for impregnating timber exposed to alternate states from wet to dry, as indeed some of them do for situations constantly wet."

I have erected a great extent of fencing which was previously coated over with a composition of coal-tar, lime, and resin. I employed a tar-barrow, as shown in the chapter on Fencing. In the pot in which the tar was boiled was mixed the undernoted quantities :—

Coal-tar, ...	4 gallons.
Slaked lime, ...	$\frac{1}{4}$ bushel.
Resin, ...	$\frac{1}{2}$ lb.

This I allowed to boil for an hour, and stirred it well during the time it was on the fire. It was then applied to the posts and rails in a hot state with strong brushes made for the purpose. I have found this a most effectual coating, and can highly recommend it. Some fencing prepared in this way and erected on this property five years ago is quite as good now as when first put up.

SECTION 16.—*The Coniferæ.*

Within the last half-century there has been introduced in this country a number of trees of the pine tribe, many of which are quite hardy in our climate, and others are not so. In this section I shall only take a brief notice of those which have come under my own observation and experience. These are as follows :—

Abies alba, white American spruce.
„ *Albertiana*, Albert's spruce.
„ *Canadensis*, hemlock spruce.
„ *Douglasii*, Douglas's spruce fir.
„ *excelsa*, common Norway spruce.
„ *Hookeriana*, Hooker's fir.
„ *Khutrow*, Himalayan spruce.
„ *Menziesii*, Menzies's spruce fir.
„ *nigra*, black spruce.
„ *Orientalis*, Oriental spruce fir.
„ *Pattoniana*.
Picea balsamea, balm of Gilead silver fir.
„ *bracteata*.
„ *Cephalonica*, Cephalonian silver fir.
„ *grandis*, great Californian silver fir.
„ *nobilis*, noble silver fir.
„ *Nordmaniana*, Nordman's silver fir.
„ *pectinata*, common silver fir.
„ *Pichta*, Pitch silver fir.
„ *Pindrow*, tooth-leaved silver fir.
„ *Pinsapo*, Pinsapo silver fir.
Pinus Austriaca, Austrian pine.
„ *Banksiana*, Banks's pine.
„ *Benthamiana*, Bentham's pine.
„ *Cembra*, Swiss stone pine.
Pinus excelsa, Nepaul pine.
„ *Halepensis*, Aleppo pine.
„ *Hartwegii*, Hartweg's pine.
„ *inops*, Jersey pine.
„ *insignis*, remarkable pine.
„ *Jeffreyii*, Jeffrey's pine.
„ *Lambertiana*, Lambert's pine.
„ *Laricio*, Corsican pine.
„ *macrocarpa*, large-coned pine.
„ *Mugho*, Mugho's pine.
„ *muricata*, Bishop's pine.
„ *pinaster*, cluster pine.
„ *Pinea*, stone pine.
„ *ponderosa*, heavy-wooded pine.
„ *Pumilo*, mountain pine.
„ *Sabiniana*, Sabin's pine.
„ *strobus*, Weymouth pine.
„ *sylvestris*, Scots pine.
„ *Tæda*, Loblolly pine.
„ *tuberculata*, tuberculated pine.
Larix Europæa, common larch.
Cedrus Libanii, cedar of Lebanon.
„ *Atlantica*, Mount Atlas cedar.
„ *Deodara*, Deodar or Indian cedar.
Araucaria imbricata, Chili pine.
Cupressus Lawsoniana.
„ *torulosa*.
Wellingtonia gigantea.

I shall take these in the order in which they are given, and make a few remarks in reference to each. I commence, accordingly, with the *Abies*, or fir tribe.

Abies.

Abies alba (*White American Spruce*, Michaux).—This tree is a native of Canada, where it is found growing on light sandy soils, but inclined to moist. It has grown well on the estate of Wass in rocky soil. It is known from the common spruce by its light-green appearance. It reaches a height of fifty feet.

Abies Albertiana (*Albert's Spruce*, Murray).—This is a native of Oregon, in California, and of British Columbia. It there attains a height of fully one hundred feet, and is a beautiful, dark, graceful tree. The branches are long and slender, with a drooping habit, which gives the tree a very graceful appearance. There is not much known of its quality of timber yet. Mr Brown, the botanist, who explored British Columbia and Vancouver Island, states that "the timber is said to be firmer, finer, and straighter grained than the Canadian hemlock spruce." It is a quick grower, and does best on a moist loam soil.

Abies Canadensis (*Hemlock Spruce,* Michaux).—This is a native of North America, and there it becomes a very tall tree. It grows best in moist soils and cool situations, but not where the water is sour and stagnant. This is a beautiful specimen of the species, and should be much more planted in this country than it has been. It is, however, a bad transplanter. We have found it best to purchase small plants and keep them in the home-nursery for a time, when they can be carefully lifted to their permanent situations. From what I have seen of it, I should say it will make a first-class game-cover, as its branches extend to a great distance all round the stem and down to the ground.

Abies Douglasii (*Douglas's Spruce Fir,* Lindley).—This grows naturally on the banks of the Columbia river, and is often found growing to a height of two hundred feet. It is a fast grower, and a tree of great beauty. There is one at Dropmore which grew sixty feet in eighteen years. There are several on the estate of Wass which have made an average growth of two feet per annum, although growing on thin soil resting on rock. In my opinion this will become one of the best timber-trees in this country. The timber is of fine quality and close-grained.

Abies excelsa (*Common* or *Norway Spruce,* De Candolle).—This tree is so well known that it does not require much notice at my hands. It is a handsome tree, and thrives well in a moist situation, but not where the water is stagnant.

Abies Hookeriana (*Hooker's Spruce,* Murray).—This is a native of California. The foliage is a rich green above, with a pale green beneath. In its native quarters it grows to a height of from seventy to one hundred feet. It is a beautiful tree, and very graceful, being not unlike the *Cedrus Deodara* in habit, but is more thickly branched, and is altogether a more handsome tree. The timber is of a reddish colour, hard and tough, and close in the grain. I should say that this will become a first-class timber-tree in this country, as the quality of the timber is good and the tree is hardy.

Abies Khutrow (*Himalayan Spruce,* Royle).—A tree from the Himalayan Mountains on their northern slopes, and is found growing in large masses. It does not attain a great height—usually about fifty feet. It is a handsome tree of a pyramidal shape.

Abies Menziesii (*Menzies's Spruce Fir,* Lindley).—This is a native of

North America, especially towards the north-west of the continent. It was found by Douglas, and is a very handsome tree, and hardy. It is growing well on the Wass estate on several soils and situations, but is making most progress on a rich loam soil. The foliage is of a light silvery colour underneath, while the upper portion is a bright green.

Abies nigra (*Black Spruce*, Michaux).—This is a native of the more northern regions of North America, where it attains a height of from seventy to ninety feet. It grows naturally in moist soils. The foliage is very dark, from which it derives its name.

Abies Orientalis (*Oriental Spruce Fir*, Pirret).—This is a very tall-growing tree, and indigenous to the countries bordering along the shores of the Black Sea. It is said to form large forests in the neighbourhood of Trebizond, on the south-eastern shores of the Black Sea. It very much resembles the common spruce, but the leaves of the *Orientalis* are shorter than the common spruce, and lighter in colour.

Abies Pattoniana (Jeffrey).—This was found by Jeffrey on the Caxadus Mountains in California, at a latitude of 42° N., and at an elevation of over five thousand feet above sea-level. Jeffrey describes the timber as being very similar to that of the larch; and if so, it may be expected to become a useful timber-tree. It was found in its native quarters growing best on a moist loam soil.

Picea.

Picea balsamea (*Balm of Gilead Silver Fir*, Loudon).—This is a native of North America, found growing on thin soils, and chiefly on the sides of mountains. The foliage is a dark green above with a silvery tinge beneath. The cones are of a purple colour. When young, this is a very handsome tree; but when it attains an age of from thirty to forty years in this country, it gets stunted, and, generally speaking, does not thrive well afterwards; the points of the shoots become of a dead appearance, and also very thick and unnatural-looking. I am of opinion that if this tree were cultivated on our poorest soils, it would thrive much better than it at present does on rich soils, on which it is usually planted.

Picea bracteata.—This is a native of California, and was found by Dr Coulter on the mountains near Santa Lucia, at an elevation of six thousand feet above the level of the sea, in latitude 36° N. Mr William Sobb, a botanical collector, found it growing luxuriantly in ravines of the mountains near to San Francisco, where he states it attains a height of from one hundred to one hundred and fifty feet. The trunk grows as straight as an arrow, the branches at the bottom spreading out to some distance and gradually becoming shorter to the top, thus forming a tapering pyramid. Mr Sobb further states that along the summit of the central ridges, and about the highest peaks, in the most exposed and coldest places imaginable, where no other pines make their appearance, it stands the severity of the climate without the slightest perceptible injury, growing on slaty rubbish which to all appearance is incapable of supporting vegetation. We do not know much of this tree in this country, as there are very few specimens of it in the kingdom. There are two plants of it on this estate, brought here in 1865. They are growing on a light loam soil, have made good progress, and have not in any way been injured by spring frosts.

Picea Cephalonica (*Cephalonian Silver Fir,* Loudon).—A handsome tree of from fifty to sixty feet high. It thrives best on dry situations in this country. It is somewhat tender when young, but becomes hardy as it grows older. It is found largely in the Black Mountains of Cephalonia, at an elevation of from four thousand to five thousand feet above the level of the sea. It attains the largest size (according to Loudon) in the hollows in the mountains, where the situation is somewhat sheltered and the soil good. The timber of this tree is very hard and durable. The best plants at present in this country are growing on dry stony soils.

Picea grandis (*Great Californian Silver Fir,* Loudon).—This, as its name implies, is a native of California, where it grows to a height of nearly two hundred feet. It is hardy in this country, and grows best in a deep loam soil. The foliage is of a beautiful light-green colour, and it is altogether a very handsome tree.

Picea nobilis (*Noble Silver Fir,* Lindley).—This is a native of the northern parts of California, where it forms extensive forests and grows to a great height. The foliage is very dense, and the branches grow with a very flat surface. It thrives best in a rich loamy soil, and attains in its native quarters a height of one hundred to two hundred feet at an elevation of from six thousand to eight thousand feet about the level of the sea. The timber is of a white colour, and soft. It is very hardy, and is a fine addition to the pinetum. In purchasing plants of this kind, care should be taken to see that the plants have been grown from seed, and not from cuttings. Those reared from cuttings, being taken from the branches of the older trees, retain for a long time a flat, one-sided, or branch-like appearance ; and it always takes a number of years to make them well shaped, which must be done by pruning, and this retards their growth.

Picea Nordmaniana (*Nordman's Silver Fir*).—This is a native of the mountains of the Crimea, where it grows to a height of from seventy to one hundred feet. It is very hardy, and is a handsome addition to the pinetum. It grows well in this country, and will in my opinion become a good timber-tree.

Picea pectinata (*Common Silver Fir*, Loudon).—This is a well-known tree, and one of the most handsome of the kind. It is a native of the Pyrenees, the Caucasus, and portions of the centre of Europe. It grows well on several soils, and in good situations attains a height of from one hundred to one hundred and twenty feet.

Picea Pichta (*Pitch Silver Fir*, Loudon).—This is a native of Mount Atlas, and resembles the common silver fir very much; but may be known from it by the leaves being narrower and more thickly set on the branches, and they are not so much of a silvery colour beneath. It is not very hardy—at least I have not found it to be so, having, in several instances which have come under my notice, been damaged by spring frosts.

Picea Pindrow (*Tooth-leaved Silver Fir*, Splack).—This is a native of the Himalayan Mountains, found growing to a height of about one hundred feet, at an elevation of ten thousand feet above the level of the sea. This is a tender plant in the case of spring frosts, and the only way to avoid its being hurt is to plant it on some high-lying and dry situation.

Picea Pinsapo (*Pinsapo Silver Fir*, Loudon).—This is a native of the mountainous districts of Spain—especially in Grenada, on the mountains of Sierra Bermeja and Sierra Nevada—at an elevation of from four thousand to six thousand feet. It is a hardy tree, and grows well in this country. We have some growing well in Yorkshire on a calcareous soil on the oolitic formation. The quality of the timber very much resembles that of the common silver fir. It was only introduced into this country in 1838, and therefore we have no large specimens of it; it is, however, a beautiful tree. It is like *Picea Cephalonica*, but its leaves are broader, less acute, and on the under side there are fewer rows of stomata.

Pinus.

Pinus Austriaca (*Austrian Pine*, Höss).—This is a native of Austria and other countries adjoining it. It is a rapid-growing tree, and does best in a dry soil of some depth, and will succeed in exposed situations, for which it is admirably adapted. There is a fine specimen of it growing on the lawn at Myton Hall, Yorkshire, the seat of Major Stapylton. The soil is a light sandy loam, and dry. There are several on this estate which have an average growth of fourteen inches per annum, growing on a light sandy loam soil with a rocky subsoil.

Pinus Banksiana (*Banks's Pine*, Lambert).—This is indigenous along the coast of North America, at high elevations. I do not consider it a very handsome tree, as it has a thin spare appearance, and the branches are few and far between; it, however, thrives well in sandy soils.

Pinus Benthamiana (*Bentham's Pine*, Hartweg).—This is a native of California, growing at an elevation of from five hundred to eight hundred feet below the line of perpetual snow, and attains a height of two hundred feet. The leaves are from ten to twelve inches long, and of a dark-green colour, and very thick on the branches. This is altogether a noble tree, and should be more cultivated in this country than it is. It has grown well on this estate on a light sandy loam.

Pinus Cembra (*Swiss Stone Pine*, Linnæus).—This is found growing naturally ou the highest mountains of France, in the Alps, and in Italy and Austria, and is there found at an elevation of as much as six thousand feet above sea-level. It was first introduced into this country about 1746. In its native quarters it attains a height of about a hundred and twenty feet. In this country the largest specimen may be fully forty feet high; but as it is a slow grower, it may yet attain large dimensions in our home-plantations. It is a very dark, dense tree, and, in my opinion, a very handsome one. The timber is of a light-brown or reddish colour, and soft. It is from this timber that the Swiss toys and ornaments are made, which are so much admired in this country. The seeds of this tree are eaten by the inhabitants of Siberia and other countries where it grows. In its native quarters it grows on thin soils resting on rock. It is very hardy in this country, some good specimens of which may be seen at different country seats in England and Scotland. One at Merton Hall, in Nottinghamshire, was in 1860 fifty feet high; and one at Cultoquhey, in Perthshire, was in 1863 thirty-five feet high, when about forty years old.

Pinus excelsa (*Nepaul Pine*, Wallick).—This is a native of the mountains of Nepaul, where it attains a height of from one hundred to one hundred and twenty feet. It was introduced into this country in 1823. It is a hardy tree in this country, and will ere long be more extensively planted than it is now. It grows well in situations not too much exposed. It very much resembles the *Pinus strobus*, but may be distinguished from it by the round crest of the other, and the leaves are larger than those of the *P. strobus*.

Pinus Halepensis (*Aleppo Pine*, Miller).—This is a native of the coasts of the Mediterranean, and is found growing in rocky soils, and generally more in the form of a shrub than a tree. It thrives pretty well in this country in poor rocky soils, but, on the whole, it does not make much progress, at least so far as I have observed it.

Pinus Hartwegii (*Hartweg's Pine*, Lindley). — Indigenous to the mountains of Mexico, where, at an elevation of as much as nine thousand feet above sea-level, it attains a height of fully fifty feet. It was introduced into this country in 1839, and may be considered hardy; but in several cases it has been cut down by spring frosts. It is a very handsome tree, and worthy of a place in any pinetum.

Pinus inops (*Jersey Pine*, Solander).—This is also a native of the north-west of America, where it grows to a height of forty feet. It is more of an ornamental than useful character, and succeeds best on dry sandy soils.

Pinus insignis (*Remarkable Pine*, Douglas).—A native of California, growing down to the level of the sea. It is a tree of medium height, but is very ornamental, from its bright-green colour. It was first introduced into this country by Dr Coulter in 1833. It thrives best on light and sandy soils, and stands the effect of the sea-breeze well. It is also a rapid grower, as may be known from the fact that one at Osborne made a growth of three feet nine inches in 1849, and in 1850 a growth of five feet nine inches, and in 1851, six feet six inches (see Lawson's 'Pinetum Britannicum,' part xix. p. 3). Some fine specimens may be seen at Longleat in Wiltshire, the seat of the Marquess of Bath, at an elevation of from four hundred and fifty to seven hundred feet above sea-level; and at Eastnor Castle, in Herefordshire, at an elevation of five hundred and twenty feet. One at Longleat, when eleven years old, was twelve feet high; and one at Eastnor Castle, when thirty years old, was forty-six feet high. Specimens on the Wass estate have made annual growths from eighteen to twenty inches.

Pinus Jeffreyii (*Jeffrey's Pine*).—This is also indigenous to California. It was found by Jeffrey in the valley of Shafta, in the north of California, where it grows to a height of about a hundred and fifty feet. The cone of this tree is large and beautiful. The foliage is a kind of sea-green colour, and about eight inches long. It is very hardy. There are a few young plants growing pretty freely on the Wass estate on a light loam soil.

Pinus Lambertiana (*Lambert's Pine*, Douglas).—This is indigenous to the Rocky Mountains and other parts of the north-west of America; and, according to the account given by Douglas, grows best in sand. The timber is white and soft, and is used in California for the inside work of house-building. It is well adapted for growing on the old red sandstone and limestone formations in this country. It was introduced into this country in 1827. We have planted it on this estate on dry rocky soil, at an elevation of five hundred feet above sea-level, and find it hardy and making fair progress.

Pinus Laricio (*Corsican Pine*).—This is a fine specimen of the pine tribe, and is indigenous to Corsica and Spain, and along the shores of the Mediterranean, and there it attains a height of about a hundred and fifty feet. It is a fast grower. The leaves are long and thinly set on the branches. This is a hardy tree; and having been introduced into this country in 1759, or more than one hundred years ago, good specimens are plentiful, and an opinion can now be formed as to its timber qualities. I am of opinion that it will become one of our most valuable timber-trees. It grows well in different soils, if not too retentive. There are some growing on a light sandy loam on this estate which are making annual growths of from fifteen to eighteen inches.

Pinus macrocarpa (*Large-coned Pine*, Lindley).—This is indigenous to North America, especially in the north-west, where it attains a height of about one hundred and twenty feet. The leaves and cones are of great length, the former being often fourteen inches and the latter one foot in length. It is quite hardy, and grows well on soils of a light loam or sandy loam description. The foliage is of a sea-green colour.

Pinus Mugho (*Mugho's Pine*).—This, I feel assured, is a useful tree for planting on exposed situations. In its native quarters it grows on cold and bleak situations on mountains, and there assumes the size of a considerable tree—from thirty to forty feet high. It very much resembles the common Scots pine (*Pinus sylvestris*).

Pinus muricata (*Bishop's Pine*, Don).—This variety has been introduced from California, where it is indigenous to the mountains as far up as an elevation of three thousand feet above sea-level. It is a handsome tree, and grows to a height of from forty to fifty feet. The colour is a very rich vivid green. It is making fair progress on this estate (Wass) in a light loam soil.

Pinus pinaster (*Cluster Pine*, Solander).—This is a native of the mountains and coasts of India, China, Japan, and on several mountainous regions, and on the coasts of Europe. It reaches a height of about sixty feet when grown in dry sandy soils; but the situation must be dry, and the subsoil free and open. The foliage is a bright green, and usually about eight or ten inches in length. It is an invaluable tree for planting along the coasts. This tree has a large tap-root and very few fibrous roots, hence there is some difficulty in transplanting it. It is a rapid grower, and the timber is soft, and not of any great value, but it is valuable to plant on exposed situations for shelter. If planted along the coast, other and more valuable trees can be reared immediately behind it, as it stands the sea-breeze well.

Along the west coast of Scotland the pinaster has been extensively planted, where it has succeeded well, and shelter has been given by it where no other kind of trees would have thriven. It is a slow grower at first, being inclined to become bushy for the first few years, but afterwards it grows much faster until it attains a fair height.

In a recent visit to France I inspected a forest of pinasters on the coast south from Boulogne. The plants were apparently about thirty years old, and were at the time on an average from sixteen to eighteen feet high. They were in a very healthy state, and seemingly making more progress now than they did the first seven or eight years of their growth. The soil they were growing upon was a pure sand, and the subsoil the same, and quite porous. The sand is so light that on the day of my visit quantities of it were driven about by the breeze blowing inland from the sea. This shows the value of the tree for planting on our coasts. It does not succeed on very high-lying and exposed situations so well—at least I have not found it to thrive so well there as on the coast-line. I have planted it extensively on hills in the midland and northern counties of England, and although a fair proportion of the plants have got away, yet there have been a good number of deaths, and the plants remaining have not succeeded so well as others planted on the coast-line.

Pinus Pinea (*Stone Pine,* Linnæus).—This tree is indigenous to the south of Europe, where it grows to a height of from sixty to seventy feet, and forms a large flat head of branches. The leaves are about six inches long, and of a dark-green colour. Some years ago I procured a quantity of the seed of this tree from the north of Italy, which has grown well. The plants are planted on a light loam soil, and are making fair progress.

Pinus ponderosa (*Heavy-wooded Pine,* Douglas).—This is a native of North America, especially to the north-west of the continent. The tree has a thin and bare appearance from there being few branches on it. It grows to a height of one hundred feet. It is a hardy pine, and is likely to become a useful timber-tree in this country. It is called the heavy-wooded pine, as the timber is said to be so heavy that it will sink in water. I have observed that the best specimens of this tree grow in this country on a light loam soil.

Pinus Pumilo (*Mountain Pine*).—This is a very useful tree for growing on dry bleak situations. It has been found to succeed well on the chalk wolds of south-eastern Yorkshire and in the southern counties. It does not grow to any great height, attaining only about twenty or thirty feet even in the best situations.

Pinus Sabiniana (*Sabin's Pine,* Douglas).—This is from the Cordilleras of New Albion, where it grows at an elevation of about one thousand five hundred feet below the line of perpetual snow, and there it attains a height of one hundred feet. The foliage is of a pale-green colour, and about a foot in length. The cones of this tree are said to be something grand, being one foot in length and eighteen inches in circumference. It is a hardy tree, and grows best on good rich soils. It was introduced in 1832 by Douglas, and one of the first planted from seed sent by Douglas is still growing in the arboretum at Chiswick, belonging to the Horticultural Society. The timber is of a white colour and tough, and is not very hardy in our climate.

Pinus strobus (*Weymouth Pine*, Linnæus).—This is a native of North America, and was introduced some time about the year 1700. It was planted extensively at Longleat, in Wiltshire, by the then Lord Weymouth, hence its name. The leaves are about four inches long, and of a pale-greenish colour. It thrives best in good rich soil. Some fine specimens are to be seen in the woods at Arniston, the seat of Robert Dundas, Esq., in the county of Edinburgh. It is said to grow to a height of two hundred feet. One specimen at Arniston is nearly eighty feet high. There are some fine specimens on the estate of Lofthouse, the property of the Earl of Zetland, growing in a sheltered situation in a loam soil, and about one mile inland from the coast. The timber of this tree is not of good quality, being soft and short in the grain, and therefore should not be planted extensively; but it is an ornamental tree.

Pinus sylvestris (*Scots Pine*).—This tree is so well known that it requires little or no description at my hands. It is the only one of the pine tribe which is a native of this country, and it is not inferior in any way in the quality of its timber to any of the others. It is a very hardy tree, and is found growing on the highest mountains in Scotland, and up to a great elevation, being found upwards of two thousand feet above sea-level. The oldest Scots pine forests of natural growth are those of Ballochbuie, on the Invercauld estate, the property of Colonel Farquharson; those of Abernethy and Duthill, in Strathspey, the property of the Earl of Seafield; and those of Rothiemurchus and Glenmore, in the upper district of Strathspey.

The forest of Ballochbuie is situated at an average elevation of about twelve hundred feet above sea-level, with a northern exposure, and in the midst of high mountains. On the lower portions the soil is a kind of gravelly clay, with a subsoil of the same; at a higher elevation the soil is a light loam resting on a gravelly subsoil; and on the highest portions the trees grow in crevices of rocks. The age of the trees in the forest range from about one hundred to three hundred years and upwards; some which have been cut down show an age of about three hundred and twenty years. The average height may be put down at eighty feet, and many of them contain as much as one hundred and sixty cubic feet of timber.

The trees have made the most progress on the dry slopes of the middle and lower portions of the forest, where the soil is a light loam with a gravelly subsoil; but, as might be expected, the timber is of the best quality on the higher grounds, and on a gravelly soil.

The timber from Ballochbuie forest is being used by Messrs Connon & Co. of Aberdeen, for shipbuilding purposes, for which the old trees are admirably adapted. This forest is situated about eighteen miles from railway communication, and about sixty miles from Aberdeen; and a high price is got for the timber on account of its age and first-class quality.

The forest of Abernethy lies to the north of the Cairngorm Mountains. Its elevation above sea-level ranges from one thousand to two thousand feet, and it has a northern aspect. The general surface is undulating. The lower and flat portions generally consist of a soil of a light gravelly peat, the soils on the hills being of a light gravelly clay, with large granite boulder-stones interspersed throughout the district. In some places there are flats of peat of considerable depth, in which are imbedded trunks of trees of the oak, birch, and Scots pine. Over the whole forest young plants of the Scots pine are to be found growing; and these thrive best, and much thicker, where the soil is a kind of sandy peat with a gravelly subsoil. The timber is of the best quality on the higher grounds, at an elevation of from one thousand five hundred to two thousand feet. The growth there is so slow that sixty rings may be counted upon one inch of the stock of a tree when cut down, and generally the growths counted in this way will not exceed forty to the inch. Such timber has been known to stand in a fence for upwards of thirty years in a good state of preservation.

The forest of Duthill is somewhat similar in character to that of Abernethy. It has a northern aspect, and the soil is generally of a gravelly peat, with a subsoil of gravel. The oldest trees will be about two hundred years. The trees in this case have made the most progress on the light peaty gravelly soils, and they have made the least progress in peat soils; but the timber is of the best quality where it has been slow of growth—that is, on the high-lying and poorest soils. In the southern parts of Scotland, and in England, the timber of the Scots pine generally is thought of little value; but when it is planted upon light peaty and gravelly soils, and allowed to stand for a long period, the timber becomes of first-class quality. In its young state it is useful for many general country purposes; but when it is desired to have it of really good quality, it should not be cut down before it is eighty years old at least.

It is worthy of notice that all the old Scots pine forests in Scotland have a northern aspect—in fact, I do not know any important extent of

Scots pine-trees which have attained a considerable age with any other aspect.

Pinus Tæda (*Loblolly Pine,* Linnæus).—This is a native of Florida and Virginia, and is there found in a great many soils and situations, attaining a height of about eighty feet, with a large spreading top. The foliage is of a light-green colour; the leaves slender, and about five inches long. Bishop Compton introduced it into this country in 1713; and good specimens are now to be seen at several country seats in the kingdom, as at Whittington and Kew. It has not, however, been extensively planted, as its timber is not valuable. It is of a soft spongy nature. It is, however, a fast-growing tree, and, I should think, might be introduced with advantage into some climates where any tree of rapid growth is important—such as some place along the coasts in the south of Europe and the Cape of Good Hope.

Pinus tuberculata (*Tuberculated Pine,* Don).—This was introduced from California in 1846, where it attains a height of about fifty feet. The foliage is of a light-green colour, and about five inches long. Gordon states that the timber is hard, and of a reddish colour. The settlers in California use the timber in erecting their houses, but it is little known in this country.

Larix Europæa (*European Larch*).—There are several varieties of the larch, but the common or European is the only one worthy of cultivation for its timber. The larch is found in the mountainous parts of the continent of Europe, Asia, and America, and is everywhere valued for its timber. It attains a height of about one hundred feet. The European is a hardy tree, and attains a large size in this country. Many fine specimens are to be found all over the kingdom, especially on the Duke of Athole's estates in Perthshire, where this tree was planted in 1741. It was first introduced into Scotland in 1734 by Lord Kames, and afterwards by the then Duke of Athole, as stated, in 1741, when it was planted at Dunkeld. These trees have grown to a very large size. There are also some very large trees of this kind in the home-park at Invercauld. The value of the larch as a timber-tree is now so well known and appreciated that it requires no commendations. It is one of the best nurses we have for planting amongst other trees, and it is also one of the best paying trees when planted in soils suited to its nature. It thrives well on different soils and situations, provided the soil and subsoil are porous, and that there is no stagnant water about the roots. As an instance of its rapid growth, I may state that on this estate we have a young plantation now four years old, and the plants average ten feet high. They are growing on a light loam soil resting on rock.

Cedrus Libanii (*Cedar of Lebanon*). — This is a native of Mount

Lebanon and Mount Taurus, where it grows to a height of from sixty to eighty feet. It was introduced into this country in 1683. Some of the first plants that were introduced are still growing in the Botanic Garden, Chelsea. There are a great many fine specimens of this tree in this country, some of which may be seen at Wykeham Abbey, near Scarborough, one of the seats of Lord Downe. There are also good specimens at Arniston in Mid-Lothian, and Hopetoun House in West Lothian. Although a highly ornamental tree, and one peculiarly adapted as a park tree, it is not much valued for its timber. It grows well in different varieties of soil, provided they are porous, and the situation not too much exposed.

Cedrus Atlantica (*Mount Atlas Cedar*).—This is a native of Mount Atlas, where it is found growing at an elevation of nine thousand feet above sea-level. It was introduced in 1844. It very much resembles the cedar of Lebanon, but may be known from it by its whiter appearance. It is quite hardy in Britain. There is a fine specimen of it at Bicton, in Devonshire, the age of which is now about twenty-one years, and it is about thirty-five feet high; one at Kew, fifteen years old, is twenty-four feet high; one at Donibristle, in the county of Fife, Scotland, seventeen years old, is twenty feet high. It grows well in the north of Scotland.

Cedrus Deodara (*Deodar* or *Indian Cedar*, Lindley).—This is a native of the Western Himalayas, where it grows to a height of one hundred and fifty feet, and nine or ten feet in diameter of stem, and at a height of ten thousand feet above sea-level. It was introduced in 1822. When young, it is a very graceful and ornamental tree; but when old, is said to form a large horizontally-branched tree. It is said to be often met with in its native localities with a girth varying from twenty-four to thirty feet, and a proportionate height and expanse of branches. A large quantity of the seed of this tree was procured in 1851 by the Right Hon. T. F. Kennedy, who was then Chief Commissioner over the Crown Woods and Forests, and given to some of the principal nurserymen, with the view of its being more extensively introduced into this kingdom. A quantity of the seed was also sown in the Royal forests, but chiefly in the New Forest, Hampshire; and a great number of good plants now remain. This was done at the time, as it was then considered that the timber of the *deodara* was hard and durable; and it is largely employed in the erection of dwelling-houses and temples in its native quarters, and also for bridges and boats, where it gives ample proof of the durability of its timber. In Moorcroft's Travels, many instances will be found of the good lasting quality of the native-grown *deodara*. In these countries it is stated that, if the timber be used when young, it very soon decays when exposed to the varying influences of the weather. There is, therefore, no reason to suppose but that Mr Kennedy may have been perfectly correct in introducing the *deodara* largely, although some young trees in this country certainly show an inferior class of timber, as nearly all young trees of any description will do; yet when it comes to a considerable age, it may prove itself a first-class producer of timber, and at all events, if not so hard and durable as the oak, it will probably be equally as good as the larch. It is a hardy tree in our climate, and I consider it worthy of being more extensively cultivated. I have planted a good number on the estate of Wass—some on a light loam soil with a stiff clay subsoil, but which has been drained, and there the trees are doing well; others I have planted on a thin rocky soil, at an elevation of six hundred feet above sea-level, and they are also growing fast. From the nature of the soil and district in which they are found growing naturally, it may safely be said that they will thrive best on the limestone, granite, and mica-slate formations, provided the sites are not too much exposed, and out of the influence of the sea-breeze, which they will not stand. So far as my experience goes, the deodar has not had sufficient justice done it in this country. Its side branches have been cut in with the view of improving the leading shoot, and all this cutting and pruning does it more harm than good, in my opinion. We should take the tree as we receive it, and allow it ample room to develop itself, leaving the remainder to nature; and then it would have as fair a chance as it has in its own native mountains, although, no doubt, our cold climate is against it to a certain degree.

Araucaria imbricata (*Chili Pine*, Pavor).—This is a native of the mountains of Chili, where it is often found growing one hundred and fifty feet high. It is of a dark-green colour, and very ornamental—unique in its appearance, and this renders it a very attractive tree. It was introduced in 1776. When young, the branches clothe the trunk in whorls down to the ground. This tree has been planted extensively in Britain, and it has proved hardy. In this climate it is a highly ornamental tree, and there is some likelihood of its becoming a timber-tree.

Cupressus Lawsoniana (Murray).—This is a native of California, where it reaches a height of about one hundred feet, and two feet in diameter. It is a beautiful, graceful, and delicate-looking tree; the foliage is of a sea-green colour, and it is very hardy. It is usually found growing in the neighbourhood of rivers and streams in California. It was discovered in 1854, and a few of the first plants grown in this country were reared in the nurseries of Messrs Peter Lawson & Son of Edinburgh, one good plant of which may be seen (1868) standing nearly thirteen feet high, which I believe is the largest in the kingdom. I have one growing on the lawn in front of my house which is now six feet high, and making an annual growth of nearly one foot. The soil is a black loam.

Cupressus torulosa (Don).—This is found in the Western Himalayas, where it grows to a height of one hundred feet and upwards ; Mr Gordon says "one hundred and fifty feet in height," and that they are all as as straight as an arrow, with the branches drooping slightly downward, and so arranged as to make the tree a perfect cone.

The seed of this tree was largely imported in 1852 by H.M. Commissioners of Woods and Forests. It grows in the most inaccessible parts of the Himalayas, and therefore its timber has not been fully tried, and no correct opinion can as yet be given from trees of home-growth. In the severe winter of 1860-61, a great many fine specimens were killed. It cannot be called a hardy tree, and yet it may live in our climate for a long period, as it is very seldom we experience such a severe winter as that which I have mentioned.

Wellingtonia gigantea (Lindley).—This is a native of California, where it reaches the immense size of from two hundred to four hundred feet in height, and thirty feet in diameter, and grows at an elevation of fully five thousand feet above sea-level, in latitude 38° N. and longitude 129° 10′ W. The bark of the old trees is said to be fully fifteen inches in thickness. It is also called *Sequoia Wellingtonia* in Lawson's 'Pinetum Britannicum,' reasons for which are there given, but which need not be entered into here. I prefer giving it the name which was applied to it by the late Professor Lindley in the 'Gardeners' Chronicle.' In 1853 our American friends called it *Washingtonia Californica* and *Taxodium Washingtonianum*, in memory of the great Washington.

This tree is the largest known on the earth. It is said that, when of mature growth, it is about three hundred feet high, and ninety feet in circumference at the root. The 'Pinetum Britannicum' says, with reference to it: "Mercantile men may bring home to their minds the enormous size of these trees in another way—viz., that used by Messrs Sang, who calculated the quantity of wood in a tree, and its price at a 1d. per foot of inch deal, which gives the astounding result of £6250 as the value of a single tree. Although this is a good mode of showing the enormous quantity of timber in one of those trees, it would not do for practical calculations of its value; for, as we shall presently see, the timber, instead of producing 1d. per foot, is worthless for any purpose yet known, and it would probably bring no return at all." The bark of part of the trunk of one of those trees will have been seen by many in the Crystal Palace, Sydenham. When it was erected in its natural position, it was one hundred and sixteen feet high, forty-five feet in circumference at the top, and ninety-three feet in circumference at the base. This specimen, however, it is greatly to be regretted, was destroyed in the fire which took place at the Palace in 1867.

Mr Lapham, the proprietor of the Calaveros or Mammoth Tree Grove, gives an interesting account of the dimensions of the trees in that grove. He says: "Most of the specimens now standing there are of the average height of three hundred feet; one, however, the 'Father of the Forest,' as the specimen has been called, must have been considerably larger. It has long since bowed its head in the dust, and now 'lies at random carelessly diffused.' It still measures one hundred and twelve feet in circumference at the base, and can be examined for three hundred feet where the trunk was broken by falling against another tree: it there measures eighteen feet in diameter, and, according to the average taper of the other trees, this giant must have been four hundred and fifty feet high, and was no doubt one of the loftiest forms of vegetable matter of the present creation. A hollow burnt cavity extends through the trunk for two hundred feet, large enough for a person to ride through."* Others are mentioned on the same authority—as the "Miner's Cabin," measuring eighty feet in circumference and three hundred feet in height; the "Old Bachelor," a forlorn-looking individual, sixty feet in circumference and three hundred feet high; "Hercules," sixty-seven feet in circumference and three hundred and twenty-five feet high. The geological formation of the district of California in which the Mammoth Grove is found is granite. Dr Winslow states, in the 'Californian Farmer' (see 'Pinetum Britannicum'), that "the basin is reeking with moisture, and in the lowest places the water is standing, and some of the largest trees dip their roots into the pools or water-runs. The soil in which they grow is rich and deep, and if composed, as it probably is, of the decayed remains of former giants of the same tribe, it is no wonder that it is so. The climate at the Calaveros Grove is good—neither very hot nor very cold—and not dissimilar to our own."

The *Wellingtonia* has proved itself perfectly hardy in the climate of this country, and indeed this might have been expected from the description which is given of the climate of the different parts in which it is found growing naturally. It remained free of injury in the severe winter of 1860-61. It is a rapid grower in our climate, but we cannot say much of its uses so far. It is thought by some that the bark will be valuable for tanning. There is a fine plant of it at Windsor, which

* 'Pinetum Britannicum,' part xx. p. 7.

was twenty-one feet high and ten years old in 1864. I have planted about thirty plants on different soils and situations on this estate (Wass), and they have all grown well, making an annual growth, on an average, of twenty inches. One, which is now five feet high, made a growth of two feet in 1867. It has grown best on this estate in a deep, rich, black, loam soil. Another, which is growing on the side of a hill in a loamy clay soil, is now ten feet high and five years old.

The *Wellingtonia* sometimes throws out a number of budding shoots. I tried an experiment with these last season (1867), which proved successful. On several plants I left all the young shoots, leaving it to nature to allow one to get the lead of the others; on several others I pinched off with the finger and thumb all the young shoots excepting one in the centre. The shoot left rushed away very quick, and, on an average, the plants so treated have made growths of twenty inches. Those trees which were left to nature made only an average growth of about six inches.

SECTION 17.—*The Cultivation of the newer Coniferæ in this Country.*

In the foregoing section I have given a short account of those coniferous trees with which I am acquainted. A great many of the newer coniferæ are, no doubt, hardy in our climate, and many of them may become useful as timber-trees in this country. The coniferæ are natives of many portions of the globe — from the cold arctic regions to the warmest parts of India. They are principally found, however, in countries of a medium temperature—over the middle and northern parts of Europe, North America, and Asia. The *Picea* are a class of trees of immense importance to mankind. They are noble trees, and generally of large size, quick of growth, and form large forests over a considerable portion of the globe. The timber of those trees is used in many countries, and is of great value both for building purposes and for fuel in their native localities, while it is sent to other countries under the name of deal, which is used in almost all commercial and domestic purposes. The resinous parts are converted into turpentine, pitch, and balsam — turpentine being got from the *Pinus sylvestris, P. pinaster, Abies pectinata, Larix Europæa,* pitch from the *Pinus sylvestris,* balsam from the *Pinus Pumilo, P. pinea, Abies balsamea;* and the bark of many of them contain great tanning properties. I am of opinion that ample justice has not been given to the cultivation of the coniferæ in this country. Very often a portion of land is laid off for this purpose, which is called the pinetum; and this usually consists of one kind of soil and subsoil only, on which nearly all the different kinds of the hardy pines are planted. We have already learned from the 16th section of this chapter, that in their native localities different trees grow in different soils, and consequently, to rear them with the greatest success, we must take this into consideration. The climate of every district of country must also be taken into account, besides the situation and aspect. It often occurs that some kinds of the coniferous tribe thrive well on some estates; while on others, and that at no great distance, the same kinds do not succeed. Local circumstances are, no doubt, the cause of this difference—the soil, climate, or position of the respective properties being the cause of the success or non-success in the growth of coniferous trees. If they are planted in low-lying situations, and where the soil is damp and undrained, then, in all probability, the spring will have advanced considerably before they begin to grow, from the want of warmth about the roots; and, as a natural consequence, the young shoots have not time to ripen and get hardy before the autumn frosts set in, and the result is, the young shoots are often destroyed in such situations. I believe that many trees which are called "tender" in some districts, get that name from the fact that the situations in which they have been placed are damp and cold; on the other hand, I think that many failures occur from planting the coniferous trees in low-lying, warm, and sheltered situations. In such places they are excited to an early growth, and continue to grow till late in the autumn, when they are caught by the frosts. A great proportion of the coniferæ should be planted on situations neither too warm nor sheltered; while, on the other hand, too much exposure generally is fatal to them, though several of them do well in exposed situations. In a natural state they do not generally grow on deep rich soils, but on thin dry soils, in hilly and mountainous countries; therefore, in choosing land for a pinetum, it should have a variety of surface, the soil being a light loam, and the subsoil open, free, and dry. This latter quality may be accomplished by drainage, if necessary.

It often occurs that it is desirable to plant some specimens of the conifers on a soil unsuited to them. This may be improved by the removal of the soil where the plant is to be put, and replacing it with one of a more congenial nature; but in this case care must be taken that a means of escape is made for the water, which will run off a stiff soil into one more open. Another consideration worthy of notice is the selection of the plants, as it must be kept in mind that the condition of the plant when young will interfere with its after-growth to a certain extent. It is better not to have plants which have been reared in pots. A tree in its natural state extends the chief portion of its roots in a horizontal direction and near the surface, in search of food, especially the coniferous tribe. When they are reared in pots, a downward tendency is given to the roots, which they afterwards retain to a great degree; and this tends to send the roots into the subsoil, where they cannot derive such an amount of food as they do at the surface. Fig. 126 shows the state of the roots of a tree which has been confined in a pot, and fig. 127

Fig. 126.

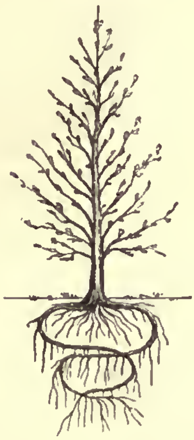


Fig. 127.

shows the roots well formed. Plants thus reared in pots never get such a firm position in the soil as those which are reared in the open ground. No harm can take place when grown for one or two years in pots, but they certainly should not be kept longer.

The coniferous tribe is reared from cuttings, grafts, and seed. The latter should of course be always chosen. Plants reared from cuttings can be easily known from their flat, one-sided appearance. Autumn is the best season of the year for planting coniferous trees; and this should be done in moist weather, and not when there are dry cold winds. They may be removed at other seasons of the year, but the season named is, in my opinion, the best for general work. It may be useful to give a detailed statement of the different coniferous plants suited to different soils, as where different soils exist, it is advisable to procure those trees which are likely to succeed best on each:—

Plants suitable for exposed Situations.

Pinus Austriaca.	*Pinus pinaster.*
„ *Cembra.*	„ *Pumilo.*
„ *inops.*	„ *strobus.*
„ *Laricio.*	„ *sylvestris.*
„ *Mugho.*	„ *Tæda.*

PLANTS SUITED FOR SANDY SOILS.

Abies balsamea.	*Pinus pinaster.*
Pinus Austriaca.	„ *Pumilo.*
„ *excelsa.*	„ *Tæda.*
„ *Laricio.*	*Cupressus torulosa.*
„ *Mugho.*	

PLANTS SUITED FOR THE SEA-COAST.

Abies excelsa.	*Pinus Cembra.*
„ *nigar.*	„ *Mugho.*
„ *Nordmaniana.*	„ *pinaster.*
„ *Pinsapo.*	„ *excelsa.*
„ *Menziesii.*	„ *strobus.*
Pinus Austriaca.	„ *sylvestris.*

SECTION 18.—*The Barking of Trees.*

The removal and curing of bark from some of our forest-trees is an important part of a forester's work; and I shall therefore give a brief description of the way in which we usually cure oak-bark.

Having had the trees marked in the wood or plantation, a large or small force of hands must of course be employed, according to the amount of work to be done in a given time, as there are only a few weeks in which oak-bark should be peeled and cured. As a general rule, this should be done from the middle of May to the middle of June. In the midland counties and south of England it can of course be taken sooner; but presuming that there are only four or five weeks in which the bark can be judiciously removed, a calculation must be made as to the amount of bark likely to be removed, and the number of labourers it will require to remove it within a given time. We usually ascertain the quantity of bark by taking the probable amount of timber in the trees to be removed; and we calculate that four tons, or one hundred and sixty feet of timber, will give, under ordinary circumstances, one ton of bark; and as we generally find that it requires an expenditure of from 45s. to 50s. to cut the trees and peel one ton of oak-bark, the number of hands required must be arranged accordingly. In Scotland the stripping of the bark is done by women and boys, but in many parts of England men alone are employed. In proceeding with the work, if the trees are below a size of from six to eight inches diameter, we usually cut them down with the axe; but when the trees are over that size, then we generally fell them with the saw.

One set of men proceeds with the cutting down of the trees, and another set removes the branches and tops with axes and hand-bills, leaving them just as they are removed from the tree, while boys strip them of the smaller branches. All the branches down to a size of one inch in diameter are thrown into heaps. The small trees and brushwood are removed to the road by men, and the larger trees are dragged to the road by horses, where they are stripped by men, women, or boys, according to the custom of the district.

FIG. 128.

The implement used in stripping is shown in fig. 128. This is inserted between the bark and the timber of the tree, and the bark is torn off. When the sap is well up in the tree, the bark comes easily off, especially in England; but in Scotland, where the climate is somewhat colder, it often requires to be beaten with a wooden mallet in order to start it from the timber. These wooden mallets are made as represented in fig. 129. They are about four inches square on the flat part, as shown at *a*, which is used in beating the bark, and about six inches deep to the high part at *b*. The head should be made of ash, and the handle of good tough timber. A hardwood handle is not so easy to the hand as one made of tough pine timber. The peeling-iron, as represented, should be made about two and a half inches square, with a hose four inches long, to hold a wooden handle about six or seven inches long. This wooden handle should also be made of foreign pine timber.

FIG. 129.

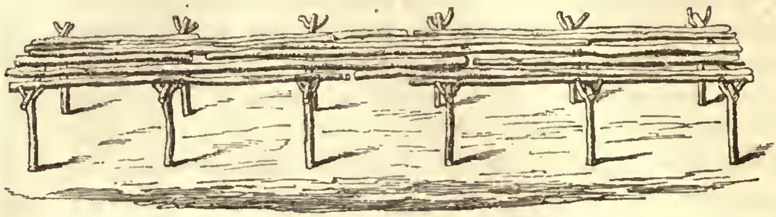
In Scotland, as stated, it is generally necessary to beat the bark before it can be easily removed; but in the southern and midland counties of England this is not the case. It is much better to avoid beating if possible, as the effect of that process is to press out the tannin of the bark, and thus the bark is injured. With the very small branches it is necessary to beat them to get the bark removed, as they are so small that the peeling-iron cannot be used upon them with any advantage; we therefore lay a small bough on a flat stone, or on the stem of the tree which has been felled, and beat it in a line from one end to the other, when the bark can easily be removed by the hand.

FIG. 130.

The next operation is to have the bark laid in such a position as will enable it to dry; this we do by erecting stages for the purpose. First of all, we procure a number of forked stakes from amongst the peeled branches, of a size of about two and a half inches in diameter, and about three feet long. These stakes are shown in fig. 130. They are driven into the ground in two rows, one opposite the other, and upon these are laid cross pieces of wood, and over all long small trees are laid to support the bark.

A general view of a stage complete is shown in fig. 131.

Fig. 131.



All the trees being previously brought to the roads and peeled, the bark is thus at hand for piling on the stages, which are erected along the sides of the roads. Good open spaces should be chosen for the stages, where there is a free circulation of air to dry the bark. Large flat pieces of bark from the trunk of the trees should be placed on the top of the other bark on the stage, to assist in throwing off water; and to facilitate this, one side of the stage should be a few inches lower than the other. No definite time can be stated as that which bark may take to dry on the stage, as all depends on the weather and the locality. In fine weather we have stacked it in good condition in about eight days from being peeled, and in dull cloudy weather it has taken three weeks to get it secured in safety. It is in good condition when perfectly dry, and when it will not bend like green bark, but breaks on trying to bend it; and when well cured, it should be of a bright cream colour, excepting, of course, the outer bark. When the inside is of a dull brown colour, there is very little tanning matter in it. The quicker it can be dried and cured, the better will be the quality of the bark. Many foresters advocate turning the bark on the stage, but for my part I do not approve of this, as when the bark dries to a certain extent on the stage, it hangs down at the ends, and turns in at the edges in the form of a rain-water spout for a house. When this is reversed, it forms a receptacle for the rain; and from being turned up at the ends, the water does not get away freely, and hence it sinks into the bark and rots it.

After the bark is dry, it is either sold to tanners on the stages, or is chopped up into pieces and delivered to the purchaser in bags. We usually build it up in stacks until it can be sold advantageously, and then have it chopped and delivered.

The cost of stripping oak-bark varies much with the rate of wages in the locality and the size of the trees. Very large oak-trees may be cut down and stripped at the rate of 30s. to 35s. per ton of bark, while others of a medium size will cost from 45s. to 50s. per ton; and small coppice shoots will cost fully 60s. per ton and upwards.

In Yorkshire we have for the last seven years peeled oak-trees averaging six feet each, for an average sum of £2, 4s. per ton of bark. The chopping has cost 6s. 6d. and 7s. per ton.

I have found that oak-trees standing thick together, and averaging one foot each, will give nearly five and a half tons of timber to one ton of dry bark; while similar trees which had received more space gave four and a half tons of timber to one of bark.

I have also found trees averaging ten feet each give four tons of timber to one of bark. Large hedgerow-trees have produced with us three tons of timber to one of bark.

Section 19.—*The Maintenance of a Stock of Game along with the proper Management of Woods.*

Many landed proprietors who are game-preservers allow their woods and plantations to be ruined because they do not wish the game to be disturbed; and they are under the impression that it is impossible to have plantations and carry on the necessary operations in them, and at the same time keep the game together. I have not found this to be the case on this estate (Wass); and on others which I know, where the plantations are regularly attended to, the game is in no way interfered with. The pheasants come to know the regular workmen from strangers, and they may be often seen quietly feeding close to workmen in the plantations.

In order to keep the plantations as quiet as possible, we divide the whole extent into different portions, and take one portion to be dealt with in each year, while the others are left unmolested.

Presuming that the woodlands of an estate extend to one thousand acres, and they are of an age to render it necessary to thin them once in every four years; then, in that case, I would divide the woodlands into four portions of two hundred and fifty acres each, one of which would be thinned and otherwise dealt with annually, leaving seven hundred and fifty acres undisturbed each year; and the two hundred and fifty acres which are in hand at one time should be completed and finished before another portion is taken in hand.

CHAPTER XXIX.

GAS FOR ESTATE PURPOSES.

Gas is made by coal being subjected to a strong heat in close cast-iron retorts, which separates the gas from the other constituent parts of the coal. The apparatus for this purpose consists of four different parts: first, the *retorts*, made of cast iron, in which the coal is heated; then the *condensers*, which condense the *solid and liquid parts*, where the tar is deposited; and next, the *purifier*, where the gas, in passing through lime and water, is cleansed from several ingredients which, if retained, would make it unfit for use. The gas then passes from the purifier to the *gasometer*, where it is held and stored for use, and in connection with which the piping is applied to convey it to buildings, &c.

Where coal is expensive, apparatus has been made for the purpose of extracting gas from wood and peat. There is also a quantity of gas in bones and oil, but it becomes expensive to produce gas from either of these substances. Where coal can be got at a fair price, it will be found to be the best material from which to extract gas.

Gas is, without doubt, the best light which we at present possess; and many landed proprietors and farmers would be glad if they could manufacture it on a small scale for their premises. Hitherto the great drawback in using it for estate purposes has been the heavy cost in the first outlay. Messrs Porter & Co., engineers, Lincoln, make a small gas-apparatus suitable for this purpose, although the expenditure is still too heavy to admit of its being generally used. The apparatus is of two kinds—the largest size being fixed permanently, while the smaller and least expensive is portable. A small gas-apparatus for a farmhouse and steading may be purchased for about £50.

For the supply of light to a village a much larger apparatus will be required, and the cost of such is regulated by the number of lights, and whether these lights are within a short distance of each other or are spread over a large surface. If the houses are far distant from each other, a long extent of main pipes will be required, and consequently a greater outlay. An idea of the expense of a village gas-apparatus may be formed from a statement of the estimated expense of one which it is intended to erect for the use of a village on one of Major Stapylton's estates. The village contains a population of about two hundred and thirty inhabitants, the houses are situated wide apart; and from this fact, and also that it is intended to convey the gas to some farm-buildings near to the village, a considerable length of main piping will be required. The following is a copy of the estimate referred to:—

Gas-apparatus for supplying 150 lights, delivered at nearest railway station to the village,	£185	0	0
Furnace, and brickwork for the same,	25	0	0
Buildings—namely, retort-house and coal-store, &c.,	100	0	0
Brick tank for receiver,	80	0	0
Seven hundred yards of main piping,	105	0	0
Services and meters,	25	0	0
Contingencies, &c.,	30	0	0
	£550	0	0

This may seem a large expenditure for a small village, and the question comes to be, Will it pay? The result of such an expenditure may be stated thus: One light will burn three and a half cubic feet of gas per hour; and taking this on an average at two hundred nights in the year, and that each light burns four hours per night, this gives a result of four hundred and twenty thousand cubic feet of gas required per annum. The next question then is, At what expense can this four hundred and twenty thousand cubic feet of gas be manufactured? I shall endeavour to answer this by giving a statement of the probable expense for a year:—

Fifty-five tons of coal will be required, say at 15s. per ton,	£41	5	0
Materials for purifying the gas,	2	10	0
Labour of one man for three months of the year,	30	0	0
Repairs,	8	0	0
Allowance for tear and wear,	4	10	0
Contingencies,	10	0	0
	£96	5	0

I now come to consider the probable annual income, which may be stated as follows:—

Sale of 420,000 cubic feet of gas, at 7s. 6d. per 1000,	£157	0	0
Sale of coke, say	5	0	0
Sale of tar, say	5	0	0
Rent of meters,	5	0	0
	£172	10	0

This leaves a balance of income over expenditure of £76, 5s.

Of course it must be kept in mind that this statement is merely an estimate, but the quantities and prices are, however, taken from an average of works in operation. The first cost could be very much reduced in many cases—thus, where building materials are cheap, much less than £100 would erect the necessary buildings; and the same remarks apply to the cost of the brick tank, and also where the houses in a village are built close together, as in that case one-half the length of main piping might suffice.

In the estimate of the annual expenditure I give the cost of the labour of a man for three months of the year. On a great many estates the labour need not cost so much—as, for example, the work could be done by contract by the village blacksmith, who might be able to attend the gas-work and also carry on his other duties; and he could do the work by contract at 1s. per thousand cubic feet of gas, thus saving 6d. per thousand feet. In a case of this kind, the gas-work would require to be erected contiguous to the smithy.

Some kinds of coal give a larger quantity of gas from each ton than others; thus it has been found that—

	Cubic feet of gas.
Newcastle cannel coal will give from each ton . .	9,830
Wigan coal, ...	10,850
Derbyshire main coal, ...	9,400
Wemyss main coal, ...	10,584

This statement of the quantity of gas supplied by one ton of the kinds of coal mentioned, is taken from the experiments made by Messrs Barlow & Wright.

CHAPTER XXX.

ESTATE BOOK-KEEPING.

It is an important matter in the management of landed property to have correct statements of all the transactions connected with it, whether of income or expenditure, and in regard also to all daily transactions. A proper system of accounts is a great desideratum; and with all the new improvements in the management of an estate, it is absolutely indispensable to have a correct record of all the operations, with expenses incurred, and a statement of the results.

The simplest form of keeping accounts is at all times the best, provided a thoroughly correct statement of all the transactions is kept.

The book-keeping in connection with an estate where there are different departments may be given under each. The chief departments will comprise the *Woods and Plantations*, the *Home-Farm*, the *Game*—which will be found in the chapter on Game and Shootings —and the *General Estate Accounts.* The following forms show the system of book-keeping carried out on this estate in connection with the several departments named under the different heads:—

Woods and Plantations—

- Estimate of probable income and expenditure.
- Day-labour and piece-work book.
- Pay-list of day-labour and piece-work.
- Private sales book.
- Ledger.
- Public sales book.

Home-Farm—

- Inventory and valuation of live and dead stock, and crop.
- Crop-book.
- Dairy and poultry book.
- Live-stock book.
- Memorandum-book.
- Cash-book.

Ledger.
Day-labour book.
Pay-list book.
Rotation-book.

General Estate Accounts—

Cash-account.
Ledger-account.
Yearly statement of income and expenditure.
Order-book.
Letter-book.
Memorandum-book.
General yearly statement of the estate.

The first example which I shall give, therefore, according to the foregoing list, will be that of an estimate of probable income and expenditure for the year. This is a most useful part of estate book-keeping, and indeed should always be done in the beginning of the estate year, whenever that may occur. A carefully drawn-out estimate is always a guide for the agent during the whole year; and it enables the proprietor to see at a glance how he may expect to stand in money matters, and what sum is left for his own personal use after the general maintenance and improvement of the estate have been provided for.

Where estimates are carefully drawn out, and every item entered on either side of the account at the beginning of each year, the proprietor can then approve or disapprove of any portion of the expenditure, just as may be thought necessary; and when an agent has got the approval of his employer to all or any portion of the estimate, he is at liberty to go on with the different works for the whole year without any more trouble.

The drawing out of an estimate of probable income and expenditure is simple, and can be done very near the truth when an agent knows his business. If he does not, he will be sure to get into excesses on either side, and consequently his estimates will be valueless.

The following is the form of estimate which we use:—

Estimate of Probable Income and Expenditure on the Estate of Newtonhall, from 1st July 1867 to 1st July 1868.

Income.

Farm Rents—	
Gorry Hill Farm,	£345 0 0
Newstead Grange,	267 10 0
Abbey Grange,	162 0 0
Carry forward,	£774 10 0

	£	s.	d.	£	s.	d.
Brought forward,	£774	10	0			
Highwoods,	360	0	0			
Clury Grazings,	1200	0	0			
Cam Bank,	1100	0	0			
Burnside,	840	0	0			
Adam's Hall,	582	10	0			
				£4857	0	0
Cottages with Gardens—						
Martin Jackson,	£5	10	0			
Thomas Beetham,	12	10	0			
Thomas Richardson,	3	5	0			
Widow Thompson,	1	0	0			
James Hall,	6	10	0			
John Robson,	8	0	0			
George Pickersgill,	6	0	0			
Charles Dalrymple,	7	10	0			
James Smith,	10	0	0			
				60	5	0
Cow-keepings—						
Jointly occupied by Henry Horner, William Robson, and Thomas Huggan,				38	0	0
Quarries—						
Springbank Quarry, let to William Scarr,				25	0	0
Shootings and Fishings—						
Shootings over Hambleton district,	£250	0	0			
Shootings over Glentummel,	560	0	0			
Fishings in river Laggan,	80	0	0			
				890	0	0
Woods and Plantations—						
From Crakeland Wood, thinnings of 24 acres, at £6, 10s.,	£156	0	0			
Thinnings from Elm Hagg Plantation, 16 acres, at £4,	64	0	0			
Thinnings from Fox Wood, 23 acres, at £8,	184	0	0			
Thinnings from Duckindale Wood, 10 acres, at £5,	50	0	0			
Thinnings from Tower Wood, 80 acres, at £5,	400	0	0			
From sales of timber from Clark's Wood, 2500 feet of oak, at 2s. 6d.,	312	10	0			
From 40 tons of oak-bark, from oak timber and thinnings, at £6 per ton,	240	0	0			
				1406	10	0
Nursery Stock to go out in Autumn of 1867 and Spring of 1868—						
20,000 oak, at 30s.,	£30	0	0			
400,000 larch, at 10s.,	200	0	0			
200,000 Scots pine, at 6s.,	60	0	0			
12,000 spruce, at 24s.,	14	8	0			
20,000 thorn, at 15s.,	15	0	0			
652,000				319	8	0
Rent of saw-mill and cottage,				80	0	0
Total probable income for the year,				£7676	3	0

Expenditure.

Salaries—		
Agent,	£300 0 0	
Keep of agent's horse,	30 0 0	
Clerk to agent,	52 0 0	
		£382 0 0
Allowances—		
To Widow Jackson, 4s. per week,	£10 8 0	
„ Thomas Huggan, 5s. per week,	13 0 0	
„ James Hall, for attending to gate,	4 0 0	
		27 8 0
Contingent expenses of Agent—		
Travelling expenses,	£30 0 0	
Stationery,	20 0 0	
Printing,	8 0 0	
		58 0 0
Farms—		
Draining on Burnside Farm, 45 acres, at £8,	£360 0 0	
Draining with open cuts on Clury Grazings, 50 chains, at 1s. 6d. per chain,	3 15 0	
Building an addition to Newstead Grange Steading, say	400 0 0	
		763 15 0
Cottages—		
General annual repairs of all the cottages,		8 10 0
Shootings and Fishings—		
Two gamekeepers' salaries,	£120 0 0	
Clearing underwood from river-banks for fishing,	6 0 0	
		126 0 0
Rates, taxes, and tithes,		36 10 0
School—		
Salary of teacher,	£60 0 0	
Schooling of ten poor children,	10 0 0	
		70 0 0
Woods and Plantations :—		
Salaries and Allowances—		
Forester,	£120 0 0	
Horse keep,	30 0 0	
		150 0 0
Thinning—		
Cutting and preparing thinnings for sale from the plantations of Crakeland and Elm Hagg, and peeling oak-bark,		230 0 0
Fencing—		
Hillhead New Enclosure, 3400 yards, at 9d.,	£127 10 0	
General repairs of fences,	40 0 0	
New wall round Barter's Plantation, 80 roods, at 9s. per rood of 7 yards,	36 0 0	
Six new gates for plantations, and hanging the same, at 18s. each,	5 8 0	
		208 18 0
	Carry forward,	£2061 1 0

Brought forward,				£2061	1	0
Draining—						
Hillhead Enclosure, 20 acres, at £3, ...				60	0	0
Planting—						
Hillhead Enclosure, 632,000 plants, as per statement of nursery stock to go out (less thorn),	£304	8	0			
Expense of planting the same, . . .	102	0	0			
20,000 pits for oak, at 10s. per 1000, . .	10	0	0			
Carriage of plants from nursery, . . .	8	0	0			
				424	8	0
Roads—						
Repairs of roads, ...				35	0	0
Pruning—						
Young oaks in Crakeland Wood, ...				5	0	0
Nursery :—						
Plants required for next year's crop—						
10,000 oak, one-year seedling, at 4s., .	£2	0	0			
200,000 larch, one-year seedling, at 2s., .	20	0	0			
60,000 Scots pine, one-year seedling, at 2s.,	6	0	0			
5,000 spruce, two-year seedling, at 5s., .	1	5	0			
5,000 sycamore, two-year seedling, at 8s.,	2	0	0			
5,000 poplar, one-year seedling, at 4s., .	1	0	0			
200 new pines, 2s. each, ...	20	0	0			
10,000 thorn, at 15s., ...	7	10	0			
295,200				59	15	0
Laying 295,000 plants, at, on an average, 1s. per 1000, ...	£14	15	0			
Digging, ...	5	0	0			
Manure, ...	5	0	0			
Cleaning, ...	15	0	0			
				39	15	0
Forester's travelling expenses, ...	£6	0	0			
Stationery, ...	8	0	0			
Carpenter-work, ...	4	10	0			
Smithy-work, ...	6	0	0			
Advertising sales of timber, ...	7	10	0			
				32	0	0
Total probable expenditure for the year, . . .				£2716	19	0

Having given the form of estimate of probable income and expenditure, I need only remark that it is applicable to incomes and expenditures of any amount—from a property of one thousand acres to one of one hundred thousand acres.

The next form of estate book-keeping on our list is that of the Day-Labour Book. This is a statement of work at which the men are employed each day. A very simple form of day-labour book is often used where labourers are constantly employed at one kind of work—thus:—

Names.	M.	T.	W.	T.	F.	S.	Total per Week.	Rate per Day.		Amount.			Remarks.
								s.	*d.*	£	*s.*	*d.*	
John Jones,	1	½	1	1	½	...	4	2	6	0	10	0	
Peter Robertson,	1	1	1	1	1	1	6	2	6	0	15	0	
James Black,	...	1	1	1	1	½	4½	2	0	0	9	0	
Alexander Short,	1	1	1	½	¾	1	5¼	2	6	0	13	1½	
John White,	1	1	1	1	1	1	6	2	6	0	15	0	
James Chapman,	1	1	1	1	1	1	6	2	6	0	15	0	
										3	17	1½	

This, however, is only suitable where the work is all of one kind; but on an estate where there are a number of men employed at different operations, it is necessary to enter minutely the kind of work at which each man is employed each day; and unless this is done, the respective cost of the different operations cannot be ascertained.

The following illustration of a day-labour book is simple enough, and does not require much explanation; and although simple, it yet affords the means of keeping a correct and full statement of the workmen's time.

When there are more men employed than I have entered, it may be necessary to have the day-labour book arranged so as to make one sheet do for a week's entry. In the case shown on page 462, one sheet is made to answer for two weeks—of course this altogether depends upon the number of hands employed.

Whoever is intrusted with the entry of the workmen's time should do so every evening. I have known many superintendents of work fill in their day-labour book every Saturday. It is, however, much better to have it done every evening, when the items to enter are fresh on the mind. The foreman or superintendent of the men should also carry a small pass-book in his pocket, to take down the names of the workpeople present on each day, and also to enter any memoranda of the work going on which may be necessary.

It is of importance not only to see that the time of the men is correctly entered, but also that each place, plantation, or any distinct work, is kept separate from any other work. When this is done, the cost of each operation can be satisfactorily ascertained when finished.

The day-labour book should be made large enough to last for one year at least; many are made to last for a number of years, but in that case they are usually large and unwieldy. I have found it much better to have one made for fifty-two weeks' entry only; and then the day-labour book can go along with the other accounts when the estate books are closed for the year.

The day-labour book shows a statement of the work on which the men have been employed each day, but it does not provide a means of receiving each man's signature for his wages when paid. For this purpose many employers who use the form No. 2, which I give on page 462, provide another column at the end of each week's statement for the signature of the recipients; but this has serious objections, inasmuch as the cost of each operation is not shown.

The following is the form which we use:—

No. 2.—STATEMENT of WORKPEOPLE employed on the ESTATE of NEWTONHALL.

DAYS OF THE WEEK.	MONDAY.			TUESDAY.			WEDNESDAY.			THURSDAY.			FRIDAY.			SATURDAY.					
DAYS OF THE MONTH.	MAY 4.	Days.	Hours.	MAY 5.	Days.	Hours.	MAY 6.	Days.	Hours.	MAY 7.	Days.	Hours.	MAY 8.	Days.	Hours.	MAY 9.	Days.	Hours.	Total No. of Days.	Rate per Day.	Amonnt.
																				s. d.	£ s. d.
Martin Jackson, .	Thinning and peeling in Crakeland Plantation.	1		Thinning and peeling in Crakeland Plantation.	1		Thinning and peeling in Crakeland Plantation.	1		Repairing roads on home-farm and policy grounds.	1		Repairing roads on home-farm and policy grounds.	1		Thinning and peeling in Clark's Wood.	1		6	3 0	0 18 0
Jonah Bridgewater,	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
William Moor, . .	do.	1		do.	1		do.		5	do.	1		do.	1		do.	1		5½	2 6	0 13 9
James Chapman, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
John Robson, . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2 6	0 13 9
Charles Robson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
James M'Queen, .	do.	1		do.		5	do.	1		do.		5	do.	1		do.	1		5	2 0	0 10 0
Charles Dalrymple,	do.		5	do.	1		do.	1		do.	1		do.	1		do.	1		5½	2 6	0 13 9
William Nicholson,	do.	1		do.	1		do.	1		do.	1		do.	1		do.		5	5½	2 6	0 13 9
Richard Kirk, . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2 0	0 11 0
Thomas Kirk, . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2 6	0 13 9
George Rymer, . .	do.	1		do.	1		do.		5	do.	1		do.	1		do.	1		5½	2 6	0 13 9
John Deighton, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
John Thompson, .	do.	1		do.	1		do.	1		do.	1		do.	1		Repairing roads on home-farm and policy grounds.	1		6	2 6	0 15 0
Henry North, . .	do.	1		do.	1		do.	1		do.			do.	1		do.	1		5	2 6	0 12 6
George Jefferson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
James Smith, . .	do.	1		do.	1		do.	1		do.	1		do.	1		Thinning and peeling in Clark's Wood.	1		6	2 6	0 15 0
John Jones, . . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
																					£12 14 0

	May 11.			May 12.			May 13.			May 14.			May 15.			May 16.								
																				s.	d.	£	s.	d.
Martin Jackson, .	Thinning and peeling in Clark's Wood.	1		Thinning and peeling in Clark's Wood.	1		Thinning and peeling in Clark's Wood.	1		Making new walk in policy grounds.	1		Making new walk in policy grounds.	1		Cleaning young hedge on home-farm.	1		6	3	0	0	18	0
Jonah Bridgowater,	do.	1		do.	1		do.		5	do.	1		do.	1		do.	1		5½	2	6	0	13	9
William Moor, . .	do.		5	do.	1		do.		5	do.	1		do.	1		do.	1		4	2	6	0	10	0
James Chapman, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
John Robson, . .	do.	1		do.	1		do.	1		do.	1		do.		5	do.	1		5½	2	6	0	13	9
Charles Robson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
James M'Queen, .	do.		5	do.	1		do.	1		do.	1		do.	1		do.	1		5½	2	0	0	11	0
Charles Dalrymple,	do.		5	do.		5	do.	1		do.	1		do.	1		do.	1		5	2	6	0	12	6
William Nicholson,	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
Richard Kirk, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	0	0	12	0
Thomas Kirk, . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2	6	0	13	9
George Rymer, . .	do.	1		do.	1		do.	1		Cleaning young hedge on home-farm.	1		Cleaning young hedge on home-farm.	1		do.	1		6	2	6	0	15	0
John Deighton, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
John Thompson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
Henry North, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
George Jefferson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
James Smith, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
John Jones, . . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0	15	0
																						£12	14	9

No. 2 (*continued*).

Days of the Week.	Monday.			Tuesday.			Wednesday.			Thursday.			Friday.			Saturday.					
Days of the Month.	May 18.	Days.	Hours.	May 19.	Days.	Hours.	May 20.	Days.	Hours.	May 21.	Days.	Hours.	May 22.	Days.	Hours	May 23.	Days.	Hours.	Total No. of Days.	Rate per Day.	Amount.
																				s. d.	£ s. d.
Martin Jackson, .	Repairing fences round plantation.	1		Repairing fences round plantation.	1		Repairing fences round plantation.	1		Repairing fences round plantation.	1		Cleaning nursery.	1		Cleaning nursery.	1		6	3 0	0 18 0
Jonah Bridgewater,	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2 6	0 13 9
William Moor, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
James Chapman, .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2 6	0 13 9
John Robson, . .	do.	1		do.	1		do.	1		do.		5	do.	1		do.	1		5½	2 6	0 13 9
Charles Robson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
James M'Queen, .	do.	1		do.	1		do.		5	do.	1		do.	1		do.	1		5½	2 0	0 11 0
Charles Dalrymple,	do.	1		do.	1		do.		5	do.	1		do.	1		do.	1		5½	2 6	0 13 9
William Nicholson,	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
Richard Kirk, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 0	0 12 0
Thomas Kirk, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
George Rymer, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
John Deighton, .	do.	1		do.	1		do.	1		do.	1		do.		5	do.	1		5½	2 6	0 13 9
John Thompson, .	do.	1		do.	1		do.	1		do.	1		do.		5	do.	1		5½	2 6	0 13 9
Henry North, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
George Jefferson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
James Smith, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
John Jones, . . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2 6	0 15 0
																					£12 18 6

	May 25.			May 26.			May 27.			May 28.			May 29.			May 30.				s.	d.	£ s. d.
Martin Jackson, .	Making open drains in Clury Grazings.	1		Making open drains in Clury Grazings.	1		Making open drains in Clury Grazings.	1		Cleaning nursery.	1		Cleaning nursery.	1		Cleaning nursery.	1		6	3	0	0 18 0
Jonah Bridgewater,	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
William Moor, . .	do.	1		do.	1		do.	1		do.		5	do.	1		do.	1		5½	2	6	0 13 9
James Chapman, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
John Robson, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.		5	5½	2	6	0 13 9
Charles Robson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
James M'Queen, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	0	0 12 0
Charles Dalrymple,	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
William Nicholson,	do.	1		do.	1		do.		5	do.	1		do.	1		do.		5	5	2	6	0 12 6
Richard Kirk, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	0	0 12 0
Thomas Kirk, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
George Rymer, . .	do.	1		do.	1		do.	1		do.	1		do.	1		do.	1		6	2	6	0 15 0
John Deighton, .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2	6	0 13 9
John Thompson, .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2	6	0 13 9
Henry North, . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2	6	0 13 9
George Jefferson, .	do.	1		do.	1		do.	1		do.	1		do.	1		do.		5	5½	2	6	0 13 9
James Smith, . . .	do.	1		do.	1		do.	1		do.		5	do.	1		do.	1		5½	2	6	0 13 9
John Jones, . . .	do.	1		do.		5	do.	1		do.	1		do.	1		do.	1		5½	2	6	0 13 9
																						£12 14 6

Total for week ending 9th instant, . . .	£12 14 0
Do. do. 16th do. . . .	12 14 9
Do. do. 23d do. . . .	12 18 6
Do. do. 30th do. . . .	12 14 6
	£51 1 9

A form similar to No. 3 is also used as a weekly day-labour statement and also as a monthly pay-bill. This may answer the purpose where only one kind of work is carried on, as, of course, then the total amount for the month shows the cost of the one operation for that time; but it is not at all suited for general estate purposes, where many different operations are carried on in the course of a month, and where it is advisable, as I have already shown, to have a correct statement of each day's work, in order to ascertain the cost of each operation. In such a statement as No. 3 the amount of time can be correctly kept; but at the end of the month, if it is required to know the number of days the men were employed at any one operation, then the only source of information on this point would be the memory of the superintendent, and that would certainly not be a satisfactory system. The following is the form No. 3 referred to:—

No. 3.

MONTHLY PAY-BILL from   to   inclusive.

Names of People employed.	First Week.						Second Week.						Third Week.						Fourth Week.						No. of Days.	Rate per Day.	Amount.	Signature of Recipients.
	M.	T.	W.	T.	F.	S.	M.	T.	W.	T.	F.	S.	M.	T.	W.	T.	F.	S.	M.	T.	W.	T.	F.	S.			£ s. d.	
																			Total for month ending ,							£		

I shall now give a sample of the pay-list of day-labour and piece-work we use, which is as follows:—

No. 4.—ACCOUNT of DAY-LABOUR and PIECE-WORK performed on the Estate of NEWTONHALL for Month ending 30th May 1868.

NAMES.	Thinning and Peeling in Crakeland Plantation.		Repairing Roads on Home-Farm and Policies.		Thinning and Peeling in Clark's Wood.		Making new Walk in Policy Grounds.		Cleaning young Hedge on Home-Farm.		Repairing Plantation Fences.		Nursery.		Making open Cuts.		Total No. of Days.	Rate per Day.	Total Amount.	WE, the undersigned, acknowledge to have received from the sums set opposite our names respectively, as payment of our wages for the time therein set forth.
	Days.	Amount	Days.	Amount.	Days.	Amount.	Days.	Amount.	Days.	Amount	Days.	Amount.	Days.	Amount.	Days.	Amount				
		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		s. d.	£ s. d.	
artin Jackson, .	3	0 9 0	2	0 6 0	4	0 12 0	2	0 6 0	1	0 3 0	4	0 12 0	5	0 15 0	3	0 9 0	24	3 0	3 12 0	
nah Bridgewater,	3	0 7 6	2	0 5 0	3½	0 8 9	2	0 5 0	1	0 2 6	3½	0 8 9	5	0 12 6	3	0 7 6	21	2 6	2 17 6	
illiam Moor, . .	2½	0 6 3	2	0 5 0	3	0 7 6	1	0 2 6	1	0 2 6	4	0 10 0	4½	0 11 3	3	0 7 6	23	2 6	2 12 6	
mes Chapman, .	3	0 7 6	2	0 5 0	4	0 10 0	2	0 5 0	1	0 2 6	3½	0 8 9	5	0 12 6	3	0 7 6	23½	2 6	2 18 9	
hn Robson, . .	2½	0 6 3	2	0 5 0	4	0 10 0	1½	0 3 9	1	0 2 6	3½	0 8 9	4½	0 11 3	3	0 7 6	22	2 6	2 15 0	
arles Robson, .	3	0 7 6	2	0 5 0	4	0 10 0	2	0 5 0	1	0 2 6	4	0 10 0	5	0 12 6	3	0 7 6	24	2 6	3 0 0	
mes M'Queen, .	2½	0 5 0	1½	0 3 0	3½	0 7 0	2	0 4 0	1	0 2 0	3½	0 7 0	5	0 10 0	3	0 6 0	22	2 0	2 4 0	
arles Dalrymple,	2½	0 6 3	2	0 5 0	3	0 7 6	2	0 5 0	1	0 2 6	3½	0 8 9	5	0 12 6	3	0 7 6	22	2 6	2 15 0	
illiam Nicholson,	3	0 7 6	2	0 5 0	3½	0 8 9	2	0 5 0	1	0 2 6	4	0 10 0	4½	0 11 3	2½	0 6 3	22½	2 6	2 16 3	
ichard Kirk, . .	2½	0 5 0	2	0 4 0	4	0 8 0	2	0 4 0	1	0 2 0	4	0 8 0	5	0 10 0	3	0 6 0	23½	2 0	2 7 0	
omas Kirk, . .	2½	0 6 3	2	0 5 0	3½	0 8 9	2	0 5 0	1	0 2 6	4	0 10 0	5	0 12 6	3	0 7 6	23	2 6	2 17 6	
eorge Rymor, . .	2½	0 6 3	2	0 5 0	4	0 10 0	...	...	3	0 7 6	4	0 10 0	5	0 12 6	3	0 7 6	23½	2 6	2 18 9	
hn Deighton, .	3	0 7 6	2	0 5 0	4	0 10 0	...	...	3	0 7 6	4	0 10 0	5½	0 13 9	1½	0 6 3	24	2 6	3 0 0	
hn Thompson, .	3	0 7 6	3	0 7 6	3	0 7 6	...	...	3	0 7 6	4	0 10 0	4½	0 11 3	2½	0 6 3	23	2 6	2 17 6	
enry North, . .	3	0 7 6	2	0 5 0	3	0 7 6	...	...	3	0 7 6	4	0 10 0	5	0 12 6	2½	0 6 3	22½	2 6	2 16 3	
eorge Jefferson, .	3	0 7 6	3	0 7 6	3	0 7 6	...	...	3	0 7 6	4	0 10 0	4½	0 11 3	3	0 7 6	23½	2 6	2 18 9	
mes Smith, . .	3	0 7 6	2	0 5 0	4	0 10 0	...	...	3	0 7 6	4	0 10 0	4½	0 11 3	3	0 7 6	23½	2 6	2 18 9	
hn Jones, . . .	3	0 7 6	2	0 5 0	4	0 10 0	...	...	3	0 7 6	4	0 10 0	5	0 12 6	2½	0 6 3	23½	2 6	2 18 9	
	£	6 5 3	£	4 13 0	£	8 0 9	£	2 10 3	£	3 19 6	£	8 12 0	£	10 16 3	£	6 7 3		£	51 1 9	

Total amount of day-labour, . . . £ 51 1 9

PIECE-WORK.

Thomas Thompson, for erecting 20 roods of new wall at Auchnaback Farm, at 5s. per rood, ...	£5 0 0	
John Mason, stubbing out old hedges by contract on Burnside Farm, as per agreement, ...	7 2 6	
Peter M'Laren, draining on Burnside Farm by contract, 65 chains, at 2s. 6d., ...	8 2 6	
Total amount of piece-work,	£20 5 0	20 5 0
Total amount, ...	£	71 6 9

It will be observed that the statement of the pay-list which I have just given contains the labour as detailed in the day-labour statement (form No. 2), with the piece-work supposed to have been performed during the same month. In the statement given there are eight columns for different work. In making such a book, more columns could of course be entered, if thought necessary, for any increase of different operations. As an example of this system, it will be found in the day-labour form that Martin Jackson was employed in thinning and peeling in Crakeland Plantation on Monday the 4th, Tuesday the 5th, and Wednesday the 6th of the month; he is therefore entered under the column for that operation three days, which, at his rate of wages as foreman, is 9s., and that is accordingly entered in the money-column opposite. It will be found in the day-labour book that he was two days employed in repairing roads on the home-farm and policy grounds; he is therefore entered in the next column accordingly—and so on throughout the different columns and each man's work; and of course the total number of days and the amount of money due to each man in the pay-list should correspond exactly with the same in the day-labour statement.

In the column for signatures of the men we always affix a receipt-stamp for all sums at £2 and upwards, across which the name is written.

The great advantage of such a form of pay-book is, that at the end of a month, half-year, or year, according as may be necessary, the total expense of each operation on the estate can be ascertained—as, for instance, under the first column in the pay-list we find that for the month of May the thinning and peeling of Crakeland has cost £6, 5s. 3d.; and under each column is found the cost of each work for the month. Should such works occur again, the different sums expended on each have only to be added together to ascertain the total expense.

If the statement is drawn out correctly, the total sum of the pay-list should be exactly the same as the total sum of the day-labour book for the month; and all the total sums of the different columns should also, when added together, amount to the same as the total amount of the pay.

Under the pay-list of day-labour I show how I enter the piece-work statements. Many land-agents have a separate statement for piece-work accounts, but this only entails more office labour; and in the case which I have given, the whole labour expense for the work is shown together.

Another form of pay-list of day-labour is shown in form No. 5. This is a similar form to that used by the Government for the management of woods and forests. It is a very useful form, but it is deficient in not giving columns for entering the cost of each operation. To arrive at the cost of any work as entered in such a pay-list, one would require to add up the days each man had been employed at it, and take the different rates, to arrive at the amount.

No. 5.

______________ ESTATE.—PAY-LIST of DAY-LABOUR for Maintenance and General Management.

NAMES.	Period during which employed.		Number of Days.													Total Number of Days employed.	Rates per Diem.	Amounts paid.	We, the undersigned, acknowledgs to havs rsceived from , through the hands of , the sums set against our names respectively in this pay-list, having been employed during ths period, on the services, and at the rates of pay stated hersin.	Signature of the Witness to the Payments.	Remarks.
	From.	To.	Thinning and Clearing.	Repairs of Buildings.	Buildings and Premises connected therewith.	Repairs of Fences.	Erecting Walls, Fences, Gates, &c.	Erecting Bridges, &c.	Making new Roads and Footpaths.	Repairs of Roads and Footpaths.	Making new Drains.	Repairs of Drains, &c.	General Labourer at the Proprietor's Residence.	Game Department.	Office Work.						
																		£ s. d.			
Totals, . . .																			I hereby certify that these persons wers employed during the periods, on the services, and at the rates of pay stated against their names respectively. ______________, *Agent.*		

Where separate pay-lists for piece-work are kept, the following form, No. 6, will be found useful; but there is still the objection, that to get at the total cost of labour for each month, the two forms have to be brought together, and the total sums added; whereas in form No. 4 the whole is shown at a glance, and only one book for labour has to be kept.

Such forms as I have given for payment of day-labour and piece-work may be bound together, so as to form a book for a year or more, or they may be kept separate for each month; and when they are thus kept, they should be backed in something like the following manner:—

No. ______

PAY-LIST OF DAY-LABOUR.

________ ESTATE.

From ____________ }
To ____________ } 18—

Amount, £ ______

No. 6.

———— ESTATE.—PAY-LIST of PIECE-WORK between the ———— and the ———— 18—

To whom paid.	Description of Work.	Quantity.	Rate.	Per	Amounts for Maintenance and Management.	Amounts for new Improvements.	Total Amount paid to each Person.	We, the undersigned, acknowledge to have received from through the hands of , the sums set against our names respectively in this pay-list, having performed the works described.	Signature of the Witness to the Payments.	Remarks.
					£ s. d.	£ s. d.	£ s. d.			
Totals, ...								I hereby certify that these persons were employed on the services and at the rates stated against their names respectively. ————, *Agent.*		

In connection with the woods and plantations on an estate it is necessary to have books to keep an account of the sales of the timber. We have always used two books for this purpose—one being for an account of sales by private bargain, and the other of sales by public auction.

The one for sales by private bargain is kept in the following manner :—

SALES of TIMBER by Private Contract, in the Woods and Plantations on the Estate of NEWTONHALL, by R—— E—— B——, during the month of May 1868.

Date.	Names of Purchasers.	Residence.	Plantations from which sold.	Description of Timber.	Bundles.	Tons.	Hundred trees.	Dozen trees.	Trees.	Feet.	Rate.	Amount.	Total.
1868.											£ s. d.	£ s. d.	£ s. d.
May 4.	William Frank,	Helmsley.	Crakeland.	Ash.	...	...	...	...	...	352	0 0 8	11 14 8	
„ 7.	do.	do.	do.	Oak-poles.	...	...	11	...	...	...	4 0 0	44 0 0	
„ 14.	George Smith,	Norton.	Hedgerows.	Ash.	...	...	...	...	...	199	0 0 7	5 16 1	
„ 16.	Robert Lurton,	Easingwold.	Elm Hagg.	Underwood.	32	...	...	...	...	...	0 0 6	0 16 0	
„ 19.	William Frank,	Helmsley.	Abbey Park.	Oak.	...	...	...	...	...	270	0 1 0	13 10 0	
„ 19.	F. Bell, . . .	Thirsk.	Duckindale.	Pea-rods.	20	...	...	...	...	...	0 0 3½	0 5 10	
„ 19.	Wm. Taylor, .	Hustwaite.	Elm Hagg.	Small ash-trees.	...	...	...	...	96	...	0 0 1¼	0 10 0	
„ 22.	Robt. Page Page,	Norton.	Abbey Bank.	Oak-bark.	...	30	...	...	...	...	6 15 0	202 10 0	
„ 22.	do.	do.	Clark's Wood.	do.	...	5	...	...	...	...	6 15 0	33 15 0	
„ 30.	John Thompson,	Wass.	do.	Oak-branches.	...	10	...	...	...	...	0 8 0	4 0 0	
													316 17 7
			PAYMENTS FROM CREDIT ACCOUNT IN LEDGER.										
„ 18.	James Watson,	Newburgh.	By cash, as per account in Ledger, folio 2, ...									£50 0 0	
„ 20.	George Berry, .	Longleat.	Do. do. do. folio 3, ...									108 0 0	
													158 0 0
			Total receipt for timber for the month, ...										£474 17 7

The form for entering sales by private contract is easy and simple, and, I think, does not require any explanations. More columns might be made, if required, for any other system of selling timber or underwood. It is an important as well as an interesting matter to know the amount of receipts from any separate plantation; and unless some such form is used as I have given, it is impossible to know what each plantation has produced, and also which pays best.

I have also shown two entries taken from the wood ledger, where entries are made of purchasers who do not pay for their purchase at the time, but have an allowance of time to pay it. The two entries are supposed to have been paid.

Sales on credit are not entered in the private sales book until they are paid; they are entered in a ledger, or what may be termed in an estate office "the wood ledger," to distinguish it from any other ledger. The following is a copy of our wood ledger:—

Dr. JAMES WATSON, Timber-Merchant, Newburgh. CONTRA *Cr.*

Date.	Plantation from which sold.	Description of Timber.	Tons.	100 Trees.	12 Trees.	Trees.	Feet.	Rate.	Amount.	Date of Payment.	Mode of Payment.	Discount.	Sums paid.
1868.								£ s. d.	£ s. d.				£ s. d.
May 2.	Crakeland.	Oak.	...	...	...	...	1200	0 1 0	60 0 0	May 18.	By cash to account,	...	50 0 0

Dr. GEORGE BERRY, Timber-Merchant, Longleat. CONTRA *Cr.*

Date.	Plantation from which sold.	Description of Timber.	Tons.	100 Trees.	12 Trees.	Trees.	Feet.	Rate.	Amount.	Date of Payment.	Mode of Payment.	Discount.	Sums paid.
1868.								£ s. d.	£ s. d.				£ s. d.
May 3.	Elm Hagg.	Ash.	...	...	...	480	...	0 2 0	48 0 0	May 20.	By cash to account,	...	108 0 0
,, 7.	Clark's Wood.	Oak.	...	...	...	...	800	0 1 6	60 0 0				
,, 10.	do.	Larch.	10	...	...	...	...	2 0 0	20 0 0				
,, 14.	do.	do.	8	...	...	...	...	2 0 0	16 0 0				

Dr. JOHN GRANT, Timber-Merchant, Burnside. CONTRA *Cr.*

Date.	Plantation from which sold.	Description of Timber.	Tons.	100 Trees.	12 Trees.	Trees.	Feet.	Rate.	Amount.	Date of Payment.	Mode of Payment.	Discount.	Sums paid.
1868.								£ s. d.	£ s. d.				
May 20.	Fox Wood.	Oak.	6	...	...	...	...	4 0 0	24 0 0				
,, 21.	Tower Wood.	do.	...	...	...	200	...	0 10 0	100 0 0				
,, 24.	do.	do.	...	...	...	150	...	0 10 0	75 0 0				

It will be observed that the entries of the sales are put down to the left hand, or debtor side; on the right hand, or contra side, the sums paid are entered until the whole is paid off, which will be by a given date, if there is, as there should be, an agreement to that effect; and in this way it can be seen at any time what amount is due by any of the purchasers.

It is much better, as a rule, to have cash payments for timber sold; and when this is done, no wood ledger will be required: but it is sometimes necessary to allow a stated time for payment of large purchases, and consequently it is necessary to keep a proper account of them.

The last statement in the ledger form, under the name of John Grant of Burnside, is shown as being not paid.

This form of private sales book is only applicable for the entry of sales made by private bargain. When sales occur by public auction, it is then necessary to have a separate book for entries in this case.

We shall suppose that the thinnings from Duckindale and Tower Wood, as entered in the estimate form, are to be sold by public auction. When the thinnings have been cut and properly laid out in lots to suit likely purchasers in the district—and we will presume that the different lots have been properly marked and numbered, and that the timber was sold, say, on the 28th day of May in 1868—we should then make the entries of this sale as shown in the following form:—

SALES OF TIMBER by Public Auction on the Estate of NEWTONHALL, on the 28th day of May 1868.

Name of Plantation.	No. of Lot.	Description of Timber.	Quantity.	Name of Purchaser.	Residence.	Sum sold at.	Date of Payment.	Sums paid.	Sums due.	Date of Full Payment.	Full Payment.
			Trees.			£ s. d.		£ s. d.	£ s. d.		
Duckindale,	1	Oak.	10	G. Smith, .	Norton.	5 10 0	May 28	5 10 0			
do.	2	do.	8	do.	do.	4 16 0	do.	4 16 0			
do.	3	do.	6	W. Nauk, .	Helmsley.	3 0 0	do.	3 0 0			
do.	4	do.	10	do.	do.	6 0 0	do.	6 0 0			
do.	5	do	20	do.	do.	12 0 0	do.	12 0 0			
do.	6	do.	2	J. Thompson,	Wass.	2 10 0	do.	2 10 0			
do.	7	do.	3	C. Rymer, .	do.	1 15 0	do.	1 15 0			
do.	8	do.	9	do.	do.	5 0 0	do.	5 0 0			
do.	9	do.	9	G. Smith, .	Norton.	9 0 0	do.	2 0 0	7 0 0		
do.	10	do.	4	J. Jones, .	Keldwick.	2 15 0	do.	1 0 0	1 15 0		
do.	11	do.	1	do.	do.	0 10 6	do.	0 10 6			
do.	12	do.	1	do.	do.	0 10 6	do.	0 10 6			
			82			£53 7 0		£44 12 0			
Tower Wood,	13	Oak.	60	Wm. Nauk,	Helmsley.	£80 0 0	May 28	£50 0 0	£30 0 0		
do.	14	do.	20	do.	do.	32 0 0	do.	...	32 0 0		
do.	15	do.	40	do.	do.	40 0 0	do.	...	40 0 0		
do.	16	do.	36	do.	do.	35 0 0	do.	20 0 0	15 0 0		
do.	17	Larch.	210	J. Jones, .	Keldwick.	126 0 0	do.	50 0 0	76 0 0		
do.	18	Firewood.	...	H. J. Quartley,	Amplefirth.	1 10 0	do.	1 10 0			
do.	19	do.	...	do.	do.	0 10 6	do.	0 10 6			
do.	20	Larch.	120	G. Smith, .	Norton.	60 0 0	do.	50 0 0	10 0 0		
do.	21	do.	10	C. Rymer, .	Wass.	5 10 0	do.	...	5 10 0		
do.	22	do.	5	do.	do.	2 10 0	do.	...	2 10 0		
do.	23	do.	8	W. Read, .	Cam.	6 0 0	do.	6 0 0			
do.	24	do.	2	C. Rymer, .	Wass.	1 0 0	do.	...	1 0 0		
do.	25	do.	10	W. Nauk, .	Helmsley.	8 0 0	do.	8 0 0			
do.	26	Oak.	6	do.	do.	6 0 0	do.	6 0 0			
			527			£ 404 0 6		£ 192 0 6			

Previous to the sale, the columns of "Name of Plantation," "No. of Lot," and "Quantity" should be filled in, and the others can be filled in after the sale. It will be observed that the first column is to receive the name of the plantations from which the lots come. The second column contains the number of the lots, as corresponding with the numbers actually painted, or otherwise marked, on the lots; the third column contains the number of trees in each lot; the fourth and fifth, the names and residences of the purchasers; and the sixth, the amount for which each lot is knocked down by the auctioneer. The next contains the date at which part or the whole of the purchase was paid; and the next column shows the amounts paid; and the next, the sums left due.

I have given three statements of books immediately connected with the forester's work, and these are "sales of timber by private contract," "wood ledger," and "sales of timber by public auction." These should consist of separate books, which can be obtained by giving any stationer a ruled form as a guide; and where all the different headings in the columns are printed, it saves an amount of office labour; and each book should be titled outside, for more convenient reference.

I will now give some specimens of book-keeping in connection with the management of a home-farm. These consist of—

Inventory and valuation of live and dead stock, and crop.
Crop-book.
Dairy and poultry account.
Live-stock book.

Besides the foregoing, there will be required for a home-farm a day-labour and pay-list book similar to what has already been shown, and also a ledger and cash-book — examples of which will be given — for the estate generally. I therefore give a sample of an inventory and valuation list, which is as follows :—

INVENTORY and VALUATION of LIVE and DEAD STOCK, CROPS, &c., on the Farm of , on the 1st October 1867.

LIVE STOCK.

Description.	Age.	Rate of each.			Value.			Total Amount.		
		£	s.	d.	£	s.	d.	£	s.	d.
Horses—										
8 horses,	5 to 8	30	0	0	240	0	0			
2 colts,	2	15	0	0	30	0	0			
								270	0	0
Cattle—										
1 bull,	3	30	0	0	30	0	0			
40 bullocks,	3	14	0	0	560	0	0			
5 cows,	4 to 8	20	0	0	100	0	0			
20 yearlings,	1	8	0	0	160	0	0			
6 calves,	...	3	0	0	18	0	0			
								868	0	0
Sheep—										
10 fat sheep,	...	2	5	0	22	10	0			
200 breeding-ewes,	...	2	0	0	400	0	0			
2 rams,	...	3	10	0	7	0	0			
150 hoggs,	...	1	15	0	262	10	0			
								692	0	0
Pigs—										
4 sows,	...	2	10	0	10	0	0			
15 pigs,	...	1	0	0	15	0	0			
								25	0	0
Poultry—										
50 fowls,	...	0	1	0	2	10	0			
14 turkeys,	...	0	7	0	4	18	0			
10 geese,	...	0	5	0	2	10	0			
								9	18	0
								1864	18	0

IMPLEMENTS.

No.	Description.	Average Value of each.			Amount.		
		£	s.	d.	£	s.	d.
2	Waggons,	22	0	0	44	0	0
4	Carts,	12	0	0	46	0	0
4	Ploughs,	3	10	0	14	0	0
2	Corn-drills,	18	0	0	36	0	0
2	Cultivators,	15	0	0	30	0	0
4	Heavy harrows,	4	0	0	16	0	0
2	Light do.	2	15	0	5	10	0
1	Heavy roller,	10	0	0	10	0	0
1	Light do.	7	0	0	7	0	0
6	Sheep-troughs,	0	10	0	3	0	0
8	Bullock do.	0	15	0	6	0	0
120	Hurdles,	0	1	6	9	0	0
14	Barn implements,	0	5	0	3	10	0
2	Dressing-machines,	11	0	0	22	0	0
52	Small working implements,	0	3	0	6	6	0
8	Sets of harness,	5	0	0	40	0	0
1	Weighing-machine,	6	10	2	6	10	0
24	Miscellaneous small articles,	0	2	0	2	8	0
					309	4	0

CROP.

Description.	Where situated.	Estimated Quantity.		Price per Quarter, and lb.			Value.		
		qr.	bush.	£	s.	d.	£	s.	d.
Wheat,	In stack,	150	0	3	0	0	450	0	0
do.	In barn,	20	0	3	0	0	60	0	0
do.	In granary,	40	0	3	0	0	120	0	0
Barley,	In stack,	200	0	1	18	0	380	0	0
do.	In granary,	10	0	1	18	0	19	0	0
Oats,	In stack	120	0	1	10	0	180	0	0
Peas,	In granary,	11	0	2	5	0	24	15	0
do.	In stack,	12	0	2	2	0	27	0	0
Beans,	In granary,	9	0	2	0	0	18	0	0
do.	In stack,	18	0	2	0	0	36	0	0
Rape-seed,	do.	250 lb.		0	9	4	4	3	4
Turnip-seed,	do.	40 ,,		0	1	0	2	0	0
Grass-seed,	do.	100 ,,		0	0	9	3	15	0
Turnips, 50 acres, at £4,	In fields,	...		...			200	0	0
						£	1524	13	4
Total valuation of live stock,						£	1864	18	0
Do. implements,							309	4	0
Do. crop,							1524	13	4
Grand total,						£	3698	15	4

When an inventory and valuation is made at the beginning of a year, and again at the end of it, it will be seen whether the farm is paying or not, which cannot be exactly ascertained otherwise, for although the cash-book may show a balance in favour of the farm, yet the stock and crop may have fallen off considerably; and, on the other hand, even should the books show no balance to the credit of the farm, yet the stock may have so increased in value as to show that the farm is paying well.

The next on the list in connection with the farm is the crop-book. Mr Stephens, in his 'Book of the Farm,' gives a very useful form of "corn-account," and one which can be recommended for the purpose. Mr Stephens has published a small work on 'Farm Book-keeping,' being that recommended in 'The Book of the Farm;' the price is small, and no one should be without it who has the management of a farm.

I have, however, had a form in use for some years which has answered the purpose very well—and the same remark applies to all the forms of accounts which I have given—and I think it best to give a form of it for the consideration of our readers:—

STATEMENT of the GRAIN CROP produced by the Farm of , the Growth of 186 .

Date.	Kind of Crop.	Quantity thrashed.			Kept for Seed.			Consumed by Family.			Consumed by Horses, Cattle, Fowls, &c.			Quantity sold.			To whom sold.	Price per Quarter.	Amount.	Date of Payment.	Remarks.
		qr.	bush.	pk.	qr.	bush.	pk.	qr.	bush.	pk.	qr.	bush.	pk.	qr.	bush.	pk.		£ s. d.	£ s. d.		

It will be observed that the foregoing form is for grain crops only, and does not include root crops or hay. The first column is to contain the date of thrashing any quantity, or of any quantity given to the family, or to horses, or sold, as the case may be. The second column is for entering the kind of crop, whether that may be wheat, barley, oats, or rye; next, the quantity thrashed; and the next four columns should show how that quantity which has been thrashed has been disposed of—that is, what portion has been used in the family, or consumed by the horses, cattle, or sheep on the farm, and how much has been sold—with the price per quarter, and the total amount of the sale, with the date of payment of the sales, and any other remarks which may be thought necessary.

A different form of crop-book is required for hay and root crops, inasmuch as grain being usually sold by measure, the former are generally sold by weight, and hence columns are required for the weight sold.

The following is the form which I have used for some years:—

Miscellaneous Produce sold from the Farm of , including Hay, Clover, Turnips, Carrots, Potatoes, Wurzel, &c.

Date.	To whom sold.	Quantity sold.			Quantity sold.			Of what.	Price per Acre.	Price per Ton.	Amount.		
		acre.	rood.	pole.	tons.	cwt.	qr.				£	s.	d.

The next is an example of a book for entries of sales of milk, cheese, and butter, and poultry, or what may be termed a "Dairy and Poultry Book." On farms where only a few cows are kept, it may not be necessary to keep such a book; but on large dairy-farms, and also on home-farms, it is necessary — as in the case of a home-farm which supplies the proprietor's house establishment with milk, cream, butter, or cheese, a proper statement should be kept of everything supplied. It often occurs that many home-farms keep from ten to twelve milch cows to supply the proprietor's house with dairy produce, but the farm is not credited with any value in return. This, as I have elsewhere stated, may be very conducive to the housekeeper's economical management, but it certainly is not doing justice to the home-farm.

The following is a useful form for the purpose:—

STATEMENT of DAIRY and POULTRY PRODUCE from the Farm of

Date.	Name of Purchaser.	Milk.			Cream.			Cheese.		Poultry.	Eggs.	Price per					Amount.	Remarks.
		quart.	pints.	gills.	quart.	pints.	gills.	stones.	lb.			quart.	pint.	gill.	stone.	lb.		

The live-stock accounts are the next on the list, and they are meant to give a correct statement of any particulars in connection with the cattle, horses, pigs, or sheep on the farm. I have been accustomed to use Mr Stephens's form of stock-account, as detailed in his 'Book of the Farm.' The following is a copy of the same:—

STOCK-ACCOUNT—1849.

		Whole No.	Cattle.	Steers.	Cows.	Calves.	Price.	
							Paid.	Received.
1849.							£ s. d.	£ s. d.
Oct. 2	To	1	Bull, ...	1				
" 2	"	6	Cows, ...	..	6			
" 2	"	10	Steers rising 1 year old, . .	10				
" 2	"	5	Heifers rising 1 year old, . .	..	5			
" 2	"	15	Steers rising 2 years old, . .	15				
		37		26	11			
" 10	"	30	Two-year-old steers bought at Yarm, at £7, ...	30	..	..	210 0 0	
1850.		67		56				
Feb. 20	By	15	Steers sold Adam Butters, at £18,	15	..	..	..	270 0 0
		52		41				
" 20	To	15	Steers bought at Darlington, at £7,	15	..	..	105 0 0	
		67		56				
Mar. 20	"	15	Steers bought at Darlington, at £8,	15	..	..	120 0 0	
		82		71				
" 21	By	14	Steers sold at Newcastle, at £18, .	14	..	..	..	252 0 0
		68		57				
May 8	"	16	Steers sold at Newcastle, at £14, .	16	..	..	..	224 0 0
		52		41				
" 15	"	15	Steers sold at Newcastle, at £12, .	15	..	..	..	180 0 0
		37		26				
June 1	"	15	Steers sold at Edinburgh, at £11, .	15	..	..	..	165 0
		22		11				
" 1	To	20	Steers bought at Darlington, at £6, 6s.	20	..	..	126 0 0	
		42		31				
Sept. 29	By	1	Heifer died, ...	..	1	..	..	4 10 0
		41			10		£561 0 0	£1095 10 0
" 29	To	15	Calves weaned, ...	..	..	15		
						10		
		56				31		
						56		

STOCK-ACCOUNT—1849.

		Whole No.	Pigs.	Breeding Pigs.	Feeding or Store Pigs.	Rate.	Price. Paid.	Price. Received.
1849.						£ s. d.	£ s. d.	£ s. d.
Oct. 2	To	3	Sows, ...	3				
,, 2	,,	1	Boar, ...	1				
,, 2	,,	20	Store pigs, ...	..	20			
		24		4				
,, 24	,,	18	Weaned (2 litters), . . .	..	18			
		42			38			
Nov. 7	,,	8	Weaned, ...	..	8			
1850.		50			46			
Jan. 1	By	20	Sold at Edinburgh, . . .	..	20	1 10 0	..	30 0 0
		30			26			
,, 1	To	25	Bought at Berwick, . . .	..	25	0 15 0	18 15 0	
		55			51			
May 8	By	48	Sold at Edinburgh, . . .	..	48	1 10 0	..	72 0 0
		7			3			
June 8	To	30	Weaned (3 litters), . . .	..	30			
		37			33			
		1	Died, ...	..	1			
		36			32		£18 15 0	£102 0 0
					4			
					36			

In addition to the foregoing account-books for a home-farm, or for a farmer as tenant, the following are also necessary:—

A memorandum-book, in which to enter any daily notes considered necessary, but not any cash transactions. This book is very useful for reference in regard to any occurrences on the farm—such as the state of the weather, the date of sowing and reaping crops, and any other incident thought worthy of note.

A cash-book is also requisite, in which every money transaction is entered, whether it be to the debit or credit account of the farm. An example of this is given in connection with the general accounts of the estate.

A ledger is also necessary, a specimen of which is also given in the *general estate account,* and need not be repeated here.

A day-labour book for the entry of the labourers' time. This should be kept according to the system already given, in which is shown the kind of work each person is employed at in each day.

A pay-list, similar to that already given, should also be used in paying the men, bringing out the number of days each man is employed at each operation, and this will show at the end of the year the cost of each operation.

A rotation-book is also very necessary on a home-farm, in which the name and size of each field should be entered, with the cropping of it each year. This is a simple affair, and may be ruled in a tabulated form by the farm-bailiff. An example of the manner of keeping the rotation of a farm with a map is given in the Appendix.

All these books are very necessary on any farm, and more especially on a farm managed by one person for another. Many farmers merely keep a day-labour book, cash-book, and ledger; but the case is quite different with any one who is responsible to another for all his transactions.

All the books in connection with a home-farm should be constantly in a state fit to be examined by the proprietor or his agent.

It may be thought that all this amount of book-work will entail a large amount of labour on the manager of a farm; but with attention to enter everything done at the proper time and in its proper place, the work is easily attended to; and where there is a resident agent on an estate, and the property can afford to keep a clerk, then he should attend to the main portion of the farm book-keeping.

Properly-kept accounts should be one characteristic of a home-farm, and the extent of many home-farms frequently makes it justifiable to keep a junior clerk for that purpose.

I now come to consider a few books which are necessary for the general accounts of the estate, and these consist of *cash-book, ledger,* and *a yearly statement of income and expenditure.*

The Cash-Account.—A cash-book may be kept either with two money columns on one page, or with separate columns on separate pages. The following is an example of the first-mentioned:—

Cash-Account. *Dr.* *Cr.*

1868.		Fol. of Ledger.		
May 1	Cash on hand at this date, . . .		£65 10 0	
„ 4	To woods, for timber sold William Frank, as per private sales book, .		11 14 8	
„ 7	To woods, for timber sold to Wm. Frank, per private sales book, .		44 0 0	
„ 10	By Lamont, Edinburgh, for 200,000 larch, one-year seedlings, at 2s., .		...	£20 0 0
„ 22	To woods, for bark sold to R. P. Page, as per private sales book, .		236 5 0	
„ 30	By labour for month ending this date, ...		...	71 9 3
„ 30	To woods, for timber sold to L. Thompson, as per private sales book, ...		4 0 0	
„ 30	By insurance, paid North Brit. Office one year's premium on —— Hall,		...	8 16 10
„ 30	By school, paid schoolmaster's salary for half-year ending this date, .		...	20 0 0
	By balance, ...		...	241 3 7
			£361 9 8	£361 9 8

The other form of a cash-account is made by taking the two opposite pages of a book, and ruled with money columns on the right-hand side of the pages, with a column for the date on the left hand; these two pages are called a folio. Then the left-hand page should be headed *Dr.*, or *Cash Dr.*, and the right-hand page is headed *Cr.*, or *Contra Cr.*—the one being the debtor side and the other the credit side. This way of keeping a cash-account is usually called a *Debtor and Creditor Cash-Book*, and is shown thus :—

	Cash	*Dr.*		Contra	*Cr.*
1868			1868		
May 1	Cash on hand at this date, .	£65 10 0	May 10	By Lamont, Edinburgh, for 200,000 larch, one-year seedlings, at 2s., .	£20 0 0
„ 4	To woods, for timber sold to W. Frank, as per private sales book, . . .	11 14 8	„ 30	By labour for month ending this date, ...	71 9 3
„ 7	To woods, for timber sold to W. Frank, as per private sales book, . . .	44 0 0	„ 30	By insurance, paid North British Office one year's premium on —— Hall, . .	8 16 10
„ 22	To woods, for bark sold to R. P. Page, as per private sales book, . . .	236 5 0	„ 30	By school, paid schoolmaster's salary for half-year ending this date, ...	20 0 0
„ 30	To woods, for timber sold to L. Thompson, as per private sales book, . . .	4 0 0		By balance, ...	241 3 7
		£361 9 8			£361 9 8

It will be observed that all sums which are received or are on hand are entered on the *Dr.* side of the account, while all sums paid are entered on the *Cr.* side; in fact, the keeper of the account is *Dr.* for what he receives, and *Cr.* for what he pays out.

A ledger-account for general estate purposes is kept in much the same way as that of the wood ledger, but more simple. It is meant to contain entries of all sales made but which have not been paid for. When a sale is made and paid for at the same time, then the transaction is at once posted into the *Dr.* side of the cash-book; but, as I have stated, when a sale is made and not paid for on the same date, then it is not entered into the cash-book, but is posted into the ledger on the *Dr.* side, thus:—

Dr. JOHN BROWN, Corn-dealer. *Cr.*

1868.		Fol.	£ s. d.	1868.		Fol.	£ s. d.
June 2	To farm for 60 qrs. oats, at 30s.		90 0 0	June 4	By cash,		30 0 0
				„ 8	„		30 0 0

Dr. JOHN STURDY, Butcher. *Cr.*

1868.		Fol.	£ s. d.			Fol.	£ s. d.
June 6	To farm for 2 fat cattle,		50 0 0				

When a payment is made on account—such as the sums stated in the case of John Brown in the ledger-account on June 4 and June 8, in which £30 was paid at each time—then they should be posted in the *Dr.* side of the cash-book as they are received, and in the *Cr.* side of the ledger as shown.

Having now shown the different forms of account-books, it remains to state how a general account is given at the end of each half-year or year, or what may be termed a yearly statement of income and expenditure. This is made out in the same form as the estimate of income and expenditure at the beginning of the year, and need not be repeated again. The income from each department—farm, plantation, or district—should be shown under its own separate heading, and the same with the expenditure. The heads of each department on an estate should render an account of this kind at stated intervals to the agent, who should arrange them all into one general statement of income and expenditure for the whole estate, which being rendered to his employer, with all the vouchers in connection with the expenditure of the different accounts, will terminate one year's proceedings. Before rendering such an account, however, he should keep a careful copy of it, either in separate sheets or in a book for the purpose.

There is another form for filling in details of expenditure which I have seen used with great advantage, as by it is shown what expense is incurred by new improvements, and also what by general management, and everything necessary in upholding the estate and general establishment. The following is the form to which I allude :—

DETAILS OF EXPENDITURE on the Estate from 186 to 186 .

Date.	Number of Voucher.	Amount.	To whom paid.	Particulars.	New Works and Permanent Outlay.	Repairs and Ordinary Outlay.	Rates and Taxes.	Farm.	Personal, including Household, Garden, Stables, Game, &c.	Miscellaneous, including Agent's Salary and Incidental Payments.		Remarks.
186		£ s. d.			£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
Total, . . £				£								
Brought forward,												
Carry forward, £				£								

There are a few other books which should be kept in an estate office, which, although they are not directly account-books, still they tend to act as a check on the other accounts, and are otherwise useful in many ways. These I shall take notice of in rotation, beginning with the

Order-Book.—In procuring anything for estate purposes, many proprietors and agents send different messengers to the various tradesmen at any time with a *verbal order* for supplies. I have frequently known it to be the case that unprincipled people have gone to tradesmen and procured articles in the name of a landed proprietor or agent of an estate without either the proprietor or agent having any knowledge of it, and the tradesman supplied the order as usual, as he always got verbal messages. To prevent such occurrences I have for several years kept an *order-book* such as shown, thus:—

	ESTATE OFFICE, WASS, ... 18......
No.	*No.* ....
.... 18.....	*To Mr* ....
Mr	*Please to supply the undermentioned for* MAJOR STAPYLTON, *and send Account with the Goods.*
	.. .., *Agent.*

The tradespeople have instructions not to supply any article for us unless they receive a written order, and that we will not pay for anything excepting for what is thus ordered. The portion to the right of the dividing line is filled in as required, and signed by the agent; it is then cut off by the line mentioned and sent to the tradesman—the portion to the left being filled up with an exact copy of the order, and retained as a check.

Letter-Book.—This is another important book for entering copies of all letters sent away. It is not necessary to write copies of the letters, as now they are taken by a copying-machine. All the outward letters should be copied, as then they can be referred to at any time in the event of their being called in question, or at any time if it is desirable to know what was said on any subject.

I may remark here, that all inward letters, or those received, should be kept and arranged in good order; and if assorted and backed with the names of the writers in alphabetical order, and with their date, they will be capable of being easily referred to at any time.

Memorandum-Book.—It is also judicious on the part of an agent to keep a regular memorandum of his daily movements and general dealings. A book should be kept for the purpose, in which to enter any daily occurrences which may require to be referred to afterwards. There are many such books prepared every year—such as those by Letts.

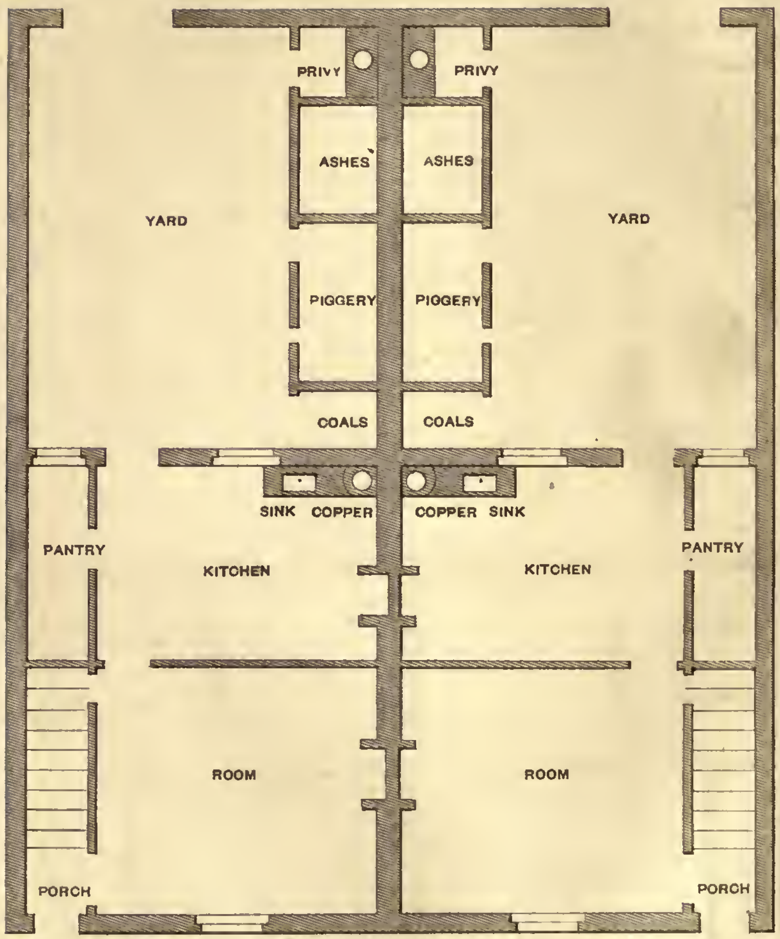
General Yearly Statement of the Estate.—This is an important document to those landed proprietors who take a real interest in their estates and in those connected with them; and by having such statements annually, and preserving them, and comparing the statement of one year with those of former years, it will be seen at a glance what progress the estate is making, as all estates should make some annual progress, and there is something wrong if this is not the case. The statement which I refer to is certainly not absolutely necessary, but it is nevertheless an interesting document. The following is the form which I would suggest, although many other headings might be added which might be suited to any particular property, so as to give a general outline and history of it:—

General Statement of the Estate of Newtonhall, 1868.

	Acres.	Roods.	Poles.	No.	£	s.	d.
Total number of acres, . .							
Do. in cultivation, .							
Do. in old woods, .							
Do. in young plantations,							
Number of farms, ...							
Do. of cottages, ...							
Do. of labourers employed, ...							
Do. of labourers employed by farmers, . .							
Do. of labourers employed by estate, . . .							
Population in villages, ...							
Do. of estates generally, ...							
Number of children under fifteen years of age, . .							
Do. attending schools, . . .							
Gross rental, year 1867, ...							
Do. year 1868, ...							
Expenses of management and general maintenance, . .							
Net rental, ...							
Arrears, ...							
Cost of improvements for year 1868, ...							
Value of stock and materials on hand, ...							

PAIR OF LABO

AS ERECTED BY MAJOR STAPYLTO



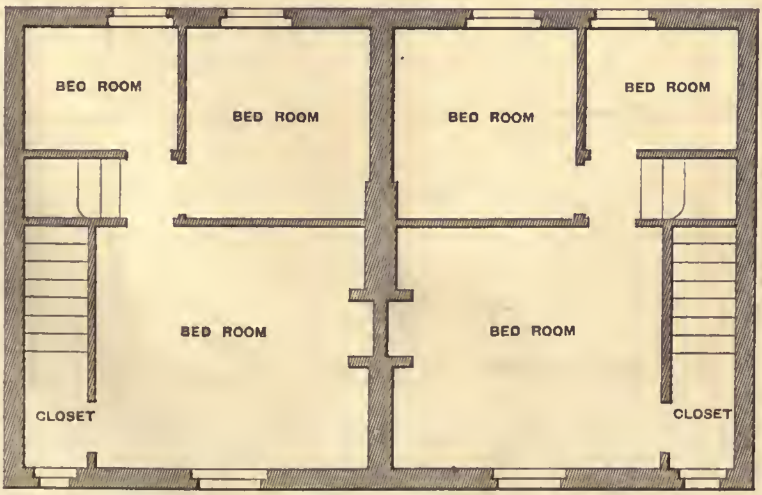
GROUND PLAN

PLATE I.

ERS' COTTAGES

ON HIS ESTATE AT WASS, YORKSHIRE.

FRONT ELEVATION



BED ROOM PLAN

PLATE II.

This is a design for a labourer's cottage, which contains a room, kitchen, and scullery on the ground-plan, with three bedrooms in the chamber-plan, and which are of the following sizes :—

a Porch.
b Storeroom, 12 feet by 10 feet.
c Room, 14 feet by 12 feet.
d Kitchen or scullery, 12 feet by 8 feet 9 inches.
e Closet.
f Stair, 3 feet wide.
g Bedroom, 14 feet by 12 feet.
h do. 12 feet by 10 feet.
i do. 12 feet by 8 feet 9 inches.

There is a back-door leading to the premises behind, which are not shown, as these must be made different if a single cottage is built, or if two are built together.

The height of the rooms on the ground-floor will be nine feet, and the same on the chamber-floor.

The cost of the construction of a pair of these cottages will of course vary much with the locality in which they are erected ; but taking them under ordinary circumstances, and built of stone, they will cost £350 per pair.

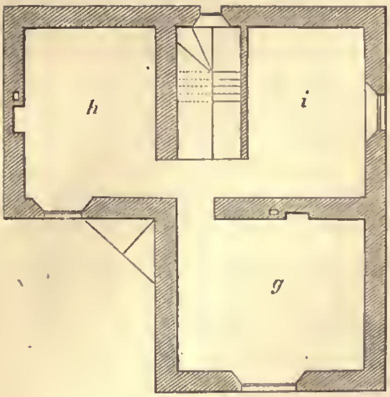
This style of cottage would look well for an entrance-gate.

PLATE III.

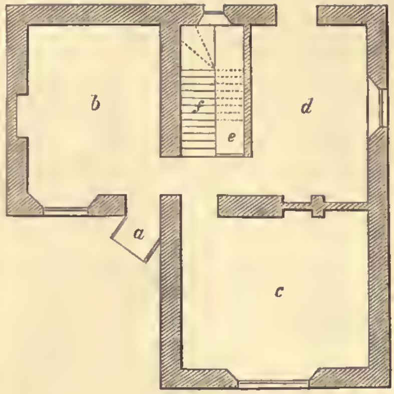
The great difficulty experienced in working the ordinary traction-engine on common roads is, that in going either up or down steep inclines, the water in the boiler gets displaced, and has a destructive effect upon certain works in the engine. Thus, in going down an incline, the crown of the fire-box is exposed to the heat of the fire, and this strong heat gradually destroys it. Again, when the engine is ascending an incline, the water falls back into a space where the great part of the steam is generated, thus preventing it from being made. This state of things is not only injurious to an engine when used as a traction, but it is highly more so on an engine used in ploughing, when it perhaps may be slowly moving up or down an incline for many hours together. I have observed this injurious effect on an engine when ploughing on an incline of 1 in 12, where the difference in the boiler-level was ten inches.

To avoid this, the Messrs Howard of Bedford have brought out a new ploughing and traction machine, an engraving of which is given in Plate III.

PLATE II.



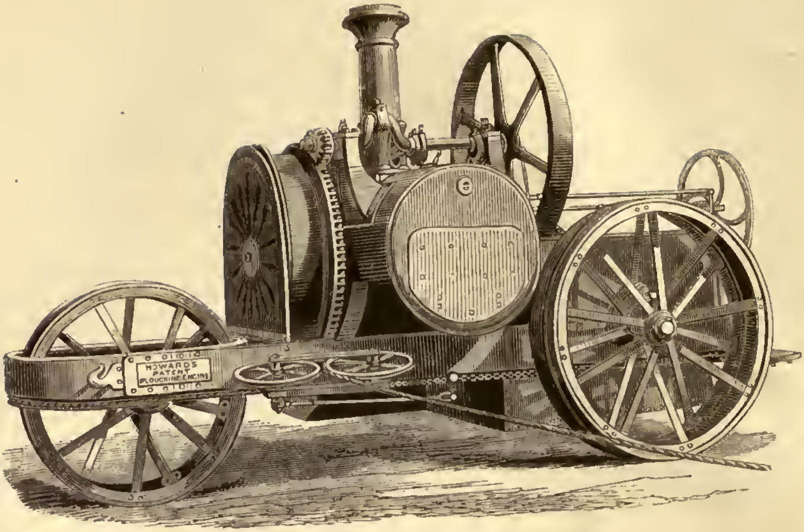
CHAMBER-PLAN.



GROUND-PLAN.

FRONT ELEVATION.

PLATE III.



HOWARD'S NEW PLOUGHING AND TRACTION ENGINE.

HOWARD'S DOUBLE-ACTION STEAM CULTIVATOR.

CROPPING MAP.

GRANGE FARM.


PASTURE
1864, TURNIPS.
1865, WHEAT.
1866, CLOVER.
1867, OATS.
1868, TURNIPS.
12-2-0.
1864, WHEAT.
1865, CLOVER.
1866, OATS.
1867, TURNIPS.
1868, WHEAT.
14-2-0.
PASTURE
1864, OATS.
1865, TURNIPS.
1866, WHEAT.
1867, CLOVER.
1866, BARLEY.
12-0-4.
1864, OATS.
1865, TURNIPS.
1866, WHEAT.
1867, CLOVER.
1866, BARLEY.
16-0-.20.
PASTURE
PASTURE
RIVER
RAILWAY

The peculiarity of this engine is, that the boiler is placed *across* the framework of the engine, instead of being lengthwise, as in the ordinary engines; this is an excellent arrangement to avoid displacement of the water in the boiler. The engine is placed on three wheels only, instead of four, as in ordinary cases. By this arrangement of the wheels the engine stands better on unlevel ground. The steerage of the engine is affected by working on the front wheel, and in this way it can be turned in a very small space.

These engines are not only useful as traction-engines on common roads, and as ploughing-engines, but they are equally useful for thrashing purposes, stone-breaking, and sawing.

In ploughing they can be used either in the double system with two engines, or in the single system with one engine.

The cost of these engines—for a twelve-horse power, suitable for traction-work, and fitted with winding-drums, and with the necessary steel-wire rope, steam cultivator, and all the necessary apparatus for ploughing—is £800; a twelve-horse-power engine for traction-work alone is £475.

In Plate III. is shown an engraving of Howard's double-action steam cultivator. This is a very useful implement. They are made with tines numbering from one to seven, as thought desirable. These tines are made broad at the base, and have prongs placed in them which very effectually loosen the soil. These implements are not only useful in scarifying the surface, but are also valuable for subsoiling. Their cost varies from £21 to £45, according to the number of tines placed in them.

PLATE IV.

Cropping-Map.

This is a map kept for entering the rotation of cropping on a farm. A plan of each farm on the estate should be sketched out, on which the cropping should be entered. We have the plans made out on cloth-paper, and all bound together so as to form a book; and we protect these with thin pliable covers, so as to make the map-book easily carried about on the estate for reference. This form of cropping-map is very useful to the agent or land-steward who has to look after the rotations of the different farms on an estate. It is handy, and shows at a glance under what crop any field should be at any time. Many agents have a series of columns for entering the cropping of a farm, but we can recommend the entering of the crop on a sketch of the field as being very useful and convenient.—See the Cropping-Map.

Plans of Farms-Book, with Statements of Culture, Extent, Rent, &c.

This is a book which will be found very useful for reference. Procure a book made up of planning paper, and about the size of fifteen inches broad by twenty inches long. On the one side of opening in the book, or what may be termed the folio, a number of columns in a tabulated form are given; and on referring to the example given, it will be found that the first column is for the name of the estate, the second for the name of the field on the farm, the third for the number of the field as entered on the plan. The plan of the farm is given on the opposite side of the folio. The next column contains the culture of each field, whether it may be permanent grass or arable. The following column contains the extent of each field, and the next the rent per acre, and the next the total rent; and then follows a column for giving the date of draining the field, and another for remarks. It is understood that where no date is given in the drainage column the field has not been drained. Then at the bottom is found the total extent of the farm and the total rent. A book made out in this form is very useful for lying in an estate office, as the culture, extent, rent, and drainage of any field on the estate can be known at once on referring to the statements.

Other columns might advantageously be added to the statement—as, for instance, in England, where land is tithable, a statement of that might be given, and the nature and quality of the soil and subsoil might also be added—in fact, any interesting item which would give a general history of each farm.

PLANS of FARMS BOOK, with Statements of Culture, Extent, Rent, &c.

GRANGE FARM.

Estate.	Name of Field.	No. on Plan.	Culture.	Extent. ac.	ro.	po.	Rent per Acre. £	s.	d.	Total Rent. £	s.	d.	When drained.	Remarks.
Newtonhall, . .	Outfield, ...	1	Grass.	12	2	0	2	0	0	25	0	0		
do. . .	Northfield, ...	2	do.	12	3	0	2	5	0	28	13	9	1866	
do. . .	Haggs, ...	3	Arable.	16	0	20	2	0	0	32	0	5		
do. . .	Riverside, ...	4	do.	14	2	0	2	5	0	32	12	6	1866	
do. . .	Geeselings, ...	5	Grass.	12	2	15	2	0	0	25	3	6		
do. . .	Turngeese, ...	6	Arable.	12	2	0	2	0	0	25	0	0		
do. . .	Hay Close, ...	7	do.	12	0	4	2	0	0	24	1	0		
do. . .	Intach, ...	8	Grass.	11	0	0	2	5	0	24	15	0	1866	
do. . .	Stackyard Field, . . .	9	Arable.	13	0	0	2	0	0	26	0	0		
do. . .	Cow Pasture, ...	10	Grass.	14	1	0	2	0	0	28	10	0		
do. . .	Ridgewayend, . . .	11	Arable.	13	0	26	2	0	0	26	7	0	...	Apt to be flooded by river.
do. . .	Huntersway, ...	12	do.	10	0	0	2	10	0	25	0	0	1867	
do. . .	Low Field, ...	13	do.	10	1	4	2	10	0	25	13	0	1867	
do. . .	Old House, ...	14	Grass.	9	0	0	2	10	0	22	10	0		
do. . .	Turn Corner	15	Arable.	7	2	0	2	10	0	19	5	0	1867	
do. . .	Dog Close, ...	16	Grass.	8	1	6	2	10	0	20	13	6	1867	Partially drained.
do. . .	Buildings, Roads, &c., .	...	...	4	0	0								
	Totals, ...			193	1	35			£	411	4	8		

Notices to Quit.

When a notice to quit is given to any tenant on an estate, it must be signed by the landlord, or by his agent duly appointed by him. It should be given to the person who is to quit. A copy of it should be kept and signed by the party who delivered it, stating that it was delivered by him to the party to whom it was addressed. But it will answer the same purpose if it is left with the tenant's servant, or with any one at the residence of the person served; and in this case the name of the person to whom it was given should be written on a copy of the notice, and signed by the party who delivered it, and the date of delivering it.

For whatever time the premises or land is let, a similar period of notice must be given, excepting in the case of tenancies for the year. As, for instance, where any premises are let by the quarter, then a quarter's notice to quit must be given; where any are let by the month, then a month's notice must be given; and if let by the week, then a week's notice will suffice.

But, on the other hand, where farms or premises are let by the year, then six months' notice will do; and such six months' notice must be given previous to the same term at which the farm or premises were taken possession of.

The following remarks, taken from the 'Law of Landlord and Tenant,' apply to this :—

No notice to quit is necessary where premises are let for a term certain, expiring on a fixed day. Where there is a tenancy from year to year—in the absence of any special agreement on the subject—it can only be terminated by a notice to quit on either side, such notice being given six months before the expiration of the current year of tenancy. But where a tenancy commences, and therefore also ends, on one of the usual quarter-days, a notice to quit given at the quarter-day last but one before that on which it is to expire will be sufficient, although the interval may be a few days short of six calendar months.

An agent for an estate who has the general management and letting of the farms cottages, &c., has authority by law to give notices to quit for his employer; but agents who merely draw rents, and have nothing further to do with the estate, have no authority to give notices to quit. Particular care should be taken in seeing that the proper name of the tenant is inserted in the notice, as if there be any mistake in this, it will make the notice null.

It is not necessary to state all particulars of the farm or premises in the notice given to a tenant. If the words "quit all the property you hold of me" be inserted, this will be sufficient.

If after the expiration of a notice to quit, a landlord or his agent should accept of any rent arising after that time, then this will be looked upon as if the landlord was doing away with the notice, unless the receiver declared at the time that it was not intended as such, or unless the tenant used fraud against the landlord in making the payment.

In the event of a tenant keeping possession of land or premises after the time of the notice to quit has expired, then the landlord can compel the said tenant to remove or pay double rent.

The following are forms of notices to quit :—

Form of Notice to Quit by a Landlord.

To Mr A—— B——,

I hereby give you notice, and require you to quit and deliver up to me or my agent, on the 6th day of April 18 , all that farm, dwelling-house, premises, and appurtenances situate at , in the county of , which you now hold and occupy of me.

Dated this day of 18 .

(Signed)

Form of Notice to Quit by an Agent of the Landlord.

To Mr A—— B——,

I do hereby, as the agent for and on behalf of your landlord, R—— A——, Esq. of , give you notice to quit and deliver up possession of the land and premises situate at , in the county of , which you now occupy as his tenant, on the day of next.

Dated this day of 18 .

(Signed)

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