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THE FORESTER.

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THE FORESTER

BEING

PLAIN AND PRACTICAL DIRECTIONS FOR THE
PLANTING, REARING, AND GENERAL MANAGEMENT
OF FOREST TREES

BY JAMES BROWN,

FORESTER, ARNISTON.

WILLIAM BLACKWOOD & SONS,
EDINBURGH AND LONDON.

M.DCCC.XLVII.



TO

ROBERT DUNDAS, ESQ. OF ARNISTON.

SIR,

Permit me to dedicate the following little Book to you, as an humble evidence of my respect and esteem.

I have the honour to be, Sir,

Your most obedient Servant,

JAMES BROWN.

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PREFACE.

HAVING, for the period of fifteen years, had my attention almost entirely devoted to the rearing up and cutting down of forest trees, I have during that time seen much to convince me that arboriculture is not in that advanced state among us which its real importance demands.

The present improved condition of agriculture is the natural result of the great attention paid to that science by the landed proprietors and farmers of Great Britain during the past twenty years; while, upon the other hand, the proper management of plantations has been almost entirely neglected, and this mainly because landed proprietors have not had their attention and interest directed towards the subject.

Many of our home woods are rapidly dying out, as if by consumption; yet the cause does not appear to be known among those who have the management of them: and, seeing this state of things, it appears to me very evident, that until

noblemen and gentlemen shall become as truly practical foresters, as they now are practical farmers, we cannot reasonably expect to see our home plantations exhibit the extent and healthy development which it is most desirable should characterise them. I am anxious that the spirit of improvement should be aroused among our landed proprietors, relative to arboriculture: and at the same time I am of opinion that it is necessary, in order to the gaining of this end, that all proprietors should be made acquainted with practical forestry, and that upon the most improved principles. It is with the hope of promoting such knowledge that I am induced to publish the present work: and I have been further encouraged in compiling it by the fact that many extensive landed proprietors in Scotland have invited me to visit their plantations, and report upon them for their future guidance; and by my having constantly found the gentlemen who have thus honoured me with their patronage as a forester, most anxious to be made acquainted with the practical details of arboriculture. I am therefore led to hope that this little treatise may be both acceptable and of service to them.

JAMES BROWN.

ARNISTON, *November 1847.*

THE FORESTER.

CHAPTER I.

VALUE OF LAND UNDER A CROP OF WOOD.—LAYING OUT OF GROUND FOR NEW PLANTATIONS.—FENCING AND INCLOSING OF GROUND FOR YOUNG TREES.—PREPARING OF GROUND FOR YOUNG TREES.—DRAINING OF GROUND FOR YOUNG TREES.—LAYING OUT OF ROADS IN NEW PLANTATIONS.

SECTION I.—VALUE OF LAND UNDER A CROP OF WOOD.

THE value of land, as generally found under a crop of wood, varies according to the nature of the land planted, and, at the same time, according as the locality may or may not be conveniently situated as regards a ready market for the sale of timber. A plantation of trees, of whatever species it may be composed, is always of more value to the grower when in the neighbourhood of a thriving sea-port, than the same plantation would be in a far inland district. The reason of this is obvious; for in the neighbourhood of a ready market for timber, the

distance for cartage is not necessarily much calculated upon by the purchaser, consequently he is enabled to give a fair price to the seller. For example:—were I to purchase good ash timber from a proprietor whose plantations were within two miles of a shipping port, I would be enabled, upon consideration of the short distance, to give him 2s. 3d. per cubic foot: in this case I would calculate upon selling the same wood at 2s. 6d. per foot, allowing the 3d. which I would receive extra, for the expenses of cartage and my own profit. Again, were I to buy the same quality of ash timber from a proprietor whose plantations were thirty miles from a shipping port, I could not give in this instance more than 1s. 6d. per cubic foot; because I would have to calculate, that although I got 2s. 6d. for this wood, it would take 1s. per foot to cover my expenses of conveying the timber to market, and at the same time to have a little profit for my own trouble. And thus it is in all cases, that for every mile of distance from the market, the purchaser of wood is obliged to give less to the seller; and this because he has to meet the extra expenses incurred in each mile of cartage, previous to getting it brought to market.

However, I may here state, as a general rule, which I have verified from my own experience, both in the lowlands and highlands of Scotland, that land, under wood, will at the end of sixty

years, under good management, pay the proprietor nearly three times the sum of money that he would have received from any other crop upon the same piece of ground.

This assertion, I am aware, will be considered extravagant by many proprietors; but to those who may consider what I have here said as beyond the truth, I beg to say that although it may be in reality beyond what they have themselves experienced as to profits from their plantations, yet I must say, that where good management has been introduced, what I have said will be found a practical truth; and in order to illustrate the point, I shall here give two examples, derived from my own experience in the felling of wood upon gentlemen's estates, both in the highlands and lowlands of Scotland.

Upon the estate of Craigston, in Aberdeenshire, where the plantations are, for the most, of larch, Scots, and spruce fir, I have thinned them at all stages, from that of sixteen years old up to that of sixty, when they were cut down as ripe; and, having taken a valuation of the trees as taken from an acre of plantation ground, at all the different stages when thinning was required among the different plantations between sixteen and sixty years, I make the value of an acre of land, as found under mixed fir-wood, in the district of country mentioned, L.190. The annual rent of the land upon which

those plantations grow was reckoned at 10s. an acre, as compared with land of the same description held by farmers in the neighbourhood; and had this land been occupied by a farmer, the proprietor would have received only L.30 for an acre during sixty years; but as occupied by plantations, we see that he received by the end of sixty years, when the crop of wood was cleared off, no less than L.3, 3s. for each year of the period the land was under a crop of wood; and upon deducting original outlay, in the form of fencing and planting, as well as labour in keeping good the plantation and in cutting down the trees for sale, and also compound interest upon the original outlay and rent progressively, during the periods no return was received, it will be found that such land occupied by wood will pay three times the amount of money, at the end of sixty years, that it could do under the hands of a farmer.

Again, upon the estate of Arniston, in Mid-Lothian, where the plantations are hard wood of general sorts, with a mixture of firs to act as nurses, I have calculated upon the same principle as that above mentioned, and find the medium value of an acre of land as under wood upon this estate to be, at the end of seventy years, L.570.

The land in the same neighbourhood lets at 30s. for farm cropping. Now, dividing this L.570 by seventy, the number of years the ground lay under

wood, we have, instead of 30s., L.7, 8s. as the rent of the same land under a crop of wood; and even after deducting all necessary expenses, as well as compound interest progressively, the proprietor has about three times the income from his land as under wood, that he would receive from the same had it been in the hands of a farmer.

These examples I consider quite sufficient for the present purpose. And further upon the same point, I beg to say, that it is not alone the simple value of the timber that makes plantations of so important a nature upon a gentlemen's property. There is the shelter that they afford to all agricultural purposes: for where no plantations are, there is invariably an inferior crop of grain upon the fields, as well as an ill-fed live stock, which should all be taken into account; and in doing so, I am of opinion that upon any landed property, well managed plantations are incalculably of more value than land three times their extent in the hands of a farmer, but without trees to give shelter; and it is well known by every proprietor of land, that he receives by far the highest rent for those parts of his lands which are most sheltered by his best plantations; and further, of whatever value land may be in the hands of a farmer, without plantations to give shelter to the same, it is of very much greater value when properly sheltered by them.

SECTION II.—LAYING OUT OF GROUND FOR NEW
PLANTATIONS.

It is admitted by every person of a refined taste, that no object is so ornamental upon a gentleman's estate as an extensive healthy plantation, situated upon a well chosen spot, and having a well defined tastefully bending outline; and this being a point of the first importance in arboricultural architecture it ought to be well considered by all who would wish to excel in the profession. I am aware that many think, and indeed say, that forest trees will grow as well in an untastefully defined plantation, as they will do in one laid out upon the first principles of refined taste, provided that the soil be good enough,—which is a false estimate of what good taste is capable of doing: and in order to contradict this erroneous opinion, I do assert, that a young plantation laid out according to scientific principles, combined with good taste, will succeed much better than one laid out in a careless manner, as will be shown by and by, under the present head.

As the future welfare of a plantation is considerably affected by the manner in which it is laid out, no man ought to attempt the laying out of ground for one, who is not naturally possessed of good taste for that sort of landscape scenery which is based upon the laws of nature, which will enable him to lay out the proposed plantation in such a

manner as to give the greatest possible effect in ornamenting the neighbouring country. It is also necessary that the person who would lay out ground for a new plantation, should be possessed of a knowledge of the nature of the growth of each sort of tree when planted upon any given soil or situation; which knowledge will enable him to judge rightly as to the effects that certain trees will have when planted in any given spot; and he will also be enabled from such knowledge to say truly, whether or not trees will grow well in the situation chosen for a new plantation. And it is further necessary that the party, in the laying out of a new plantation, should be acquainted with, or at least have in view, any local peculiarities of the district, relative to cold and destructive winds from certain points. From such knowledge he will be able to lay out the proposed plantation in such a manner, that it shall have the greatest possible effect in giving shelter to the surrounding fields, which is the principal end a proprietor aims at in having woods upon his estate.

The larger that any piece of plantation is, the sooner will the trees therein come to useful size, and answer the desired end; and the smaller it is, the more likely are the hopes of the planter to be disappointed. And the reason of this is obvious:—for the young trees growing in an extensive plantation, as soon as they rise a little above the surface

of the grass or heath, begin to shelter one another; whereas, if the plantation be narrow, the young trees can hardly be said ever to come the length of sheltering one another—for every breeze of wind blowing through the whole breadth, acts upon every single tree almost as powerfully as if each tree stood singly and alone. Therefore, it is most profitable for proprietors always to plant in large masses.

Trees planted in a mass of one hundred acres extent, will be more healthy, and come sooner to profitable size, both as affording timber and shelter, than they would if planted in a mass of ten acres. From this it follows, that if a proprietor wishes to plant one hundred acres upon his estate, he will raise more healthy timber by planting in one mass, than he would do by planting the same extent in four masses of twenty-five acres each.

No young plantation, upon an exposed situation, should be less than one hundred yards broad at any given point; and, where the soil is of a light, thin, mossy nature, and not apt to raise trees to good size, one hundred yards may even be too little for breadth. If there be much mossy ground upon the site intended for a new plantation, or if there be much of it consisting of poor, thin, gravelly heights, as is often the case in unimproved districts, a narrow or small plantation will not succeed profitably. A small plantation may succeed upon

a good loamy soil in a sheltered situation ; but upon a bad soil, and an exposed situation, I would advise not to plant at all, unless it be done in large masses.

Almost every gentleman's estate lies in a manner peculiar to itself ; the wind that might prove hurtful to one estate, might not do so to another marching with it : therefore it is, that the particular winds which prove most hurtful to an estate, should always be taken into consideration in the laying out of a plantation upon it.

I have already said above, that the welfare of a young plantation depends in a great measure upon the manner in which it is laid out. I also said, that a plantation laid out according to scientific rules, combined with good taste, will succeed much better than one laid out in a careless unscientific manner. The following are the rules by which I generally guide myself in the laying out of a new plantation :—

First.—In laying out its boundary line, avoid all straight lines upon the exposed sides, and, if possible, make no straight lines at all upon any side. They are disagreeable to the eye of taste, and are without meaning when applied to natural objects : in nature there are no straight lines, and that for a wise end, for they are without strength to resist outward pressure.

Second.—The greatest extent of a new planta-

tion should be laid off against the prevailing wind of the district, and at the same time, the greatest extent should be kept along the highest part of the ground to be planted.

Third.—The best possible form of boundary line which can be thrown out against the wind, upon the most exposed side of a plantation, is the convex. Such a form of boundary line weakens the strength of the wind when it hits upon it: the strength of the storm is, as it were, divided, when it hits upon the projecting bend of a well defined convex.

Fourth.—Upon the most sheltered sides of a plantation, the boundary line may be made to bend one way or another, as good taste may direct; but in all cases, making a concave bend only where there is a good breadth of planting immediately behind it.

Fifth.—The highest parts in a neighbourhood ought to be chosen for the site of a plantation. By choosing such a situation, the greatest possible shelter is likely to be attained for the neighbouring fields; and, at the same time, a plantation situated upon a height always forms a prominent and a pleasing object to the proprietor. A bare height always carries along with it the idea of barrenness, but when planted with trees, it forms one of the most pleasing objects in the landscape of a gentleman's estate.

Sixth.—In the laying out of a new plantation,

intended for the protection of live stock, there ought to be several rather deep sinuosities upon the most sheltered sides. These sinuosities ought to be upon a bold wide scale, so as not to cause any weak point to project from the body of the plantation; for, if this be the case, such weak points would not thrive, and consequently always have a mean appearance.

Seventh.—If in the general arrangement of the boundary line, it should be found necessary to make a bend having its concavity to the storm side, care should be taken to construct such a bend in a hollow part of the ground, or, at least, as low as possible, and it should be backed by a good breadth of planting behind.

In the laying out of a new plantation, there is much room for the display of good taste. Every person is pleased with the effect of well arranged figures upon grass in a flower garden; and the several plantations upon a gentleman's estate ought, in like manner, to be well laid out figures upon a large scale. Many have told me, when speaking upon this point, that it is superfluous to lay out a piece of plantation with as much view to taste as is necessary in garden and pleasure-ground scenery; but I have always maintained, that taste is as necessary in the one case as in the other, and that any proprietor has a right to tasteful arrangements, and is pleased therewith when surveying his farms,

as much as with the other, when surveying his pleasure grounds. If, in the general arrangement of a young plantation, a display of taste were to be injurious to the welfare of the same, then I would say, let taste have nothing to do in the matter; but the truth is quite the reverse of this. All true taste is based upon the works of nature: therefore, when we make the bendings and turnings of the boundary line of a plantation in conformity with the securing natural strength to resist the storm, we at the same time give the most pleasing effect to the mind of the person who looks upon it.

The bendings in the outline of a plantation should always be made to follow the natural rising and falling of the ground; that is, where any lateral heights may project from the main body of the ground laid out for a plantation, make the fence line take a bold convex turn in the same direction, and that just so far as may be considered necessary for the extent in view; and where a hollow of the ground occurs, make a fence line take a bold concave turn there, coming up again in the form of the convex where the ground begins to rise. In the laying out of a new plantation, if it is at all to be seen from the windows of the proprietor's mansion, or from any part of his pleasure grounds, great care should be taken to make it have the most pleasing effect when viewed from such points; for if it should be badly laid off it will

prove a continual eye-sore, and if well laid off it will prove a constant source of pleasure.

The method of laying out plantations in the form of strips, so often to be met with in Scotland, gives a poor and mean appearance to a gentleman's estate, particularly when found about the home grounds. The form in which they have generally been made is in straight lines, from twenty to thirty yards broad. In such narrow belts of wood the trees are very seldom found in good health; and, upon a little consideration of the matter, this is not to be wondered at—because, from the narrowness of such strips, the proprietors were always afraid to thin them, wishing to keep them in a thick state, in order to give as much shelter as possible, and the natural consequence is, from being left too thick, the one tree soon kills the other. And even where such strips have been well managed, it cannot be expected that they could produce either good healthy timber or make a good shelter; for, being so narrow, the trees never come to shelter one another. But it is a happy circumstance in the history of arboriculture, that few such strips are now planted: gentlemen are now beginning to see the impropriety of such a method of raising plantations; and now, almost in all cases of good management, we see the old-fashioned narrow strip giving place to the well defined, extensive plantation, which is, indeed, the

only profitable way of rearing trees for any useful purpose.

SECTION III.—FENCING AND INCLOSING OF GROUND
FOR YOUNG TREES.

It is absolutely necessary that every piece of ground laid out for a plantation should be fenced in some way or other, previous to its being planted. A fence not only prevents the inroads of sheep and cattle, but it at the same time tends very much to shelter the young trees, and to bring them on rapidly. It is, indeed, surprising to observe the difference that a very low fence makes upon the growth of young trees, as compared with those which are not protected by one. Any proprietor, or forester, upon looking through his several plantations, will observe that, in all young plantations, the most rapid growing, and at the same time the most healthy trees in it, are to be found immediately behind the outer fence; and, upon the other hand, in all older plantations, the best grown, and at the same time the most healthy trees, are to be found in the centre of the same, or, at least, a considerable distance back from the fence. Now, it may be asked, what is the reason that the best wood is found in the inner parts of old plantations, while the most rapid growing trees are to be found, when young, behind the boundary

fence? The reason, as proved from experience, is this:—

During the first eight or ten years of the age of any young plantation, the boundary fence is the only shelter that the young trees have; and it is evident, that those trees which grow immediately behind the fence will receive most of the benefit of its shelter; consequently, from the circumstance of their receiving more shelter than their neighbours further off, they must grow more rapidly, until such time as their tops begin to rise above the level of the fence, when they are considerably checked by the cold winds. At this stage, they begin to grow thick and bushy, rather than advance in height, and, immediately upon their becoming so, they begin to shelter all their neighbours inside, which, again, begin to have double the advantage of their neighbours outside; for the trees upon the outside had shelter only so long as they were below the level of the top of the fence, whereas those inside have now a shelter which every year increases upon them for their advantage, in height as well as in thickness. All this comes in to prove that a fence is a great mean of furthering the healthy development of a young plantation, independent of its protecting from the inroads of cattle at the same time. I always calculate, that a plantation with a good fence is ten years in advance of one without such protection.

Many different methods of fencing have been adopted for the inclosing of young plantations upon gentlemen's estates, and, no doubt, different methods will still continue to be adopted, according to the different sorts of materials to be had in abundance in the neighbourhood of the plantation to be constructed.

Under the present head, it will be enough for me to enumerate the principal sorts of fences, as in common use in Scotland; and, giving an idea of the cost of raising these in each case, I shall leave it to the discretion of the parties planting to judge for themselves which sort of fence they may adopt, which, of course, must be in most cases determined according to the kind of material most conveniently to be had.

The first is the thorn hedge, which is a fence well known throughout all Britain. This sort of fence is very much improved by having one-third of beech plants mixed among the thorns in planting, particularly upon high situations with a light soil. There the thorns are apt to die early, but when mixed with beech plants, which thrive well in a light soil, the fence is much improved, both in health and appearance.

The hedge is a fence well adapted for all situations where a neat, cultivated, and clothed appearance is the object, but is not to be recommended for a soil of a mossy or sandy nature upon a high

exposure. In such a situation, and under such circumstances, it will not live long; but upon a clay soil, or loam, it will survive well, and have a very ornamental appearance.

The cost of planting a thorn hedge, including a ditch four feet wide by two deep, where the ground is of a wet nature, including plants from a nurseryman, will average about one shilling and eightpence per rood of six yards; and where the ground is dry and does not require a ditch, the same work may probably be got done for one shilling per rood.

Second.—The most extensively used fence, in the high inland districts of Scotland, is the *Dry-stone Dyke*. From the nature of the country in those high districts, stones are plentiful, and, of course, easily attainable, from which circumstance it is a fence much in use for all purposes. Stone dykes have the effect of affording considerable shelter to young plantations as soon as they are put up for that purpose; as also giving shelter to cattle in the adjoining fields, which, of course, is not the case with a young hedge fence. The dry-stone dyke used to be built entirely without the addition of any lime or mortar to bind it, and consequently it was always apt to be broken down by cattle, or any other strong pressure coming in contact with it; but within ten years past, a great improvement has been effected in the building of them, by having

the top, or cope stones, all put on and bedded in lime, which keeps the dyke altogether in a more firm and compact state than that built upon the old principle.

The dry-stone dykes are generally built, including the cope, about five feet high, thirty inches broad at bottom, and tapering regularly upon each side to about twelve inches thick at top of building, which is four feet high. They receive the addition of fully another foot in height by having the cope and cobble placed on the top of the regularly built part.

The price of erecting a stone dyke depends entirely upon the conveniency of getting stones for the purpose. If stones are to be carted far for the line of fence, the expense becomes considerable; but the stones being laid down, it is generally got done for 2s. 6d. per rood of six yards, including the cope and cobble well put on with lime. This is the price generally paid in Mid-Lothian, but in many other districts, where lime is more expensive, 3s. per rood may not be an over-estimate. The stone dykes make a very desirable fence upon high districts, where, upon account of their immediate height, they at once give shelter to young trees in a new plantation, but they are certainly not to be recommended as an ornamental fence; therefore, they should be excluded from any gentleman's home grounds, for in such a situa-

tion they always give a stranger a mean idea of the place.

Third.—In many high-lying parts of Scotland, where stones are not easily got at, and where, upon account of the nature of the soil, it would not be advisable to plant hedges, a very neat and good fence is often put up for the purpose of inclosing young plantations, termed the *Turf Dyke*. I have seen these turf dykes answer the purpose extremely well, both in the lowlands and highlands of Scotland. In building them, the turfs are cut from the surface soil, upon each side of the line of fence, which turfs are generally cut about five inches thick, or less, according as the surface will or will not admit of that thickness. The turfs being cut, they are built the one above the other to the desired height, which is generally about thirty inches, and all firmly packed together.

The turf dyke is generally made about thirty inches broad at the bottom, and tapering regularly upon each side to fourteen inches at top. The body of the dyke is built with the turfs grass side under, but the top turf has the grass side uppermost.

In order to prevent sheep or cattle of any description from getting over the turf dyke into the young plantations, which they are meant to protect, one or two bars of paling are generally put along the top, which are nailed to stobs, driven

into the dyke, so deep as to go through the dyke into the solid ground under it. This makes a very good fence where stone dykes are not easily attainable, from the want of materials, and can be put up, including paling and stobs, and men's time putting in the same, for fourpence per yard.

Fourth.—The common wooden paling—that is, the fence consisting of wood stobs driven into the ground at regular distances, with bars of wood, sawn for the purpose, nailed horizontally upon them—is very much used as a fence for all purposes, and is so well known throughout Britain as to need no explanation from me here. However, I may say, that, owing to the open nature of such a fence, it is not at all adapted for the protecting of young plantations upon high grounds, and ought to be used only in rather sheltered situations, for the subdividing of fields, and protecting young hedges. The cost of erecting a wooden paling, with three horizontal bars, is about sixpence per yard, including workmanship and nails.

Fifth.—The wire fence, upon wooden posts, has often been recommended as a substitute for other materials where those are scarce; but I can by no means agree with those who recommend wire fences for young plantations, upon a high and exposed situation. The wire fence is most admirably adapted, by its invisibility, for all purposes upon a gentleman's home domains; but as a fence where

shelter is an object, it is by no means to be recommended.

I am not aware that any practical planter has as yet come forward, presuming to recommend the wire fence for his purposes upon high grounds. The wire merchant, who has the material for sale, is the only person who has yet ventured to recommend wire fences for all purposes; but I here beg to state, that proprietors in general will do well to be cautious as to how far they introduce wire fences upon high and exposed parts of their estates. No fence is more ornamental for a gentleman's home grounds; but at the same time it must be remembered that no fence gives less shelter. The price of erecting wire fences upon wooden posts, for the purpose of protecting from sheep and cattle, is about 1s. 6d. per yard.

The above are the kinds of fences most generally in use for the protection of young plantations. The proprietor who plants extensively must judge for himself how far he is with propriety to adopt one fence in preference to another—and that, of course, must always be decided by the nature of the soil and situation, and the convenience as regards materials: observing in all cases to erect a fence that will combine shelter with durability upon high and exposed situations; and where the situation is low and naturally sheltered, the taste may more reasonably be consulted. In all cases of fencing for the

protection of young plantations, the work should be particularly well executed; for if it be badly done, and a part of the fence be broken down by any slight accident, cattle may get in, and do more damage in one night than could be well recovered in the course of some years. This I have experienced so frequently, that I here beg to advise all proprietors to be most strict in the executing of such a piece of work, where, in fact, the wealth of their estates is at stake. If the fencing should be set by contract, as is often the case, the contractor should be bound to keep his work good for three years after it is finished; under this engagement, he will, for his own sake, be anxious to do his work well.

SECTION IV.—PREPARING OF GROUND FOR YOUNG TREES.

Some practical foresters have maintained that all ground, previous to its being planted with young forest trees, ought to undergo a course of preparation by trenching or ploughing, and by having lime or manure in some way or other applied to the land. Such a course of preparation as either of the above may be very proper in some cases, but is by no means always either necessary or profitable in the end. As I have very often been questioned by proprietors relative to the utility of trenching,

ploughing, or manuring of land previous to its being put under a crop of young forest trees, I shall here state very briefly my mind upon the matter.

First, then, trenching has frequently been recommended as a proper preparation of the soil for the reception of young forest trees. The expenses necessary to be incurred in the act of trenching ground for forest trees is the most prominent point that occurs to the mind; and, indeed, it is a very formidable point to get over. It is evident that, however much good might arise to trees from the trenching of the ground upon which they might be planted, it could not in practice be carried to any useful or great extent. In ordinary cases, land cannot be got trenched under eight pounds an acre; and where trees have been formerly, and huge roots have to be taken out of the ground, even fifteen pounds would not be too much for the trenching of an acre in such a condition. Therefore, in general practice, it is entirely out of the question.

The trenching of ground, as a preparation for young trees, may be very proper, and even necessary, upon a small scale—near or about a proprietor's policy grounds in a sheltered situation—particularly where large trees may have been newly taken down, and where it is desirable to have old roots taken out previous to replanting; but it is only in such a case that trenching, in my

opinion, ought to be recommended in the cultivation of forest trees, and even then only if the subsoil be naturally good. There is no advantage gained by trenching ground for forest trees which is not decidedly better attained by a well conducted system of drainage.

Many practical foresters have argued, that all land newly cleared of a crop of old wood should be trenched, and the old roots taken out previous to being replanted with another crop of forest trees; and I do confess, that at the first glance, such a proposition appears feasible. Those who argue for this pitch of refinement in the cultivation of forest trees, wish to cultivate them much in the same manner as we at present cultivate corn; but such a system of forestry is, in my opinion, altogether superfluous, and nature points out the same thing to us if we will but observe her manner of proceeding in this work.

In all parts of the world corn can be had good only by carefully cultivating it—at least I am not aware that corn of any sort can be found in a state of nature nearly so good as it is found under the hands of the husbandman; which points out to us, from nature herself, that in order to have corn good and in sufficient abundance to answer our wants, we must cultivate it, and that carefully; and, accordingly, we in this case proceed in the manner pointed out to us by nature. Upon the other hand, I beg

to ask those who contend for the trenching and taking out of all old roots of trees from any piece of ground previous to having it replanted with other trees, where do we find the best crop of timber trees—in the natural forest or in the cultivated one? We have only to compare our home plantations with the natural forests of America or Norway, and we at once find an answer for ourselves. It is a fact well ascertained, that the natural forests upon the continents of Europe and America have, for ages past, produced in succession many crops of heavy timber, and yet we know well that there was no trenching of ground there. Let us cultivate as we will, by trenching or otherwise, we have not yet produced trees in our home woods equal to those in a state of nature; and the simple reason is, that in the growing of trees in our artificial forests, we are continually aiming too much at what we term cultivation. We are always anxious to improve upon nature. This may, indeed, do in many things; but unless we shall follow the direct path which nature points out to us for the growing of forest trees, we most assuredly never will succeed.

In the natural forest we never find two successive crops of the same species of tree upon the same soil; by attending to which principle in nature relative to forest trees, a great part of our success in cultivating them in our home woods depends. All that nature requires of us, in order to produce

a second crop of wood upon the same piece of ground, is to change the crop—for this is always done when nature is left to herself. Therefore, in conclusion, upon the head of trenching, I have to say, that it must be, and has indeed been found to be, an unnecessary operation. I could, from my own experience, point out many instances where it has done more harm than good to young trees; therefore it is that I cannot approve of it. All that is necessary, in order to grow trees upon any soil, is to *drain*; and if a crop of wood have been upon the same soil formerly, and is but newly cleared off, change the species of tree for a crop, and success will be the ultimate result.

Second.—The *ploughing* of land has been much recommended as a preparation of the ground for young forest trees. In my opinion, where the soil is naturally good, there is no necessity for the ploughing of it previous to its being planted; but where the upper stratum of soil is naturally poor and thin, with *moorbond-pan* under, a deep ploughing is absolutely necessary in order to break the pan and mix a portion of the subsoil with the upper. The fact is, that a soil of the nature of *moorbond-pan* is naturally unfit for the growing of forest trees; but where the proprietor of such a soil, in the general arrangement of his improvements upon his estate, may wish to plant such a piece of ground with forest trees, the trench-

plough must first be used, in order to open up the soil and break the pan. I am not aware that ploughing is advantageous to the growth of forest trees in any other case. I am aware that *fir-trees*, planted and growing upon land which has been frequently ploughed previously, seldom live long, or attain to any considerable size free from disease, which at once points out that nature wishes no interference of such a kind. Generally speaking, trees for a few years grow faster upon ploughed land than upon the natural undisturbed soil, but do not live nearly so long; therefore I again beg to recommend that all artificial cultivation of the soil ought to be avoided when healthy timber is an object.

Third.—Liming, and otherwise manuring of the soil for young trees, has been recommended by some, and disapproved of by others: in my opinion, and I speak from experience, all artificial excitement of a young tree by the application of manure is ultimately injurious to it. I have seen small plantations grown upon the system of trenching, liming, and otherwise manuring; and in such cases I have generally had occasion to observe, that the trees grew rapidly for a few years at first, but, as soon as the exciting influence of the manure had begun to fail, the trees fell into a bad state of health, and seldom attained that confirmed state of maturity which is the case when

nature has her own way. However, I cannot say as to what state of perfection trees might grow were manure added to their roots at stated intervals; nor do I think it necessary that we should know the results of such a system of training, because it could be of no real use to grow trees upon such an expensive system.

SECTION V.—DRAINING OF GROUND FOR YOUNG TREES.

There is no preparation of the soil so advantageous to the welfare of young forest trees as that of draining. Draining not only dries the soil from all superfluous moisture, but it also cleanses it of many bad ingredients which might otherwise prove injurious to the health of trees, and prevent their full development. To the want of draining may be attributed the greater part of cases of unhealthiness in plantations for forty years past. The disease in the larch, which has been so prevalent in Scotland for some years past, may be almost entirely attributed to the neglect of this precaution, as shall be particularly explained when I come to treat upon that subject in this treatise. I have, within these last ten years, seen very many plantations in Scotland fast going back from the want of draining; and having been often called upon to give my opinion relative to the unhealthy state of such planta-

tions, I have, in almost all cases, found damp to be the principal cause, and therefore recommended an efficient course of open draining as the only means by which they could be recovered; and wherever my plan for the recovery of the health of such plantations has been put into operation, a recovery has been the result, excepting in some cases where the trees were too old and stunted to indulge any hope of their recovery. Since I came to be forester at Arniston, I have, by draining alone, brought several young plantations into health, which, before that operation was done, were fast going back; and from experience I find, that if the constitution of trees under twenty years old be not too much injured by the effects of dampness, they will show signs of recovery the second year after the ground is drained about them,—that is to say, as soon as the young roots begin to draw nourishment from the dry and improved soil.

Draining is quite as necessary for the profitable rearing of young trees, as it is found advantageous in the profitable growing of corn, which we now see so much improved every where by that most excellent art. Such as our corn fields were fifty years ago, such are the most of our plantations of the present day.

Twenty years ago, it was considered a piece of superfluous work to drain land where young trees were to be put in; therefore it is not to be won-

dered at that we have at the present time so many unhealthy young plantations. During my apprenticeship I have planted young trees in ground where, when I made a pit for a young tree, I had to plant it immediately, for fear of the pit filling with water; and yet the person who had the management did not appear to think that draining was necessary. And such was the case with foresters generally at that time. However, the foresters of that period are not to be blamed for not draining their ground previous to its being planted, any more than farmers were to blame for the same neglect before they became aware of the advantages of draining. But the case is altogether different now. Every farmer and forester is now aware of the advantages of draining land, whether it may be for the growing of corn or of trees; and yet we have often occasion to see this knowledge taken no advantage of, both among farmers and foresters.

Any farmer who now sows his fields without first draining them, is, by his more intelligent neighbours, considered unworthy of holding his land; so, in like manner, the forester who would attempt planting a piece of ground naturally wet, and not first have it thoroughly drained, would certainly be unworthy of holding a situation as forester in any gentleman's establishment.

The land intended for a new plantation being all

well fenced, the next important step to be taken, in order to fit it for the reception of young trees, is the draining it, which draining must be executed in such a manner as to free the land from all superfluous moisture, and to keep it in a free open healthy state. I may here remark, that all drains made in plantations among trees, whether these may be old or young, ought to be left open. To cover drains, where the roots of trees have access to them, is the most effectual way of ultimately rendering them useless. They might, indeed, answer the purpose for a very few years; but as soon as the roots of the tree began to spread themselves firmly into the soil, they would collect about the drains more than any other part, and the consequence would be, that in a very short time covered drains would be entirely choked up with the roots, and rendered useless.

It is seldom found necessary to drain every part of the ground that may be laid out for a new plantation. There are, it is most reasonable to suppose, many spots quite dry enough for the rearing of healthy timber trees, in almost every district of any considerable extent—which spots the experienced eye can at once detect by the general appearance of the plants growing upon the surface; but for the guidance of those who may not have had experience enough for this purpose, it may be necessary here to lay down something like a rule, by

which they may distinguish land in want of draining from land not requiring it. Attend, then, to the following hints:—At certain distances throughout the whole of the intended plantation, say at twenty yards, cast pits rather more than twelve inches deep; and if, in those pits, water should appear to gather within ten hours after being made, the land there is unfit for the growing of healthy trees without being drained; and where no water appears in the pits, the land there may be reckoned dry, and may be safely planted with forest trees without being drained.

The distance at which drains should be put on the ground, depends entirely upon the nature of the soil to be dried: that is, if the soil be a stiff clay, or a retentive moss, the drains may require to be laid on as close as fifteen feet apart; and if, upon the contrary, the soil to be dried be of an open sand or gravel, through which the water can pass freely, thirty feet distant may not be too far separate. In all cases where I drain for the planting of forest trees, of whatever nature the soil may be, I never put on drains closer than fifteen feet, nor wider than forty, if the soil require draining at all. If the soil for a plantation of trees be drained more frequently than at fifteen feet, the trees are very apt to be blown up by the roots when they come to be heavy topped, particularly if the drains are not kept in a clean state; and if

land requires draining at all for the growing of trees, it is my opinion that forty feet should be the greatest distance, for beyond that distance between drains, land cannot be said to be drained efficiently.

The depth and general size of the drains must in a great measure be regulated by the nature of the soil to be dried. In a heavy clay soil, I have found that wood drains should be at least twenty inches deep, and upon a light friable soil, fourteen inches may be quite deep enough; and according as the soil may be inclined to be light or heavy, any intermediate depth between the two extremes above specified may be fixed upon—always observing, that the more the soil is inclined to clay, the deeper the drains should be made.

The breadth of all such drains, at the surface of the ground, must of course vary according to the depth required. The rule which I have laid down for my own practice as regards this is, to make all open forest drains one-third wider at the top than the depth intended: that is, if the depth of a drain be fixed upon as fifteen inches, the breadth of the opening at top will require to be twenty inches, and so on with any other depth. The breadth of all forest drains at bottom ought to be sufficient to allow a common spade free room to pass along for the purpose of cleaning.

The cost of making such drains as have been above specified, must always be regulated by the

nature of the soil, and the price of labour in the neighbourhood where the work is to be done. In Mid-Lothian, I have got drains fourteen inches deep, and requiring to be picked in the under-half, done for one farthing per yard; and drains twenty inches deep, requiring extra picking, for two farthings per yard. A particular point to attend to in the draining of moor or waste land, for the planting of young forest trees, is the manner of laying on the drains upon the ground; they must be laid on in that position which is found to be the best adapted for drawing off and intercepting the superfluous water in its natural descent. I have seen several plantations of late, and those of considerable extent, drained in a very inefficient manner, the drains not having been properly laid down upon the ground. To those who may be unacquainted with the art of making open drains upon moor or waste land, the following hints may be useful:—Upon level ground—that is to say, upon ground not having any perceptible fall for a considerable distance, great caution must be used, in order to produce artificially a fall or descent for the water that may collect in drains made upon such a level. The manner of going to work in such a case is as follows:—look for the lowest part of the ground, which, if it cannot be detected by the eye, may be determined by the spirit-level, which every drainer ought to possess; and having found the lowest part of the ground

requiring drainage, ascertain by the spirit-level how deep a main drain can be made there, in order to have, at the same time, a proper descent to carry off the water from it; having fixed this point, cut a main drain along the lowest part of the ground, at least three feet deep, and endeavour to give it as good a descent as possible. The main drain being made, say three feet and a half deep, and five feet wide at the top, lay off your smaller or common drains at proper distances, and at right angles to the main drain; and in making the common drains, say that you wish to have them twenty inches deep, make them of that depth at the top, or the end farthest from the main drain, and proportionally deeper, as you approach it; and when you finish the small drains into the main one, you can have at least one foot and half of descent between the two ends of your drains, which is quite enough for a drain of any ordinary length. If this main drain have to receive water from a considerable number of small ones, as will be the case if it is of any considerable length, and if it have to receive water from drains laid off upon each side of it, great care must be taken to make it large enough. In many cases it may be found necessary to make a main drain even larger than the dimensions I have specified above; but this must in all cases be regulated according to the number of drains that may have to be emptied into it, and much also depends upon the

length of the small drains themselves—for if these are of great length, and put in pretty close upon the ground, they will, during a flood, pour a great quantity of water into the main drain: but to avoid the consequences of too much water falling into any main drain, it is a better plan not to allow any small drain to run above one hundred yards without falling into a main, or at least a sub-main one, which again empties itself into a main drain.

In putting open drains upon land having a natural declivity, they should be run nearly at right angles with the descent of the ground; but at the same time, care must be taken to make every drain with a slight fall downwards; for if they have not at least one foot in a hundred of descent, they will be apt to become choked up with mud and other vegetable matter, which is sure to accumulate, if not carried away by a brisk run of the water in the drains. All drains made upon what is generally termed a dead-level, soon become useless; therefore, the great point to attend to for the keeping of drains in a clear state is, to give them a good brisk run for the water, as it issues from the sides. However, caution is necessary lest this should be overdone; for if the ground be sandy or gravelly, a rapid descent would prove dangerous by undermining the sides of the drains: consequently, it should always be observed, that where the soil is light and sandy, just so much descent should be given

to the drains as will carry the water briskly along, and prevent stagnation; and where the soil is stiff, a quicker descent may be given, if thought necessary.

All main drains should be made in the lowest parts of the ground to be dried, and they should increase in size, according to the quantity of water they may have to contain. All sub-main drains should be made in a position between the main drains and the smaller ones; and as they are intended to collect the water from the smaller drains, and convey it to the main ones, they should be of a convenient size between the two. All open drains in a wood ought to be examined and cleaned once in two years; for if they are not attended to in this manner, they are apt to choke by vegetable matter lodging in them.

SECTION VI.—LAYING OUT ROADS IN NEW PLANTATIONS.

In all plantations of any considerable extent, it is absolutely necessary to have vacant tracts left through them unplanted, in the form of roads; and in laying these off in a new plantation, care should be taken to see that no part of the wood should be above one hundred and fifty yards distant from some one of such roads. The necessity of this precaution will appear evident, when it is taken into consideration that the trees, when grown to any

considerable size, will have all to be carried from the interior to some one of such roads, in order to have them taken away in carts; and when the trees become large, and require to be carried a considerable distance, much valuable labour must be wasted before they can be laid down cart-free by the men.

The roads in a plantation need not be made more than fifteen feet wide. In all cases, however, they ought to be so broad as to allow two carts to pass one another with freedom, when laden with wood.

When the roads are marked off, which of course ought to be done previous to the ground being planted, they ought to be divided from the rest of the ground by a drain of sixteen inches deep, running along each side of them, throughout their whole extent, whether the ground may be wet or not. The drains are meant not only to keep those roads in a dry, firm state, but to give them an appearance distinct from the rest of the plantation; and being thus drained on each side, they are not apt to be cut or damaged, by a cart or any other wheeled carriage passing along them; and when thus kept dry, they form a fine ornamental green ride, for the proprietor and his friends at all times, as well as answer the purposes of accommodation in wood operations.

If there be any particularly romantic-looking spot within the bounds of the plantation, the road should be made to take a turn in that direction; or if there

be any particular height from which a distinct view of the surrounding country may be had, make a road to pass by it, with a narrow foot-path leading to such a height. In short, in making roads through a plantation, as well as in making walks through pleasure grounds, good taste and ornament should be kept in view; and it is as easy to do any piece of work well, as otherwise.

CHAPTER II.

SEASON OF THE YEAR BEST ADAPTED FOR PLANTING OPERATIONS.

—DISTRIBUTION OF YOUNG TREES, SO AS TO SUIT THE DIFFERENT SOILS AND SITUATIONS IN A NEW PLANTATION, AND HABITS AND PECULIARITIES OF THE VARIOUS SPECIES.—DIFFERENT METHODS OF PLANTING YOUNG TREES, AS PRACTISED BY FORESTERS.—HOW TO CHOOSE YOUNG FOREST TREES, WHEN BUYING THEM FROM PUBLIC NURSERIES.—UTILITY OF PROPRIETORS HAVING THEIR OWN HOME NURSERIES.

SECTION I.—SEASON OF THE YEAR BEST ADAPTED
FOR PLANTING OPERATIONS.

MANY practical planters have laid down that the months of March and April are the only proper months or season of the year adapted for planting operations. For my own part, I have planted extensively at all times between the months of November and April, both included, while the weather was fresh, and have had equal success from planting in all the different months. I may, however, say, that I always prefer the months of November and December for the planting of hard wood, and those of February, March, and April, for the planting of the fir and pine tribes. If the ground intended to be planted be naturally dry, I put in both hard wood and firs in the months of November and December; but if the ground be naturally wet,

and the drains only recently made, I delay planting such ground till the spring months.

Where planting operations are not carried on extensively, it may be an easy matter to delay till a certain time in the year, as the private opinion of the party intrusted with the work may suggest to him; but where three or four hundred acres are intended to be laid down in wood, in one season, it is always found necessary to take advantage of the whole season, from November till April, whenever the weather will permit, in order to have the work all done before the growth of the plants begins, which is generally about the middle of April. Those who advocate planting in the spring months only, say, where planting operations are to be executed upon an extensive scale, "put on the greater number of men, and have the work done in the shorter time;" but I beg to say here, that those who advise to put on a great number of men, in order to have the planting of a piece of ground quickly accomplished, are not worthy of the name of practical foresters; and cannot have had much experience in the results of such operations, as performed at different times, and under different circumstances.

Every experienced planter who has had occasion to employ a considerable number of men, in order to get through his work as fast as possible, is aware of the difficulty there is in getting a large number of labourers from any neighbourhood properly qua-

lified to conduct the operation well, and as it ought to be done. Common country labourers are seldom acquainted with planting operations, and require at least a few weeks' practice before they can be safely trusted; therefore it is, that when a number of inexperienced men are brought together to plant, the work is always badly done; and, consequently, is seldom attended with success in the end. In planting extensively, my method has always been, to prolong the season of operations, and with a few experienced men to do the work in a proper manner; and by so doing, I have generally been very successful.

In reading the above assertion, many may be inclined to say, that if the weather were to prove unfavourable, it would be impossible to get through an extensive piece of planting with a few men in one season; and, at first sight, there appears, indeed, some reason in this objection: but I answer, that very much depends upon the proper management of the work in hand. In planting extensively, with a few good hands, I do not generally begin at one end or side of the plantation, and make good all the ground as the work proceeds, as is the custom with many planters who employ a great number of men at once. In almost every piece of ground laid out for an extensive new plantation, there is generally a variety of soils and situations in it, and of this variety of soils and situations I always take the advantage, thus:—when the wea-

ther is fine and fresh, I set the men to plant upon the most exposed sides or parts of the ground, and also to plant any piece naturally wet; and when the weather is cold or wet, I set them to plant upon the most sheltered parts, or where the ground is naturally dry; and in the case of frost coming upon them, I always reserve the making of pits for hard wood, which can be done during frost, and is still carrying on the work, and at the same time keeping the workmen in employment. In short, by conducting planting operations in the manner above referred to, ten good experienced men will do far more work in four months, than twenty inexperienced ones in two months; and, what is of more importance, the work by the few hands will be much better done, and prove far more satisfactory in the end. Not long ago, I had an interview with an old forester of fifty years' extensive and successful practice, who, upon conversing with me upon the point now under consideration, told me, that his rules for planting, for the last twenty years, had been, to plant dry ground in autumn, either with hard wood or firs, and to plant ground naturally wet in spring. Also to plant dry ground in wet weather, and ground naturally damp in dry weather; to the advantages of which method I can myself bear testimony from my own experience, and any planter who will go to work upon these principles, will find the happy results arising therefrom.

SECTION II.—DISTRIBUTION OF THE YOUNG TREES,
SO AS TO SUIT THE DIFFERENT SOILS AND SITUA-
TIONS IN A NEW PLANTATION.—HABITS AND PECU-
LIARITIES OF THE VARIOUS SPECIES.

Next to the draining of the soil, nothing is of more importance, in order to insure the future welfare of any young plantation, than the proper adaptation of the different sorts of trees to the various soils and situations therein. This is a point in arboriculture which has all along been too little attended to by planters in general; and the not attending to this point, is in a great measure the reason that we at the present day see very many of our home plantations, in Scotland, mere eye-sores rather than ornaments. I have often regretted very much to see larch and Scots firs of thirty years' standing in an unhealthy and dying state, where if beech, or any other of the native sorts of hard-wood trees, had been planted, they would undoubtedly have proved both useful and ornamental; and again, as often have I seen stunted-looking hard-wood trees striving for existence, where if firs or pines had been planted instead, all would have been well; which at once shows the low state of arboricultural knowledge among us. Upon a little reflection, it must appear evident to every inquiring man interested in the welfare of our home plantations, that a forester, in order to be one profitably, must be per-

fectly acquainted with the natural habits, constitution, and peculiarities of every tree that he attempts to cultivate; for if he is not so, the ultimate result of his work must in a great measure be left to chance. I by no means wish to say any thing lightly of the qualifications of foresters; but, at the same time, I feel in duty bound to say the truth, and that is, that taking foresters as a body of men, there is extremely little of useful practical information among them; and in order to prove the truth of this assertion, I may say, that foresters in general are not so able to cultivate the trees which grow under their notice, upon natural principles, as we find gardeners do the plants under their notice. And, admitting this, what is the reason of such a deficiency in their professional character? So far as I have been able to trace the cause of this defect among my brethren, I am led to think, that it is the want of having proper sources of information upon their business. Gardeners have been assisted by the advice of many able and scientific men, who have written much for their instruction; while the forester has had very little indeed written for his information. It has often been observed, that gardeners make better farmers and foresters than any other class of men; and it is the truth; but the reason is, that they have, or rather are obliged to have, a closer acquaintance with the nature of plants than any other class of men. A

gardener cultivates several thousand of distinct species of plants; and yet he is generally able to adapt each species to that sort of soil which is found to be best suited to its nature. The gardener, in cultivating a *heath*, for instance, gives it a light, sharp, mossy soil and a cool dry situation; and he does so because he knows that the heath, in its native country, is an inhabitant of a light dry soil, and hilly or mountainous situation; and so on with every other plant he cultivates. Now, the principal thing to be observed here is, that the gardener who cultivates his plants with the most success is he who can by his art give his plants most nearly that soil and situation which is found to be their condition in a state of nature; which is just the point that the forester ought to attend to also.

Foresters, knowing that trees in the natural forest develop themselves to the greatest magnitude there, ought to make themselves aware of the particular circumstances which induce or assist that full development; and upon knowing the peculiar circumstances attending the full development of each species in the natural state, they ought to make their practice agree therewith; which is the only way that any man can arrive at perfection as a forester.

I shall here give a short statement of the natural peculiarities of the principal sorts of trees grown in our home woods; and also point out the particular circumstances which are favourable to the healthy

growth of each species. Such a statement will, I am persuaded, prove useful to proprietors, and also to foresters who may not have had long experience; at least, it appears very evident to me, that such knowledge is necessary to both proprietors and foresters, and if acted upon, would be the means of removing that very bad practice among arboriculturists, of planting all sorts of trees promiscuously in any soil or situation.

The ELM TREE (*Ulmus campestris*) is a native of Britain, and is found growing naturally, or in a wild state, in many parts of England. It is considered one of the finest and tallest of our European timber trees for park scenery, and lives to a considerable age. There are many elms in England and Scotland which exceed two hundred years of age; however, it appears to me, that the most profitable age of the elm, as a timber tree, is between sixty and seventy years—the wood of the tree is then in its best condition, and after that age it will not increase materially in the bulk of its available timber.

The quality of the wood of the elm depends entirely upon the nature of the soil and situation upon which it is grown. When grown in a low, sheltered situation, and upon a heavy soil, the elm attains its greatest bulk of timber; but then the wood of trees grown in such a condition is generally brittle, and is soon affected by *rot*; in fact,

very few trees grown in such a condition are found sound in the heart if they have attained any considerable size. Where the elm is found growing in a low, sheltered situation, and upon a light soil, the tree grows very rapidly, and attains its greatest perfection as a tall spreading ornamental tree; but under such conditions the tree seldom lives long, and generally is found to die suddenly when rapidly grown. Another peculiar circumstance attending elm trees grown in a sheltered place and upon a light soil is, that they are generally found what is termed "shaken;" that is, the heart wood of the tree is all split into longitudinal pieces, consequently the wood of such trees is of little value.

Upon a high and exposed situation, the elm succeeds best upon a light dry soil; but if the soil be stiff it will not succeed in developing any thing like valuable timber. In situations twelve hundred feet above the level of the sea, I have seen good valuable elm trees growing upon a light and rather sandy soil; but at the same height, when the soil was inclined to clay, I have always seen the elm assume a low spreading habit, and very apt to become knotty and of little value as regards its timber.

The circumstances which are most favourable to the healthy growth of the elm are, a dry loamy soil, rather deficient in vegetable matter, which would produce too keen an excitement to the growth of the tree, a free exposure to the open air, and

the situation upon a slope rather than upon a level.

In the forest the elm tree requires considerable space in order to develop itself properly; the natural habit of the tree is to spread out its branches horizontally, and if much confined by its neighbours, it becomes drawn up and weakly, and does not grow well to timber.

The BEECH TREE (*Fagus sylvatica*) is a native of Britain, and is found growing naturally in almost all old plantations. It is a very ornamental tree upon a lawn or park, and often attains even greater dimensions than the elm, and lives to about the same age. The beech is not considered a valuable timber tree, although it bears a strong massive appearance; the wood is very brittle and short-grained, and not well adapted for purposes where strength and durability are required. It is a tree which, from its accommodating habits, is well fitted for growing in a forest among others; but, upon account of the little value now set upon its wood, it is not extensively introduced among other more valuable trees in modern plantations. However, few trees suffer less from bad management than the beech; although it may have been overburdened and crushed down among other trees, yet, when it is once relieved, it will shoot up again, and in a few years make good its position among its neighbours. Upon poor, thin, sandy soils, and even

in a high and exposed situation, no hard-wood tree is more worthy of a place. I have seen the beech grow well upon a soil and situation where almost no other tree could have existed, not even the Scots fir. In a high-lying dry situation, with a free circulation of air, the beech lives to its greatest attainable age; and in a low situation, with a rather humid atmosphere, the tree reaches its greatest size; but in such a state it generally dies quickly after attaining full size.

The circumstances which appear most favourable to the healthy development of the beech are a dry and rather light soil, with a considerable proportion of lime or chalk.

I have often had occasion to remark healthy beech plantations in all sorts of soils, from a stiff clay to a light sand; and, in my opinion, this accommodating nature of the tree is the reason why we so often see at the present day so many old beech trees about the seats of proprietors in Scotland.

The ASH TREE (*Fraxinus excelsior*) is a native of Britain, and a well-known tree. It is considered one of the most useful of all our hard-wood trees for general country purposes, and is much sought after by carpenters and coach-builders. A peculiar characteristic of this tree is, that the quality of the wood is always the better from being rapidly grown, the opposite of which is the case with most other trees. On very poor soils, where the ash grows

slowly, the wood is brittle, and soon affected by the rot; but where the growth has been vigorous, the timber is very tough, elastic, and durable. The ash never attains such thickness as some of the other forest trees. Upon the estate of Arnistoun, in Mid-Lothian, there are ash trees fifteen and sixteen feet in circumference; but trees of such large dimensions are not numerous, neither is it necessary that the ash should attain such a large growth, considering that smaller trees always yield much better timber. From its upright habit, the ash forms one of the best trees for a forest; in fact, many other trees are improved by growing along with it, particularly the larch, which is almost always found healthy when growing among ash trees.

The circumstances which are found favourable to the healthy development of the ash are—as regards soil, a good strong loam, rather rich than otherwise, and rather moist than dry; that is, the ash does not disagree with a little moisture, provided that this moisture have free and ready access away from the roots, and is not liable to remain in the least degree stagnated. The ash is often found of large dimensions growing upon bare rocks; in such cases, the roots of the tree get into the seams of the rock, and are watered by the moisture which descends between the strata. The ash is fonder of shelter than either of the other two trees I have already described; therefore, to grow it well, it is

an advantage to plant it in a hollow or glen, or in the interior of a large plantation.

The GREAT MAPLE, or SYCAMORE, (*Acer pseudo-platanus*,) is supposed by some to be a native of Britain, and by others of the continent of Europe. This tree is more generally known by the common name of the *plane* tree, which is the *platanus* of botanists, and is originally from the Levant. The sycamore grows to a large size, and lives to a great age. There are many sycamores in Scotland, at the present time, which I have myself measured, and found nearly twenty feet in circumference and sixty feet high. It is not a tree that carries height along with its girth, when compared with many other forest trees; but it is, notwithstanding, a magnificent tree, and few, if any other, can vie with it upon the lawn or park. It is a fast-growing tree, well adapted for almost every situation, and well worthy of a place in every forest where the soil is not damp nor mossy, nor the situation too much exposed; it being a rapid-growing tree, it requires room to develop itself properly. The timber is reckoned of equal value with that of the elm when of good size.

The circumstances which are found most favourable for the healthy development of the sycamore are—soil, dry, sandy loam, with a free exposed situation—as in the open parks about gentlemen's home grounds: however, this tree may be profit-

ably planted in almost every situation where the beech will thrive, but it will not succeed in a damp or mossy soil.

The various species of POPLAR (*Populus nigra* and *P. alba*) are trees well worthy of a place in every forest where the ground is suitable to them; that is to say, where the ground is heavy and rather damp, and in a sheltered situation; but they will not succeed if planted upon a high-lying dry site.

The poplars are all quick-growing trees; and although the wood is soft, it is a good deal sought after. I have known poplars of thirty-five years of age sold for five pounds each. The circumstances which are most favourable to the healthy and full development of the poplar are—a rather damp, heavy soil, with a sheltered situation.

The WILLOWS (*Salix alba*, *Huntingdon willow*, and *Bedford willow*) are all good timber trees, and are equally deserving of a place in the forest as the poplars above mentioned are.

The wood of the willow tree is tougher, and sells at a higher price, than that of the poplar. The circumstances favourable to the growth of the willow tree are the same as those already stated for the poplar.

The BIRCH TREE (*Betula alba*) is a native of Britain, and found in great abundance in many high-lying dry situations. It is found very useful for the planting up of any poor, thin, stony parts,

where nothing else would make a valuable cover. It will even thrive in a soil rather damp; but it is observed that the largest and healthiest trees of the species are always found upon a dry soil, which circumstance at once points out that a dry situation is most favourable to their healthy development. The wood of the birch is not reckoned a valuable timber; it is principally sought after by gunpowder manufacturers, who buy it after it is stripped of the bark.

The ALDER TREE (*Alnus glutinosa*) is, like the birch, a well-known tree in Scotland, and very common in its natural or wild state in many parts of the Highlands. It is a tree particularly well adapted for a damp piece of ground upon a high situation, where nothing else more valuable could with advantage be put in. The alder, like the birch, is not considered a tree of much value, and should always be dispensed with where any tree of greater worth would grow. I have found it extremely useful when I have planted extensive plantations upon high moor grounds; in such situations, there are often damp mossy spots included within the bounds, on which it will succeed well after the ground has been partially drained.

In travelling through the Highlands of Scotland, we often meet with large tracts of natural birch and alder; and upon examining the position of those two different trees, as found in their native glens, it is

at once observed that the birch chooses the high and dry spots, while the alder is seen luxuriating in the swampy, low-lying grounds, and this at once points out the circumstances favourable to the growth of each. The alder, after being stripped of its bark, is used for making charcoal.

The OAK TREE (*Quercus robur*) is the most valuable of all our timber trees. The oak is well known to be a long-lived tree, and its wood to be of great durability. There is one point relative to the oak which may not be so well known, and which I think it proper to refer to here; and that is, that there are two species of oak generally found growing in our forests—the one the true British oak, and the other a species evidently introduced from the Continent at a very early period, and which is of a very inferior quality as compared with our true British oak. The *Quercus robur*, or true British oak, has the acorn-stalks long, and its leaves short, firm, and set-looking; whereas the one introduced, and of inferior value—*Quercus sessiliflora*—has the acorn-stalks short, and the leaves long. The acorns of the former grow singly, those of the latter in clusters.

The forests upon the continent of Europe consist chiefly of the *Quercus sessiliflora*, and it is well known that the timber from those forests is worthless; and it is to be regretted that such worthless oak is becoming abundant in Britain. I am informed

that the greater part of the New Forest in England is composed of the *Quercus sessiliflora*. It is certainly worthy of the attention of Government to have properly experienced men appointed, in order to point out and collect the seed of the *Quercus robur*, and have it decidedly introduced instead of the other bad sort which, it is evident, is gaining ground in our forests every year.

Even every landed proprietor in Britain, who has occasion to plant oaks, should be particular in having his plants reared from acorns of the true species, either by raising them upon his own grounds, or giving a good price to a respectable nurseryman in whom he can place confidence. By such careful means of going to work, the true species could very soon be introduced into every part of the country. It is often remarked that "the oak used to be a wood almost indestructible by time when put into the building of a house; and now, oak is no better than almost any other wood, whatever purpose it may be used for." There is no doubt that this assertion is to a great extent well founded; as we see, on the one hand, from many instances of old oak beams still remaining in several old buildings in the country, and on the other, from the short period that the greater part of the oak now used is known to keep in a sound state when used for any purpose whatever; and the superiority of the old oak beams is to be

traced to the fact, that at the time of their being used, there was scarcely any other sort of oak in the country but the *robur*, or true sort, of which sort the old beams consist.

Few trees are more hardy than the oak; it accommodates itself to almost any soil or situation: but, notwithstanding this vigour and hardihood of nature, it will not develope itself to perfection unless it have a good dry loamy soil, with some shelter. The largest oaks that I have ever seen grew upon a dry sandy loam, with a free exposure to air; however, although the oak may attain its greatest dimensions under such circumstances as these, we find it growing to the size of useful timber wherever it has the advantage of a soil with a dry bottom, and not too much exposed to storm—as for instance upon the top of a bare hill. The oak will not thrive nor live long in a deep mossy soil.

The HORSE CHESTNUT (*Æsculus hippocastanum*) is a native of Asia, and upon account of the softness of its wood, is not much esteemed as a forest tree; it is, properly speaking, an ornamental lawn tree, and should not, in my opinion, be planted in a forest as a timber tree in this country. It requires shelter and a good rich soil, under which conditions it is an extremely rapid-growing and very ornamental tree.

The SWEET CHESTNUT (*Castanea vesca*) is a native of Britain, and grows to very large dimen-

sions, but is not now much esteemed as a forest tree—the oak, being more valuable and hardy, is in all cases preferred. The wood is seldom sound when the tree has arrived at full maturity; however, it makes a very fine ornamental tree upon a lawn or park, and it requires a good strong soil and considerable shelter, in order to make it develop itself properly.

The LIME TREE is properly an ornamental lawn tree, and very seldom introduced into the forest. The wood is valuable when of a large size, but as it requires a sheltered situation and a pretty strong soil to make it grow large and valuable, it cannot with propriety be recommended for the forest.

The SCOTS FIR (*Pinus silvestris*) is a native of Scotland, and is a well-known tree throughout the whole of the north of Europe. It is found growing naturally in many parts of Scotland, particularly in the native forests of Iqvercauld and Rothiemurchus, where there are by far the finest specimens of this tree to be found in Britain. The Scots fir, in favourable situations, attains a very large size, frequently eighty feet high, and three and four feet in diameter. Next to the larch, it is the most valuable of what is generally termed the *fir tribe*. The timber of the Scots fir is much influenced by the soil and situation upon which it is grown; that produced upon the cold high districts of the north of Scotland, is found superior to any imported from

any other part of Europe; while that which has been planted and reared in the Lowlands is not nearly so good. Even within the Lowlands themselves, the quality of the Scots fir is very much influenced by the particular situation upon which it is grown; and as an instance of this, I may here mention that upon the estate of Arniston, the Scots fir growing upon the high and exposed parts of the estate is of excellent durable quality, while that growing in sheltered parts of the home plantations is extremely worthless and soft; and this same observation relative to the quality of the Scots fir, as affected by situation upon the estate of Arniston, is equally applicable to every other estate in the Lowlands; the best timber always being obtained from trees growing upon a thin soil and a high exposed situation.

There are two varieties of the Scots fir, the *Pinus silvestris*, and the variety *montana*, which is the true *Highland* or *Bonnet fir*. The late Mr Don of Forfar says, "that the *montana*, or true pine, is distinguished by the disposition of its branches, which are remarkable for their horizontal direction, and for a tendency to bend downwards close to the trunk. The leaves are broader and shorter than in the common kind, and are distinguished at a distance by their much lighter and more beautiful *glaucous* appearance. The bark of the trunk is smoother than in the common kind; the cones are thicker,

and not so much pointed. The plant is also more hardy, grows more freely in almost any soil, and quickly arrives at a considerable size." Of the truth of this assertion of Mr Don's, I am perfectly satisfied, although many botanists will not allow that these two species are really distinct; they say that soil and situation have the effect of changing, in a great measure, the external appearance of this tree; but those who so assert cannot have had much experience of them. I have myself seen, and that very often, the two distinct species growing in the same plantation, and close to one another; now, were it the case that soil and situation changed the external appearance of the trees, why were they found to have different external appearances when growing upon the same soil and site?

There is another feature which is very remarkable in the true pine as compared with the common one, which is this. The boll of the true pine, or *Bonnet fir*, when standing singly in a park, rises to a considerable height before it sends off any horizontal branches; the branches, as it were, form a bonnet on the top of a pole, whence the origin of the name of bonnet fir; whereas the boll of the common sort, if left to grow singly upon a park or lawn, sends out branches almost from the very ground.

The Scots fir, in its natural state, is found clustering together in one mass, seldom associating with

any other sort of tree ; indeed, this is the case with all the pine tribe—each species being generally found congregated by itself. With reference to the common Scots fir, the best timber trees for general purposes are raised where they are standing pretty close in one mass ; but the most picturesque form of this tree is found when standing singly, and has room to spread out its branches. When grown in one mass close together, the trees are found clean stemmed, and drawn up to a great height ; consequently, such trees are available for many purposes, whereas, when standing singly, the tree is generally found short-stemmed, thick, and branchy.

No tree, a native of Britain, can with more safety be planted out into any soil and situation, provided only that soil be a dry one. I have seen a crop of good Scots fir timber taken off almost every sort of soil, of an earthy or stony nature, but upon a mossy soil I have never seen good Scots fir timber grow.

The NORWAY SPRUCE FIR (*Abies excelsa*) is a native of the north of Germany and Russia, and is a beautiful and stately tree. It is now widely dispersed throughout Britain, particularly in the Lowlands of Scotland. It is a hardy tree, and, when planted in a favourable situation, soon grows to useful size. It is not so valuable in its timber as the Scots fir ; but from its rapid growth, and from its tendency to grow in a rather damp situation, where the Scots fir would not succeed so well, it is

often preferred. It is the tallest of all the European firs, and forms indeed a majestic object when grown detached. In the home woods upon the estate of Arniston, many of the spruce firs rise to the height of eighty and ninety feet, with a diameter of two feet and a half. It is not so hardy as the Scots fir, if planted upon a high situation; in fact, upon a dry soil and a high situation, it does not attain to large size, and is soon affected by *heart-rot*. The circumstances which appear most favourable to the healthy and full development of the spruce fir are, a good strong loamy soil, and rather a low-lying sheltered situation. The spruce fir thrives in a soil rather inclined to damp than otherwise.

The SILVER FIR (*Picea pectinata*) is another excellent timber tree for the forest, and is not cultivated to the extent in our plantations which its value demands. In every respect, the observations made relative to the spruce fir are applicable to the silver fir, only, I may add, that the silver fir is even a more hardy tree than the spruce.

The LARCH (*Larix Europæa*) is one of the most valuable of the pine tribe. It is a native of the mountainous districts of Germany, and is found to endure the climate of Scotland equally as well as the Scots fir, but is more particular with regard to the circumstances which favour its healthy growth than that tree. As an instance of the success of the

cultivation of the larch in Scotland, I may refer to the plantations of the Duke of Athol in Perthshire. There, some of the larch trees were to be seen one hundred feet high. Upon the estate of Arniston, there are several larches above eighty feet high; and one, in particular, is yet growing, which contains above one hundred and fifty cubic feet of timber, and is apparently quite sound.

There are two varieties of the larch generally cultivated in Scotland, the white and the red. The white is the variety which attains the greatest dimensions of timber, and is the sort most generally cultivated, although they are both often seen growing together in the same plantation, and that by mere accident. It is said, that upon the Athol estates the red larch does not contain above one-third the cubic contents of timber which the white larch of the same age does; and this is observable in every plantation where the two varieties are found growing together.

No timber tree at present cultivated in our woods, begins to repay the expense of culture nearly so soon as the larch does. It is a rapid-growing tree, and is well adapted for almost every country purpose. It generally sells at nearly double the price per cubic foot that Scots fir brings, and, besides the price of the wood, the bark is available for tanning purposes. For some years past, the larch has been subject to disease in our plantations in Scotland,

which circumstance has caused considerable sensation among planters in general; relative to which I intend to speak hereafter, as may be seen in its proper place in this book. (See *Cause of Disease in Larch Fir Plantations.*)

The circumstances which are found favourable to the healthy development of the larch are,—as to soil, it is not particular, but the roots must have a constant supply of water, in order to keep the earth in which they grow in a pure state, as is the case upon all rugged mountain slopes, where there is a continual descent of water from the higher ground to the lower.

Having now briefly stated the peculiarities of each sort of forest tree which is generally cultivated in our plantations, for the sake of timber, &c., I may add further, that all deciduous hard-wood trees, to grow them properly, require more shelter than the firs or pines do; consequently, in all cases of planting a piece of ground upon a gentleman's estate, the hard wood ought to be planted upon the most sheltered parts, always keeping the firs and pines upon the high and exposed districts. And this is only imitating the proceedings of nature in the same operation; for, in the natural disposition of trees over the surface of the earth, the firs and pines inhabit those cold high-lying districts where the soil is thin, and the oak, ash, elm, &c., inhabit the more temperate regions nearer the equator.

The hard-wood trees, to grow them well, require a heavier and a richer soil than the firs do ; which suggests to us, that in laying out a new plantation, the hard wood should be planted in the heaviest and richest parts of the soil contained in it.

The planter being possessed of a knowledge of the soil and situation adapted to the healthy growth of each species of forest tree, his duty is, in the planting of a piece of ground with forest trees, to plant those sorts which, from his knowledge, he has reason to expect will succeed upon it. With this view he may proceed thus :—Let him examine the nature of the soil throughout the whole extent of the ground designed for planting, and, having done so, consider what sort of tree will succeed best, for a permanent crop, upon each different soil and situation that may be contained within the bounds of the intended plantation ; and, having determined this point, proceed to have pits made for all hard-wood trees intended to be put in—say at eight feet distance from each other. Wherever the soil is found of a loamy nature, and the situation is not too high, plant oak, ash, elm, or plane-tree, at the distances specified ; but in all cases giving the preference, in number and extent, to that species which is supposed to be most likely to succeed best upon the soil ; and observing, in all cases where it is intended that one sort of hard wood alone shall be the ultimate crop, to plant no other kind of hard

wood among them; that is, if you wish to have any particular part of a plantation to be entirely an oak forest ultimately, plant those in pits at eight feet distance, and make up to the requisite thickness with firs, generally Scots and larch, which are only intended to act as nurses to the hard wood, and to be cut down by degrees, in order to give the latter room as they rise up and fill the ground. Where it is intended to have a mixed hard-wood plantation, distribute the different sorts in accordance with taste, and make up to the desired distance, which is generally about forty inches, with firs.

Having planted all the better parts of a plantation with hard wood, as above mentioned, if there be any thin heathy parts, which would not raise such wood to advantage, occupy such parts entirely with firs; and in doing so observe that, if it be considered that larch trees would grow to any useful size, but not so as to be relied upon for a permanent crop upon the ground, then plant Scots firs, say at seven feet apart, for a permanent standing crop, and make up to the desired thickness of about three feet, with larches, which can be thinned out as the Scots firs require to have room—and in this manner the larch thinnings will come to pay well; for, if the entire crop had been Scots firs, little or no value could have been got from them by the first thinning—the larch being always valuable when young, while the Scots fir is not.

If, in planting a new plantation, there are found spots of ground lying very high, with an extremely thin, poor, sandy soil, upon which it would be doubtful if even Scots firs would attain useful size, or live long as a permanent standing crop, plant upon such spots, one half Scots firs, and the other half birches and beech, of each an equal number per acre. By so doing, if the Scots firs happen not to succeed, as is very likely upon a high-lying sandy soil, then the birches and beeches are sure to keep the ground; and, although they may probably never come to be a valuable crop of timber, still it is desirable to have a cover, though but for the sake of shelter, upon such portions of the land.

If, on the other hand, there are any low-lying, damp, swampy parts in it, make up such parts with alder, birch, and spruce firs; and give the preference in number to that sort which may be considered most likely to succeed best as a permanent crop; and, when they come the length of thinning, it can then be judged which sort will stand, and which should be taken away.

If there be any rugged precipices or steep glens within the bounds of a new plantation, plant larches and oaks, in equal proportions; and, if it is considered necessary for the sake of shelter, plant a few Scots firs upon prominent points; and in any hollow parts of such grounds, put in poplars or willow-trees, or, if not too damp, spruce firs.

If the situation to be planted be near the sea, no plant, in the form of a forest tree, will succeed so well, as a nurse for others, as the PINASTER, or cluster pine. Upon situations near the sea-coast, it is often difficult to get trees of any description to succeed to any considerable extent, even so as to make a moderate shelter; and it is in such situations that the pinaster is found useful.

Upon the estate of Dunskey, the seat of Colonel Hunter Blair, in Wigtonshire, it was found impossible to grow almost any thing like trees, until the pinaster was planted upon the heights along the sea-shore; and now, since those have risen up,—and they grow very rapidly,—the different sorts of common hard-wood trees are thriving well behind them. In such a situation, they do not, of course, rise up so as to make valuable timber themselves, yet, as they grow very bushy, they form an excellent shelter for trees inland, and by the shelter attained from them, the more valuable trees behind succeed, which is the end in view in planting them.

SECTION III.—DIFFERENT METHODS OF PLANTING YOUNG TREES, AS GENERALLY PRACTISED BY FORESTERS.

In the planting of forest trees, two different methods are in practice among foresters: the first is the method of planting in *pits*; and the second,

the method of planting in *notches*, either with the common spade, or the planting mattock. The method of planting in *pits* should be employed for all hard-wood trees, for two years' transplanted larches and Scots firs, and for three years' transplanted spruce firs. These pits are made with the common spade, at the regular distance of from four to ten feet, as the case may be; that is, if the whole of the plantation intended to be done, is to be planted with hard wood and two years' transplanted firs, then the whole ground will require to be pitted to the distance required, but observing to make the pits for the hard wood larger than those intended for the firs; and in order to do the work properly, make all the pits for the hard wood first, say sixteen inches on the side of the square, and fourteen inches deep, and having the pits for the hard wood made at the distances, say of ten feet from pit to pit, make those for the firs nine inches on the side of the square, and ten inches deep, and just as close one to another as may be considered sufficient for the nature of ground, say three-and-a-half feet over all. If after having the pits made for hard wood upon a piece of ground, it may be found advisable to plant up with one year's transplanted firs, then no more pits will require to be made there, for it is not necessary to be at the expense of making pits for any firs which are under two years transplanted.

In the making of such pits as are above described, I generally let the work by contract, and I cause the contractor to cut off the upper turf as thinly as possible, and lay it on one side of the intended pit; and in taking out the soil, in the act of making the pit, I cause him to lay it upon the opposite side, which comes to be of great advantage in the act of planting: and where the soil is hard in the pit, the pick must be used to open it up to the desired depth. I have generally got pits made for hard wood, to the dimensions already named, for 1s. 6d. per hundred, and those for firs, for 1s. per hundred; but if the pits have to be made among old roots, where large trees have formerly been, 6d. more per hundred in each case may be considered a fair price.

In the case of planting up a piece of ground among old roots, the remains of former trees, the pits should be made at least two months previous to commencing to plant in them; by having the soil in the pits a few weeks exposed to the influence of the atmosphere, it becomes much more healthy and congenial to the roots of young plants.

The manner of planting the young trees in those pits must be regulated according to the nature of the situation of the ground to be planted: that is, if the situation be a low sheltered one, I plant a tree in the centre of each pit, and, cutting the

turf which comes off the surface of the pit exactly into two halves with the spade, I make them fit closely upon the young tree, with the grass side uppermost; but if the situation to be planted by the method of pitting be an exposed one, then I plant a tree in one of the corners of each pit, and by so doing it is kept firm in its place by having a rest against the firm sides of the pit: and here let me observe, that this method should always be practised when the trees are apt to be blown about by winds and storms. In planting trees in such pits, great care is necessary to see that they be made perfectly firm in the new soil of the pit. But in making the trees firm in the pits, no tramping or beating with the feet should be allowed, until the whole of the earth be put in; for if the planter begin to beat the earth upon the roots of the young tree, while they are only half covered with soil, he is sure to do them injury; and, knowing the evil of this from experience, I never allow a man to beat the earth about the roots of a young tree, until he has it all into the pit, when a good firm tramping with the feet is necessary, in order to keep the plant properly in its place until its roots take hold of the soil. After the earth has been all put into the pit and made firm, the turf should be put over the whole as closely as possible, and made firm in order to keep out the drought.

A few weeks ago I had a conversation with an

extensive proprietor of land in the north of Scotland, who, while speaking to me relative to the different methods of planting trees, said that he was of opinion, that the plan of making pits for young trees was altogether superfluous, and ought not to be practised; because upon his estate he had hitherto planted by the same method, and found that the pits when made were only receptacles for holding water. Now, as it is possible that many other proprietors may hold the same opinion, I here beg to make a few observations relative to the good arising to young trees when planted in pits.

If the roots of a young hard-wood tree, or a two years' transplanted fir, are put into the ground, merely by a simple opening with the spade, they are so soft and tender, that they are unable to push their way through the solid earth in search of food, and the natural consequence is, that if the tree does not altogether die, it grows weakly, and is long in attaining the character of a healthy tree. If the soil be of a damp open nature, the tree may succeed well after the roots become strong enough to push their way; but if the soil be naturally poor, and of a binding quality, the probability is that the trees planted in it without pits will die altogether.

As to the pits made for the reception of young trees becoming a receptacle for water, that can only be the case under bad management; for where

the ground has been drained for young trees, the water will not stand in the pits; and where the ground has not been drained in the manner already inculcated, it is not in a fit state for planting trees in; therefore, I repeat again, that it is only under bad management that pits made for young trees can retain water. Where trees are planted in pits made upon land in a dry state, their young and tender roots have at once free access into the open soil; consequently, the trees soon establish themselves in their new site; and, generally speaking, I have found that trees planted in pits, after the manner I have recommended, are ten years in advance of those planted otherwise.

I may here observe, that it is only necessary to plant in pits those trees which are of pretty large size, such as two years transplanted, and upwards; but trees under that age and size, having smaller roots, require to be planted only in the natural surface soil, which is generally free and open to the roots of all small plants.

The method of planting termed *notching*, or *slitting*, is done with the common spade or planting mattock, and is so well understood by all planters, that it would be superfluous to enlarge upon it here. It is the practice most commonly in use for the planting of all small trees, such as two years' seedlings, or one year's transplanted firs. The great point to attend to in this system of

planting, is to see that the cut or notch be properly closed about the young plant after it is inserted, which should be done by the planter using the heel of his shoe in beating the cut all quite close again. The system of notching in trees by the planting mattock, is done upon the same principle as that by the spade, and is generally practised upon a thin hard surface, where the spade could not be used conveniently.

SECTION IV.—HOW TO CHOOSE YOUNG FOREST TREES WHEN BUYING THEM FROM PUBLIC NURSERIES.

Every proprietor who has occasion to plant forest trees to any considerable extent, will find it necessary to supply himself from some respectable nurseryman; and in doing so, it is absolutely necessary that healthy trees should be selected; and also those of such a nature as may be suited to the situation where they are intended to be planted for good and all.

The proprietor who intends to plant, should either himself visit, or cause his forester to visit, during the summer previous to the planting season, any nursery from which he intends to purchase his supply of young forest trees, and see that the stock of young trees in it are in a clean healthy state, and free from all SCALE, BUG, or any other vermin generally infesting young trees.

Such a visit in the summer season may by many be considered an unnecessary piece of work, but every experienced planter can attest to the propriety of it. I have known an instance of diseased trees from a nursery being the cause of propagating the same disease through several plantations in the neighbourhood; but in asserting this, I do not mean to say that any respectable nurseryman would be guilty of sending diseased trees to any of his customers; but I do mean to say, that every planter or forester should, previous to making a purchase, go and visit the nursery grounds, and judge for himself, as to whether he shall buy them or not; and the proper time for such a visit is during the month of July, when the trees are in full leaf and in a vigorous state of growth.

In that month, all young trees should have the bark upon the main stem and branches clean and free from any appearance of *scale* or *bug*; and when a little of the surface skin is removed by the nail of the thumb, the bark under should be of a pure healthy transparent green colour, and not pierced by any small holes; the surface bark of a young tree in perfect health should be easily removed from the inner bark. There should be no appearance of small holes in the leaves at this season of the year; neither should they have the appearance of having been bitten short by any insect.

Having visited the public nursery grounds in the month of July, and found the general health of the young trees quite satisfactory, it will again be necessary for the intending planter to visit the same grounds about the first week of November, in order to make a purchase of such trees as he may require for the season. In making purchase, it is absolutely necessary to bear in mind the nature of the ground and situation to be planted. If the ground to be planted be a thin soil upon a high situation, then choose trees from the nursery that have stood rather widely in the rows, and have had free air and room, and are rather of a low set, bushy character, and altogether presenting a hardy appearance—plants of such a character will suffer very little indeed from being removed to a high climate; and for a high situation, always choose one year's transplanted firs, and hard wood not exceeding two feet in height; if plants of an opposite character be chosen for a high situation—that is, tall, slender plants, which have made long shoots of young wood the previous summer—they will be sure to suffer, and it is more than probable that more than one half of them may die.

If the situation to be planted be a low sheltered one, with a good soil, then choose tall well-grown plants for it; for in such situations there is generally a luxuriant growth of the natural grasses, and unless the young trees be pretty tall, they would

be altogether choked by such a mass of herbage surrounding them. Above all, it is necessary to be most particular in seeing that the young trees chosen be well rooted; that is, having plenty of small fibrous roots, which are the mouths by which the plant derives its nourishment from the earth. In a rather light soil, not too highly manured, the roots of young trees are generally good; but if the young trees have grown in a stiff heavy soil, there is a risk of their being badly rooted; that is to say, they will most likely have few small fibres, and young trees with few fibres never succeed well when replanted—and more especially the *Pine tribe*. Much of the success in the growing of trees in the forest, depends upon a good healthy choice from the nursery; therefore this point should always be carefully attended to by every intelligent planter.

No proprietor should grudge to give a fair price to a respectable nurseryman, in order to have his orders punctually attended to: the gentleman who offers a fair price is always sure to have a good article sent him; when a proprietor offers a low price to any nurseryman for his trees, the nurseryman is not enabled to bestow that labour upon the lifting of the young trees which is necessary to secure the safety of the roots. Trees of the pine tribe, if they are lifted out of the earth carelessly, generally lose one half of their roots, and in such a case the trees cannot grow; therefore, every

planter ought to see that the trees he uses are carefully lifted from the nursery ground.

SECTION V.—UTILITY OF PROPRIETORS HAVING
THEIR OWN HOME NURSERIES.

That every extensive proprietor of land, who has occasion to plant young forest trees to any considerable extent, should have a piece of ground adapted for the raising of a few young trees, is quite consistent with good management in forest operations. I do not here mean to advise, that every gentleman should be his own nurseryman; for the raising of forest trees to such an extent would be altogether out of the question, and such a state of forest operations would come to be found bad management. No gentleman's forester, however well qualified he might be, can possibly have sufficient time and opportunity to attend to the minute operations of raising young trees from the seed, from cuttings, layers, &c.; but I do assert, that a piece of ground kept as a reserve nursery, is absolutely necessary in order to good management.

In order to point out the utility of gentlemen having their own home nurseries, and in order to point out to what extent it is advisable for them to cultivate their own young trees, previous to planting them out into the forest, I shall here detail my

manner of proceeding at Arniston with regard to this operation.

At Arniston, we have about two acres occupied as nursery ground. In it I raise all our own oaks from the acorn; and as I am in the habit of getting a regular supply of acorns, I have ready for transplanting out into the forest grounds about twenty thousand every year successively; and having this piece of ground occupied as a nursery, I am enabled to raise the oaks in it to a pretty large size previous to planting them out, which is of great advantage to us, as we have very many hares and rabbits to contend with; and besides, being tall, they are not apt to be choked by long grass and weeds overtopping them. To get such large plants as I am in the habit of using for our home woods, from the common nurseries, would be quite impracticable to any considerable extent. I do not raise all our oaks to a large size previous to planting them out, but only a part, so far as is required for our home woods. This spring (1847) I have planted out in the home plantations six thousand oaks from three to five feet high, with strong fibrous roots; and, in order to have them strong bushy plants, I give them abundance of room plant from plant in the rows, which is never the case with plants got from the common nurseries. In our nursery ground, I also raise yearly three or four thousand larches to a pretty large size, as also a number of all the

common sorts of trees generally planted in the forest, which, when I have them grown to the desired strength, I plant out into the forest ground to fill up any vacancies which may have occurred among the young plantations; and even in some instances, where a small plantation may be required to have an immediate effect, I have planted up with such large trees entirely.

Now, from what I have said above, my meaning will appear evident in advising proprietors to have their own home nurseries; and that is, that they may have a command of good specimens of all the general varieties of trees to plant out at any time into any parts of their plantations where they may be required. No proprietor's establishment can be said to be complete, as relates to forests, without such accommodation. Without a reserve nursery, no forester can have young trees at command in order to meet the demands of his employer as occasion may sometimes require. Without a reserve nursery, no gentleman can reasonably expect to have forest operations conducted properly. It would be folly to send forty or fifty miles to a nurseryman for a few good trees to answer some particular purpose, when the same could be got more conveniently and more safely from the home nursery; and even after sending for such trees, they might not be such as were expected. Difficulties of this kind I have myself experienced in

certain situations ; but where I have had the accommodation of a home nursery, I have been able at all times fully to meet the demands of my employer, and that also at a very moderate expense ; therefore it is, that having experienced the disappointments attendant upon the want of a reserve nursery, I would here urge every proprietor to adopt the system of having a small one, merely with the view of raising a few particularly good trees, for a particular purpose, and the extent of ground to be occupied as such must be regulated according to the probable demand ; that is, if the forest grounds be extensive, two, or perhaps three acres may not be too much, and if the forest grounds be not extensive, half an acre may be quite enough. In making such a nursery, never let it be in a sheltered or low-lying part, for there the young trees would be drawn up and weakly ; neither make it upon a stiff clay soil, for in such a soil young trees never make good roots—but let the situation be rather an exposed one, with a light friable soil ; there the young trees will become bushy and hardy, and also throw out numerous fibrous roots, which is always favourable to the healthy growth of young forest trees which have to be transplanted.

CHAPTER III.

MANNER OF PROCEEDING WITH PLANTING OPERATIONS.—EXPENSES OF LAYING DOWN LAND UNDER NEW PLANTATIONS.—THE KEEPING OF TREES IN A YOUNG PLANTATION CLEAR FROM GRASS AND WEEDS.—THE NATURE AND NECESSITY OF THINNING PLANTATIONS.—THE NATURE AND PRACTICE OF PRUNING PLANTATIONS.

SECTION I.—MANNER OF PROCEEDING WITH PLANTING OPERATIONS.

IN all planting of young forest trees, the superintendent of such operations should be a man who has had considerable practical experience in that line of work. No man should undertake, or be allowed to undertake, the management of planting operations, who has not had at least ten years' experience in his profession; unless he has had such experience, and that rather upon an extensive scale, he will not be able to judge for himself in any extraordinary contingency. A man who is allowed to undertake planting operations without proper practical experience, is generally put off his way by every change of the weather, and then knows not how to proceed; in such extremities he seeks the advice of others, who, very likely, are as ignorant in the matter as he is himself: consequently, the

mind of an inexperienced man is liable to give in to wrong advice, and then the whole work goes wrong; time is lost, the work is badly done, and, in the end, failure is the sure result. This state of things, I am aware, often happens in planting operations; therefore, for the guidance of those who may not have experience enough, I shall here lay down, in a general manner, the way of proceeding with planting operations as they ought to be done.

The land having been all well drained, when it is intended to plant young forest trees, and the drains having been allowed to act upon the ground for at least one month previous to commencing to plant, and also the greater part of the pits made for any hard wood that may be to plant,—the next important point that the planter has to attend to is the bringing forward the young trees from the nursery. The superintendent of the planting operations, previous to the arrival of the trees upon the ground, must walk carefully over the whole of the land to be planted, and note down in his memorandum book the number of the different sorts of trees that will be required for the planting of each division, as it naturally divides itself according to soil and situation; and having noted this in his book as correctly as he possibly can, he will, upon the arrival of the cart with the young trees, cause to be *sheughed** in a careful manner, in

* Laid in quantities in furrows, to prevent their withering.

each district, the number and kinds of trees required for it.

The number and kinds of trees having been laid down in their respective places, the superintendent of operations will next bring forward the number of men that may be thought requisite for the work to be done; and each man or planter ought to provide himself with a boy for the purpose of handing the young trees, and each boy should be provided with an apron for holding his trees when taken out of the ground, as well as to keep their roots safe against any cutting winds that may prevail. These matters being all properly arranged, the superintendent will, when his men are all collecting in the morning, strive to be the first man upon the ground, and arrange in his own mind quietly as to what sort of a day it is likely to be; and if it have the appearance of being a fine one, put the men to plant upon the most exposed parts of the ground, and if otherwise, upon the most sheltered parts. Although the day should prove wet, if the men have all collected, and are willing to work, let them do so, but only as long as the ground is not saturated with rain, which can at once be known when the young trees will not firm in the ground; as soon as the superintendent sees that the men cannot, with the usual beating, firm the trees in the ground, let him give orders to drop work at once: to persevere in such a state of

things is the worst of management. However, upon dry ground, this will seldom occur. If the day should prove frosty, let the men be set to make pits in a dry part of the ground—an operation which should always be left for days of this nature; but the superintendent should be most careful never to allow a tree to be planted in such pits till the frost has been properly thawed out of the earth; to plant a young tree among frozen earth will kill it as certainly as if it had been put into boiling water: therefore the planter should always be extremely careful to avoid this.

In planting a piece of ground, if there be hard wood to put into it, those should be all planted first; that is to say, previous to planting firs among them. In order to save time, I very often cause a few men to go on filling up the pits that have been made with hard wood, in the proportions that may be thought necessary as to the number of each sort; and immediately behind these I cause perhaps twice the number of men employed in planting the hard wood to follow them with the firs, filling up the ground to the requisite closeness as they proceed.

The superintendent must go backward and forward among the planters, minutely examining their work; in short, he must examine almost each tree as it is put into the ground, whether it may be done by the pitting or notching system, and see that it is properly planted and made firm in the

ground; and when the least fault is observable, it ought to be checked at once, and the fault laid to the person who did it. Every cut made with the spade in the act of planting a tree should be firmly closed, in order to prevent the drought from taking effect upon the roots.

The principal use of the boys in the operation of planting is to put the plant into the pit, and to hold it there until the men have it properly fixed in its place; the boy should never be trusted with making firm the plants, as is too often done by careless planters, but the man should be made responsible for the good planting of the trees. In planting by the notching system, the boy puts the roots of the young tree into the cut as it is opened by the man with his spade; and in this case also the man must attend to make the trees firm in their place. Many planters throw down a tree to each pit, and that for a considerable distance in advance of the men at work, which is decidedly a bad way of going to work, for by this method the roots of the young trees are often exposed for half an hour and more to the open air, which is always against their welfare; whereas, when boys are employed for the purpose, they keep the roots of the plants sheltered in their aprons from the drying winds, and, at the same time, the man has always more opportunity for the handling of his spade properly than if he had to stoop down and lift a tree each time he came

to a new pit, which he must do where no boys are employed.

SECTION II.—EXPENSES OF LAYING DOWN GROUND
UNDER PLANTATIONS.

In calculating the expenses likely to be incurred in the laying down of a piece of land under a crop of young forest trees, the proprietor has to consider, first, the nature of the figure in which he may intend to lay out his plantation. Upon the form or figure of a plantation much of the expense of fencing it depends; and as this item forms a very considerable proportion of the entire cost, it will be proper here to show the circumstances which, when attended to, lessen this expense.

When a proprietor intends to plant a piece of land upon his estate, say to the extent of fifty acres, he cannot exactly calculate the sum that would be required for the fencing of it until he has laid out the line of plantation, and actually measured the same—unless, indeed, he shall fix upon a regular-sided figure; and in order to illustrate the truth of this, I shall here give an example:—To lay out a plantation of fifty acres in extent, in the form of strips of four chains, or 88 yards broad, the proprietor would require to erect 5676 lineal yards of fence to inclose it; and supposing the fence used in the inclosing of this plantation

in the form of strips to be stone dyke costing 1s. per yard, then the whole expenses of fencing, in this instance, would amount to L.283, 16s., equal to L.5, 13s. 6d. per imperial acre upon the land inclosed.

Again, supposing that instead of laying out the fifty acres in the form of strips, the proprietor wished to lay out the same quantity of land in the form of a regular square; then the side of a square that would contain fifty acres will be 490 yards; consequently, the four sides added together will amount to 1960 lineal yards, which would be the extent of fencing required, instead of 5676, which was required in the last instance, although the same quantity of ground is inclosed in both cases. And taking again the 1960 yards to be stone dyke at 1s. per yard, the whole expense of fencing the square of fifty acres would be only L.98, equal to L.1, 18s. 6d. upon each acre of the land inclosed. Now this at once points out to proprietors of land the great utility of planting all plantations in a solid compact form in order to prevent a large original outlay; by the cheaper method a much more valuable plantation is raised, independent of any other consideration.

The above examples point out the impossibility of giving any thing like a just rule whereby the expenses of fencing ground for a new plantation can be ascertained, which in all cases must be

influenced by the form in which the ground is laid out: however, in calculating the probable expenses necessary to be incurred in the laying out of plantations per acre, I shall give two examples, as under:—

For home ground with hard wood, inclosed by stone wall five feet high, with mortared cope.

To medium expenses of fencing, per acre, with stone wall, 76 yards at 1s.	L.3 16 0
To 100 roods of open drains, at 1½d. per rood,	0 12 6
To 500 pits for hard wood, at 1s. 6d. per 100,	0 7 6
To 500 hard-wood trees, at 20s. per 1000,	0 10 0
To 3500 firs, at 6s. per 1000,	1 1 0
To five days of a man planting an acre, at 2s.	0 10 0
	<hr/>
	L.6 17 0
	<hr/> <hr/>

For moor ground, with firs only, inclosed by turf dyke, and paling on top.

To medium expenses of fencing per acre, with turf dyke and paling, 76 yards at 4d.	L.1 5 4
To 100 roods of drains, at 1½d.	0 12 6
To 4000 firs, at 5s. per 1000,	1 0 0
To four days of a man planting, at 2s.	0 8 0
	<hr/>
	L.3 5 10
	<hr/> <hr/>

The first example contains the highest cost per acre that ever I found necessary for planting of hard-wood plantations,—and the second contains the lowest that ever I could get the work done

properly for. I am aware that many planters say that they can do the work more cheaply—but this of course must depend upon the average amount of wages as given to labourers in the district; what I have stated above is taken from notes of expense actually incurred by myself; and, of course, I can speak with certainty upon the subject only so far as my own experience goes.

SECTION III.—THE KEEPING OF TREES IN A YOUNG PLANTATION CLEAR FROM GRASS AND WEEDS.

Any piece of ground having been planted with young forest trees, in order to keep them in a healthy growing state, it is necessary to have them kept clear of all long grass, as well as any other weeds that might have a tendency to injure them, by over-topping and crushing them down. Upon this head, the forester should keep a sharp look-out during the summer season, particularly the first one after the young trees have been planted; and wherever it is observed that the grass or any other weeds are likely to become strong, and to fall down upon the young trees, a careful man, with a few women and boys under his superintendence, should be sent over the different young plantations, who, with common shearing sickles, should be made to switch away all grass, &c., from every young tree that may require this to be done.

This work must be carefully done, particularly where boys or other young people are employed, as they are very apt to cut off the tops of many of the young trees if they are not strictly looked after; therefore, the man who is put over them should not work alongside with them, but go immediately behind them, and closely inspect all that they have done as the work proceeds, observing that they do not pass over any young trees requiring to be cleared, as well as seeing that those cleared be done in a proper manner. This operation ought to be performed twice during the summer season, viz.—between the middle and end of the month of June, and a second time in the month of August; and where the trees are growing among vegetation of a rank description, the same work may require to be repeated for three or four years successively, or at least until such time as the young trees rise above the rank growth of the weeds in the summer season.

Young trees, besides being apt to be injured by grass and other common weeds, are often still more seriously hurt by whins and broom growing among them. It very often happens, that young trees are planted where whins and broom have been cut down, and not grubbed out by the roots; in which case, the whins in particular are sure to push out a stronger and more vigorous growth than ever the following year. Whenever this may have been

the case, the planter ought to have particular attention paid to such parts, and see that the young growths of the whins as they rise up do not hurt the young trees. And for the purpose of clearing away the young shoots of the whins, a strong sickle will be found to answer the purpose well; and in the doing of the work, they ought to be shorn clean by the surface of the ground, wherever they are found among the young trees, whether they may be injuring them in the mean time or not: for though the whins may not hurt the young trees in many places in a young plantation for the first year of their growth, they will decidedly do so the second year, when it will be much more difficult to get the better of them. Therefore it is always necessary to cut such rubbish during the first year of their growth, when in a soft state; besides, if they are allowed to stand undisturbed upon the ground for a whole year, they give shelter to rabbits, hares, and other vermin, which are always a most dangerous stock in young plantations.

Where whins have been, even although they may have been grubbed by the roots previous to the ground being planted with trees, it is, I am aware, a most difficult matter to take them out so clean as to prevent any roots that may be left in the ground sending up shoots of considerable strength the first summer after; consequently, it

is necessary to attend in a particular manner to those young plantations where whins have existed previous to the young trees being planted. I have frequently seen large tracts of young plantations entirely ruined from not having been cleared from rubbish in due time; and in such a case, where this necessary clearing of the young trees has been neglected, a replanting of the ground must take place before any thing good can be expected. This of course is the cause of a great outlay of money, all which might have been saved had due attention been paid at first.

The necessary expense of doing this sort of work is but trifling. Upon the estate of Arniston, we employ a man with six young people, from the beginning of June to the end of August, constantly clearing among the young plantations; and I find that where no whins are, the expenses of keeping clear a young plantation, for the first four years, costs about 16s. per acre; and where there are whins to contend with, the operation costs about 25s. per acre, until the trees rise above them.

SECTION IV.—THE NATURE AND NECESSITY OF THINNING PLANTATIONS.

Thinning is one of the most indispensable operations in arboriculture. The right understanding of the nature and design of thinning plantations

forms one of the most important points to be aimed at by every practical forester.

The object which ought to be aimed at by the forester in the act of thinning, is the regulating of the trees in a plantation to such a distance one from another, and that in such a manner as is, from well observed facts, known to be favourable to the health of each tree individually, as well as to the general welfare of the whole as a plantation.

In order to grow any plant to that size which the species to which it belongs is known to attain under favourable circumstances, it is necessary that it have space of ground and air for the spread of its roots and branches, proportionate to its size at any given stage of its growth; and upon this the whole nature and intention of thinning plantations rest.

It is, in my opinion, much to be regretted that there does not exist, both among proprietors and foresters, a sounder knowledge relative to the nature and intention of thinning plantations than there is. I have frequently seen plantations upon a high situation going back, from having been injudiciously thinned; and in a low situation, I have as often seen them going back from not having been thinned at all: where the blame rested I know not, neither is it my business to inquire into that, but this I must say, that in all such cases there is evidently bad management.

There are, indeed, few proprietors' estates in Scotland upon which there is not considerable room for improvements, as regards the thinning of their plantations. There is a decided loss of timber, as well as shelter, whenever plantations are made too thin; and there is also equally as decided a loss where they are not sufficiently thinned. Wherever plantations have remained long in a close state, and are thinned suddenly and severely, which I term injudicious thinning, they are at once cooled; and that I reckon equal to being removed a few degrees of latitude farther north, or to a situation a few hundred feet higher than the original; and the natural consequence is, that the greater part of the trees which have undergone such treatment, become what is generally termed *hide-bound*—the bark contracts, and prevents the free flow of the sap, consequently it stagnates and breaks out into sores; the trees fail to make wood; and, in fact, the whole plantation falls into a state of consumption and declines gradually. I have frequently been called upon to examine and give my advice relative to what ought to be done with plantations in such a state as that described above; and wherever I have found plantations above thirty years old to be in the state described, and to have stood in the same state for four or five years, without showing much signs of any improvement, I have always in such cases recom-

mended to cut down at once, drain, and replant the ground. However, I may here mention, that if the situation be a rather sheltered one, and the soil dry, a recovery of an over-thinned plantation will often take place, although the trees, after having been checked, will never attain that size they would have done had they been otherwise treated; but where the situation is exposed, and the natural soil cold and damp, recovery is out of the question.

Upon the other hand, where plantations are not enough thinned, the trees become drawn up weakly, and seldom attain the size of useful timber before maturity comes upon them. And where any plantation has stood long in a state without being thinned, particularly a fir plantation, it is, I may say, impossible to recover it; for if even a very few trees be thinned out, a number of others, from the want of their shelter, are sure to die, which ultimately causes blanks to occur here and there, and the wind getting play in such blanks, great havoc is often done among the trees during a storm. As an instance of this, I may here mention, that upon the estate of Arniston, a fir plantation of above thirty years' standing, and to the extent of nearly forty acres, had been allowed to grow on in its natural state from the time that it was planted up to the period stated, when an attempt was made to take a few trees out of it, by way of thinning it gradually; and this having

been done, many more were blown down the very first storm that occurred, and an opening having been made by the wind, the whole plantation in a short time became a complete wreck, so much so, that when I came to the place, I had the whole cleared off and replanted.

From what has here been stated, it will appear evident that there is a great loss sustained by every proprietor who allows his plantations to be mismanaged, either from not thinning them, or from over-thinning them; and the result may be reckoned the same in both cases.

Upon many estates, I have often regretted to see plantations of considerable extent, and of perhaps forty years' standing, with the firs all overtopping and crushing down the hard-wood trees. From the appearance of such plantations, it was evident to me, that they never had been thinned: the hard-wood trees were miserable-looking things, and not more than ten or twelve feet high, striving for existence; while the firs, which, of course, grew more rapidly, were more than thirty feet high, and of a broad spreading habit, from having been widely planted among the hard wood: and in this state many plantations have been allowed to grow up, under the false impression that the firs were of more value than the hard wood for the sake of shelter.

Now, I beg to ask if any circumstance could be a

more convincing proof of the want of sound knowledge relative to thinning? If the hard-wood trees had been relieved in due time, would they not at forty years' standing have been valuable; both as timber and as affording shelter? Could not the firs have been all taken out for estate purposes, and been of value to the proprietor, while at the same time they left a more valuable crop of hard wood on the ground? But as the case was, the hard-wood plants were useless, and past recovery; and upon the ground where a valuable crop of hard wood might have been, there existed only a few firs of little permanent value, either for shelter or as timber.

The distance at which trees in a plantation ought to stand one from another, must in all cases be determined by the nature of the soil and situation upon which the trees grow, and also upon the ultimate object the proprietor may have in view as regards any particular plantation; but as a sort of guiding rule for thinning, I may here state, that if in any particular plantation it should be intended to rear up trees for park or lawn scenery, then, in such a case, the distance between each individual tree ought to be at least equal to the height of the same; and this rule ought to be kept in view at all stages of the growth of the trees, in order that they may have free room and air to form spreading tops as well as massive trunks, which is the true and natural form of

every tree, and which constitutes the great beauty of lawn trees.

If it should be intended to rear up a plantation of hard-wood trees principally for the sake of value in timber, and of giving shelter at the same time, then, in such a case, the distance between each individual tree ought to be equal to about one half the height of the same; and this ought to be kept in view at all stages of the growth of the trees, in order that they may not have so much free air and room as to allow of the spread of their branches horizontally, nor yet to be so much confined as to be drawn up weakly from the want of air. If it should be intended to rear up a plantation of firs or pines, for the sake of shelter and timber, then, in such a case, the distance between each tree ought to be a little more than the third of the height, which is the distance found most favourable to the useful development of the fir and pine tribes, as timber trees.

In order to give a clear and practical description of the manner of proceeding with thinning operations in the forest, it will be necessary to treat of them under three distinct heads; and which I shall do in the proper place—(see under the heads, *System of thinning mixed hard-wood, fir, and oak plantations*); but it may be necessary here to observe, that all plantations, ere they require to be thinned, must have grown for at least eight years, and even

this period may in the most of instances be far too early; in fact, no particular period can be specified as to the length of time that a plantation should stand, previous to commencing to thin it; for in this case, much depends upon the nature of the soil and situation, upon whether or not a plantation may have been well laid out, and upon the state of the ground, as being dry or damp. These things considered, it will appear evident, that no particular time can be stated as to when a plantation should be thinned for the first time; but that this must be judged entirely by the state of the trees, whether they may have grown rapidly or not. I have myself found it necessary to thin a young plantation of seven years' standing, at which age the trees were twelve feet high; but upon the other hand, I have much oftener seen plantations of fifteen years' standing, scarcely the length of requiring to be thinned: therefore, observation upon the spot is the only sure way of determining this point.

SECTION V.—THE NATURE AND PRACTICE OF
PRUNING TREES.

For three or four years past, many conflicting opinions relative to the pruning of forest trees have been issued in some of the periodicals of the day; which opinions, I believe, have had more a tendency to darken the point referred to, than to

throw light on it. Many have recommended pruning as an operation eminently favourable to the health of forest trees; many more doubt this; and as many more affirm that pruning ought not to be practised at all: and each, as he advocates his own peculiar system of management as regards this, gives an instance of some plantation he has had under his care, as undeniably illustrating the advantages of the system he recommends. Now, all the diversity of opinion arises from the want of a properly extended knowledge upon the subject in question. A man of extensive experience comes to find, that no particular rule can be laid down to answer the pruning of trees in all cases—he finds out that pruning in some cases is proper, and in others improper; but the inexperienced man, who wishes to be instructed in the art of pruning, when he sees one man strongly recommend pruning in all cases, and another as strongly urge its not being practised in any, is brought to a stand. He becomes bewildered, and knows not how to proceed; he is not able in his own mind, from deficiency of experience, to reason whether in his own case he should prune or not. Now, the only way reasonably to confirm the mind upon this important point is, not to lay any particular stress upon any particular example that may be given; but to examine the true nature of the art of pruning, and the tendency it has to improve or retard the healthy development of trees



in various situations; in short, in order to a right understanding of the nature of pruning, as applied to forest trees, attention must be paid to its effects upon trees under every variety of circumstances. I consider it proper, that every proprietor of plantations should be able to judge for himself in the matter of pruning, and to detect proper from improper pruning; and to this end, I shall enter minutely into detail under this head, and give a distinct statement of my reasons for pruning in one case and not in another. But before entering into detail regarding the practical operation, it will, I think, be proper first to examine the effects that the amputation of a branch from a tree has upon its constitution; and such previous knowledge will prepare the mind for a better understanding of the true nature of pruning, as it is generally practised among foresters.

A tree, through the agency of its roots, draws liquid nourishment from the earth in which they are placed, mostly in a state of solution in water; which liquid nourishment, or what is generally termed the sap of the tree, ascends the trunk through the longitudinal vessels, or pores of the wood; from which again, each branch or limb of the tree is supplied in succession. The body or trunk of a tree forms one bundle of longitudinal tubes, through which the sap ascends from the roots to the branches; and from this bundle, each separate branch is supplied

by its own separate line of tubes; or, which is the same thing, each particular root of a tree has to draw nourishment from the soil to supply its own particular branch; and the communication between those two points is maintained by a particular set of vessels in the trunk of the tree. The watery part of the sap, when it ascends into the leaves, is for the most part given off by them in the form of perspiration, and the sap which remains at this point undergoes a change previous to its descent in the form of proper woody matter, which change is effected by the leaves inhaling *carbonic acid* and other gases, which enter into the composition of the returning sap; and in this manner there is a continual circulation of the sap in the tree—the roots drawing in and supplying the whole with moisture; which, when it is raised to the leaves, undergoes a chemical change, and is returned in the form of proper woody matter. And now the practical deduction to be drawn from this is, that every branch growing out of the main body of a tree, is by nature meant to act as a laboratory, in which woody matter is prepared and returned for the joint supply of itself and the body of the tree; and from this we are bound to conclude, that when we cut a branch from a tree, we take away from it the means of supplying it with a certain proportion of woody matter for its enlargement; and this is, indeed, the case with pruning in all cases of the opera-

tions. But under good management in pruning, this depriving of a tree of its due means of nourishment is only of a temporary nature; and in one or two years after the operation has been done, and when the tree operated upon has had its growth properly directed, the increase of timber is at once remarkable, as compared with others of the like nature and age which had not been pruned, or with others which had been unscientifically managed.

When a large branch is cut off immediately from the body or trunk of a large tree, the usual sap which supplied it in its ascent from the roots, will be stopped short, and for a time will ooze out at the cut part; but shortly, the sap as it rises in those vessels of the trunk which formerly supplied the branch taken off, becomes stagnated, and causes rot in that part, which can never be the case while the branch remains to draw up and prepare the sap in its leaves; and this is the case in all instances of large branches, as they are cut from large trees. But in the case of a branch being thus cut from a young sapling in a rapidly growing state, the tree is not injured, but improved; the sap of the plant being in such a vigorous state, that rot cannot take place. Now, the practical deduction to be drawn from this is, that the amputation of a large branch immediately from the body of a large tree, instead of being favourable to its health and value as timber,

has quite the contrary effect. I say immediately from the body of a tree, because the cutting off of a part of a branch is by no means injurious to the health of a tree; but upon the contrary, when part of a large branch is cut off, the flow of sap to that part is checked, and the body or trunk of the tree is in proportion enlarged.

During my practice as a forester, I have had extensive opportunity of observing the nature and quality of full-grown timber, as it has been effected by different kinds of management in the way of pruning. Having seen much timber of all ages cut up for different purposes at saw-mills, I have had occasion invariably to observe a practical truth, that wherever branches of above four inches in diameter at their base had been cut from the trunk of the tree, the wood for a considerable way under that part which had been so pruned was worthless and of a black colour; and where much cutting of large branches had taken place in one individual tree, I have always found such a tree to be scarcely fit for any valuable purpose whatever, when it came to be cut up; and where the pruning had been done a considerable number of years before the tree was cut down for use, the wounds upon the surface were not easily observable, and in fact, such trees often appear sound to outward appearance; but when the bark is removed, the pruned part is at once observable, and the vessels leading from it, down to the

roots, are generally found soft and of a black colour.

Upon the other hand, I have always had occasion to observe, as a practical truth, that in the cutting up of trees which had not had their large branches cut off close by the trunk, the timber was of good quality, and sound throughout, excepting where extreme old age had caused natural decay; and of the truth of this I am perfectly convinced. Therefore, I hereby beg to advise every proprietor of plantations, never, as he values their health as timber, to cut clean from the boll of a tree a branch which is more than four inches in diameter at its base.

Having now pointed out the effects that the amputation of a branch from the trunk of a tree has upon its constitution, I next proceed to detail the method which ought to be practised with pruning operations in all cases; and in order to a right understanding of this most important point in arboriculture, I shall bring under consideration the pruning of trees, from the time that they are planted out from the nursery, to that of their full growth in the forest, under every variety of circumstances, as I have had occasion to observe them.

Many foresters are in the habit of closely pruning all young hard-wood trees, particularly elms and oaks, when they are newly taken from the nursery grounds, and preparatory to planting them

out into the forest; which system of close pruning is most injurious to the health of all young trees when newly lifted from the ground. The system of pruning which is generally practised by foresters in this case is, to cut off clean to the main stem, all strong branches, and only leave a few small twigs near the top of the plant, with the view of drawing up the sap. The natural consequences of such a cutting off of all the stronger branches from a young tree are, that, when the sap ascends in the plant in the spring, it is arrested at the wound where the first or lowest branch was taken off, and escapes from the cut part by evaporation; and the sap being thus arrested, there is a natural effort made by the plant to produce young shoots and leaves at this point, in order to convert the sap into proper woody matter; consequently, we almost always find a few young shoots made the first season immediately under the part where the lower strong branch was taken from the plant, and all the rest of the young tree above this growth of young shoots dies—the sap not rising to carry on life above the part where the new shoots spring out; and, even if the sap should not be all arrested at the point referred to, the part above it remains in a sickly and unhealthy state; while the young shoots produced lower down draw all the nourishment to themselves, and ultimately form a distorted unshapely plant, unless it be carefully attended

to, by giving some one of the shoots the preference, and, cutting away all the rest, allow it to become the top.

The proper manner of proceeding with the pruning of forest trees, as they are newly lifted from the nursery, and preparatory to planting them out into the forest grounds, is to *shorten* all the *stronger branches* that have the appearance of gaining strength upon the top or leading shoot of the young tree; and this shortening of the larger branches ought to be done in such a manner, as to leave only about one third of their whole length remaining, with, if possible, a few small twigs upon it, in order the more readily to elaborate the sap as it rises in the spring; and in this state the young trees may be planted with the greatest assurance of success. The great advantage of this method of pruning young trees is, that when the sap rises in them, the first summer after planting, there being a regular supply of small proportionable branches along the main stem, leaves are formed, and sap is drawn up regularly to every part of the tree; consequently, the tree maintains an equal vigour throughout. Were all the branches left upon the young trees, the roots, from the effects of removal, would not be able to maintain the whole with due nourishment; and the consequence would very likely be, that the plants would die down to the ground-level, from which part of the trees numerous young

shoots would issue, much in the same manner as they do from the cut part of those trees which have been over-pruned.

It is now a well-ascertained truth among all practical foresters, that when a young tree is in a vigorous state of growth, and the wood full of sap, previous to its having made any hard wood, any branch may be taken off without doing the least injury to it; therefore, it is just at this stage of the existence of a tree, that it can with certainty be made to do well or otherwise, according as it may be attended to, to give the top the lead in the growth, to check the stronger branches, and to give the tree that shape it may be intended it should have when it attains full age.

When young hard-wood trees have been pruned in the manner above recommended, and after they have been planted and grown in their permanent situation for the space of five or six years, they will by that time have got themselves properly established in the ground; which circumstance is known by their putting forth considerable shoots of young wood. At this stage of their growth, it will be necessary to go over them all with the pruning-knife, and cut close to the main stem or trunk all the parts of the branches that were formerly shortened, and, at the same time, to take off clean with the knife all other branches that may have gained strength, or may have the

appearance of gaining strength, upon the top or main shoot ; but it should be particularly observed, that this pruning ought never to be allowed to be done until the young trees have decidedly established themselves in the ground, and are in a vigorous healthy state of growth ; for, if it be done while the trees are in a sickly state, no advantage will be gained, but, upon the contrary, much injury will be done.

I have now given a statement of the manner of proceeding with pruning operations, in the case of young trees about to be planted out into the forest ; and also the treatment they ought to receive after being five or six years established in the ground. There may, however, be,—and, indeed, too often are,—cases where hard-wood trees, while young, have been entirely neglected ; and, seeing this, it will be proper to consider the treatment that such ought to receive. I shall first suppose that we have to do with a plantation of young hard-wood trees, which had received no pruning at all previous to being planted ; and we shall further suppose, that the trees are oaks, and of five or six years' standing in the forest grounds. Upon examining the state of young hard-wood trees of the description above mentioned, it will be observed, that the greater part of them have died down to the part resting upon the surface of the ground, and that from this part a number of branches have issued, each contending

for the lead in the growth. In such a case as this, no time should be lost in giving the strongest and most healthy shoot the preference, and cutting away all the rest, as well as the dead part of the tree, nearly by the ground, or at least down to the part from where the young shoots issue; prune up the shoot intended to be left for the future tree, by taking off all the stronger branches clean to the boll or stem; and in this manner go over each and every young tree in the plantation, always choosing the most healthy shoot for the future tree, and one which appears to have naturally a good balance of branches, with the leader or top shoot strong in proportion to the rest of the branches. We shall again suppose a plantation of oaks, of the same age as the one above alluded to, but the trees in which, instead of having been planted without any pruning, have been pruned too severely when lifted from the nursery ground, and previous to being planted. The treatment in this case must in every respect be the same as in the former; that is, all the dead wood should be cut away immediately above the point from which the young shoots issue; and the strongest and most healthy shoot being fixed upon for the future tree, it must be properly pruned up, by taking off all the stronger branches, and cutting cleanly away the rest of the inferior shoots, which formerly contended with it. But, in a case of this nature, where the trees had been over-

pruned previous to their being planted, there is often more difficulty in making choice of a good young shoot, than where no pruning had taken place at all. And this arises from the young shoots springing from the main stem in a horizontal manner, and that, too, very often a considerable way up the stem. In a case of this nature, where a proper leading shoot, rising perpendicularly, cannot be got, the only way, and the method I always follow myself, is to cut the main stem by the surface of the ground, and allow a set of new shoots to rise up. The chance generally is, that, when the tree is thus cut down, all the new shoots will rise in an upright position, and a choice can be afterwards made; but wherever a proper leading shoot can be had, let it be chosen, although it come away rather far up upon the stem. If it rise perpendicularly, and the plant be in a vigorous healthy state of growth, it will succeed well. This sort of work should be done in the spring months, so that the growth may set in immediately after the operation is performed.

It very often happens that a forester, upon entering a new situation, finds that the several plantations which are put under his management have been hitherto much neglected; he finds that, in many cases, pruning is absolutely necessary, but he is at a stand to know how to proceed. If he be a man who has not had much experience,

he is very apt to go wrong in a case of importance. He looks upon the trees before him, and he is, no doubt, aware that pruning is necessary to their health; but, in consequence of some particular circumstance connected with the trees with which he has to deal, he finds much difficulty in making up his mind as to the manner in which he ought to proceed. If he should be a man who has had extensive practice, he will look back upon his former experience, and consider where and when he had to deal with a case resembling the one that may be before him: if he has, he will review the manner in which he went to work in it; and, at the same time, he will consider the consequences that attended such operations, whether these were beneficial or not; and, in all cases, he will endeavour to govern his conduct in pruning operations by the result of his past experience. Whatever method of operations he has known to succeed well, he will put again in practice, according as the nature of the case may require; and whatever method he has found to have been followed by injurious effects, he will avoid putting again into practice except in particular cases, where he is aware it would answer the end desired.

With regard to the pruning of forest trees generally, all would be simple and well, provided a distinct practical rule were attended to, both by proprietors and foresters, for the rearing up of

plantations at every stage of their growth; but in practice, the case is almost always the contrary. No distinct practical rules being adhered to among foresters as a body, one goes to work in one way, and another in a contrary way, in the same piece of work, and in the manner of doing the work all depends upon the practical experience of the man. A man of sound practical experience finds out for himself what ought to be done, and guides himself in the execution of his work accordingly; but the man of small experience, unless he has some definite rule laid down to guide him, will go to work merely under the direction of his own judgment, whether that may be right or wrong; and if his master, the proprietor, has not himself a knowledge of how the work ought to be done, matters will often go very far wrong indeed, even so much so, that often the greater part of the plantations upon an estate, if not ruined, are made of very little value indeed. We will very frequently see plantations upon an estate overpruned, while those upon a neighbouring one are not pruned at all, which at once points out the bad management that exists relative to forest operations in general.

In one place where I acted as assistant forester, I had a most convincing proof of the want of a practical rule among foresters as a body, relative to pruning, and which told me at once that they have hitherto acted in such matters more

according to their own private judgment than upon any well-founded scientific rules. When I went to B—— as under forester, I found the head forester an old man, who had reared up most of the plantations upon the estate; and the situation being in a high exposed part of the country, he had never either pruned or thinned much; in fact, in the most of cases, pruning had never been practised at all, from the idea that the baring of the trees of their branches would diminish the shelter that the trees were meant to produce. Many of the plantations consisted principally of a mixture of ash, elm, and plane-trees; and from the circumstance of the firs having been cut out pretty early, the trees were low-set, and spreading in the habit of their branches, never having been much drawn up, and were about thirty years old. Shortly after I went to this place, the old forester died, and a young man was appointed in his place. The proprietor wishing to have his plantations improved, and having no knowledge of how the work ought to be done himself, he of course left the whole management of his plantations to his forester. The new forester set about the pruning and thinning of some of the plantations at once, and a number of men were set to accomplish this: I was appointed one of the pruners, and my orders from the forester were, to prune all the trees left standing upon the ground, and to give every tree a clear stem to

one half its entire height. The trees being generally from twenty-five to thirty feet high, we gave each tree a clear stem of from twelve to fifteen feet from the ground; and in doing this, we had often to cut off large branches from the boll as thick as itself, which gave the trees completely the appearance of having been manufactured artificially; and, having been very thickly set with branches all along the trunks, when they were pruned, the entire trunk was a surface of wounds. With regard to the tops of the trees, our orders were not to do any thing, excepting where two or more tops appeared to strive for the preference, in which case we left only one, cutting away the others. Having left that place shortly after this operation of pruning had taken place, in five years after I went to visit it, and that in order to draw for my own private instruction a lesson of experience, by observing the effect of the former severe pruning upon the trees; and the consequence was exactly that which I anticipated in the doing of the work. Upon looking over those plantations, the ruin of which I had myself assisted in bringing about, I felt sorrow to think that gentlemen should be imposed upon by ignorant men. All along the bolls of the trees and about the wounds which had been made in the cutting off of the large branches, young shoots had sprung out; the trees were generally now hide-bound, from having been suddenly exposed, and the

atmosphere cooled about them—the trunks had scarcely increased any thing in girth since they were pruned, and the top branches had made little or no wood. The trees, generally speaking, were ruined in their health, and all hope of their recovery was gone: and from this example I had indeed a lesson of experience for my future guidance, and my reason for stating the circumstance here is, that it may be a lesson to others also. The question now comes to be, whose mismanagement had been the cause of ruin in the case alluded to? Whether was the blame attributable to the old forester who neglected to prune and train up the trees as he ought to have done, or to the young man who succeeded him and pruned the trees without due consideration and experience? In my opinion they were both to blame; for, had the old forester pruned and thinned in due time, all would have been well in the end; and had the young forester been more cautious, and pruned and thinned gradually, all might have been well also. The practical truth that I wish to enforce from this instance of mismanagement is, that in every forester great caution, combined with practical experience and reflection, necessary before he commences to thin or prune any plantation. A gardener or farmer, from the temporary nature of the crops which they raise, although they mismanage any of their crops, all can be redeemed in the course of another year;

but in the case of mismanagement in a forester, the work of past years is lost, and thirty or forty years, with a considerable outlay of extra money, may possibly not be sufficient to redeem what is put wrong.

Having given the above example of mismanagement, in order to point out the necessity of using caution in entering upon pruning operations, I shall now proceed to give a few examples of the manner in which I have gone to work in similar cases of neglected plantations; and I am convinced that, wherever plantations have been neglected as to pruning, if they are under thirty years old, they may, if dealt with as I shall here point out, be recovered, so far as to make profitable timber trees, although probably not to that extent of value that might have been expected had the same trees been properly pruned and trained up in their young state.

When I came to act as forester upon the estate of Arniston, I found that many of the hard-wood plantations under thirty years old had never been pruned at all, and that there was great need for means being used as quickly as possible, to put such into proper state. In setting about this part of our forest operations, I determined to begin with the younger part of the woods, as being most likely to recover quickly, and to be of the most value ultimately if taken in due time, and to go on with the pruning of the older districts of plantations

as I could find convenient opportunity. Having laid down this principle, as a rule of procedure, I commenced first upon a plantation of oaks, about twelve years of age—which plantation, I saw, had never, up to the period I commenced upon it, been either thinned or pruned. The first thing I did, when about to commence pruning in this piece of plantation, was to go carefully over the whole, and examine most minutely its state; observing, in a particular manner, whether or not the situation was exposed; and being convinced, from the general bearing of other plantations in the neighbourhood, that the situation was rather sheltered than otherwise, I determined upon thinning out the firs pretty freely from among the young oaks: having done so, and had the firs all cleared off which were cut, I found that the young oaks had been a good deal crushed down by the firs, which had grown very freely as compared with the oaks; and in consequence of having been thus crushed down, many of the latter had grown strongly to side branches, and not to height; but wherever the oaks had had free top room, with firs rather close upon their sides, they were tall plants and generally well shaped. The average height of the oaks was from five to eight feet; the bark of the trees was clean and fleshy, and generally speaking they were in good health. In the pruning of those trees, I first had all the small branches not exceeding

two-thirds of an inch in diameter at their base, cut from the trunks, and close to the bark, to the height of about one-third the height of the tree in each case; next, all branches which grew upon the same part, with a diameter at base exceeding the last mentioned, I cut off to within about four inches of the stem or trunk from which they proceeded, leaving the stems in the mean time; and all large top branches, which appeared to be gaining strength upon the leading top shoot, I shortened down to nearly one-half of their whole length: but in all cases where two top shoots appeared, I cut one of them closely away, always leaving the one which appeared to be the most healthy and strong, and which at the same time appeared to come most directly from the centre of the system of the tree.

But I must observe here, that in the pruning of a young hard-wood plantation, all the trees do not require to be pruned to the same extent—in many instances it will be found that pruning is not necessary at all; and so it was in the case of the plantation I am referring to. Wherever a hard-wood tree is drawn up rather closely among firs, with sufficient head-room, it seldom produces many side branches, but will grow upwards to the light; therefore, in all cases of pruning, where the side branches upon a young tree are few, let such remain, and merely shorten them down where they are long and slender. Pruning is an unnatural

operation, and ought always to be avoided unless absolutely necessary ; that is, it ought to be avoided wherever the tree does not produce unnaturally strong side branches, excepting in so far as to clear from branches one-third of the height of the tree from the ground, in order to form a trunk ; and even upon this part, where the branches are large, they ought to be taken off gradually, as already noticed. Having gone through this plantation, and pruned the trees therein in the manner above described, I allowed it to remain so for the space of two years ; when I again went through it a second time, and pruned in the following manner all the oaks that stood in need of it.

Having taken out a few more of the firs, which I observed were rather encroaching upon the young hard wood, and having examined the general state of the same, I found that they had thriven remarkably well during the two years since I pruned them. I now found, that from being relieved of a superfluous and unnatural weight of side branches, they were growing tall, and in a generally healthy and rapid-growing state ; therefore, seeing this, I cut close to the main stem or part which formed the trunk, all those stumps which I formerly shortened to four inches, and in regulating the tops of the young trees, I merely shortened such shoots as had the appearance of ultimately gaining strength upon the main top shoot. With regard to my rea-

son for not having cut away the strong shoots or branches from the main stem when I first pruned those trees, I have to observe, that had I cut them away at the first course of pruning clean to the bark of the trunk, the consequence would have been that the sap of the young trees in its ascent would have been arrested at the cut parts, young sapling shoots would have been formed upon the stem immediately under the cuts, and the general health of the trees would have been injured from the sap not rising unchecked to the top shoots : these evils were avoided simply by cutting off a large portion of each large branch, and leaving a small portion of each upon the stem, in order to continue the regular flow of the sap to that part, and which, from being partially weakened in the branches, was proportionately forced to flow upwards to the supply of the top parts of the trees ; after this had taken place, the stumps were cut away without doing any injury to the trees. By this method of pruning off parts of large branches from a tree, I have often brought unhealthy trees to a state of sound health ; and as soon as I observed that such trees had regained their health, which is at once observable by their making vigorous shoots of young wood in the top branches, I immediately cut away the parts of the branches that were left, when the wounds were soon made up by the extra supply of proper woody matter, which

increased with the health of the trees ; but this cure is only applicable to trees in a young state. I have succeeded in effecting it upon trees under twenty years old.

After pruning the oak plantation in the way just detailed, I next set to the pruning of another oak plantation of about twenty years' standing. This other plantation of oaks was situated in a rather sheltered part of the estate ; and from having been nursed by Scots firs, many of which were growing when I commenced pruning operations there, the oak trees were very much drawn up. I observed that the oaks had never been either thinned or pruned, and consequently were growing within four feet of one another—that being the distance at which they had been originally planted. As the situation was a sheltered one, I thinned out a few of the Scots firs, and also a few of the oaks, previous to commencing to prune ; and when I had those removed, and the trees standing more upon their own weight, I saw that they were, from the effects of having been drawn up, very slender, and not able to stand much exposure or much cutting in the way of pruning, although they were from eight to fifteen feet in height ; and seeing them in this delicate state, I only shortened a few of the stronger side branches below, and at the same time shortened a few top branches upon each tree as I found it necessary, in order that they

might be properly balanced, and that the wind might not have much power upon them. In this state I left them for two years, when I again examined the trees, and finding that they had improved in a remarkable manner, I again set to work and gave them a final pruning. I have seldom found any plantation make such an improvement as this one did during the two years that I allowed it to recover itself before giving it a final course of pruning: this was owing to the gradual manner in which I thinned out a few trees, and cut off a part of the branches as a preparation for pruning. This is what every forester ought particularly to attend to; for, had I foolishly and thoughtlessly commenced to prune severely at first, it was quite possible that every tree in the plantation might have been thrown into an unhealthy state,—which, indeed, I have more than once seen done;—but by having gone cautiously to work, I had the satisfaction, at the end of two years from the time that I first examined those trees, to find them not only stiff, healthy, tall trees, but in a most vigorous state of growth also; and, finding them in such a state, I pruned them upon the same principle as stated in the former case—that is, I pruned off all the branches to one-third the height of the tree in each case, in order to form a clean trunk; and above this, among the top branches, I merely shortened such as had the appearance of gaining

strength upon the top. And wherever two distinct tops occurred in one individual tree, I cut off one, always leaving the one which appeared the most strong and healthy, and which issued most directly from the centre of the system of the tree, although in many cases it did not take an upright direction; for let it be observed, that an oak tree is the more valuable for having a bend in its form, such trees being useful in ship-building.

In a similar manner I have pruned plantations of thirty years' standing; but in the case of pruning at such an advanced age, no branch should be cut from the trunk that exceeds three inches in diameter, if it is intended that the timber should be of value when of full age; and even where such branches are to be taken off, they should be shortened in one year and cut clean off the year following, by which precaution the vessels which convey the sap to the branch receive a gradual check, and are to a considerable extent deadened before the complete amputation takes place, and consequently the body of the tree is not injured by such gradual treatment. And again, this is in a great measure influenced by the nature of the situation upon which the trees may be growing. If trees growing upon a high and exposed situation are not properly pruned when they are young, they will not admit of much pruning when above fifteen years old; in such a situation the sap of the

trees always flows slowly as compared with others in a sheltered spot, and seeing this, pruning ought to be avoided in such a situation when the trees are about ten years old. Trees growing in a sheltered situation are generally in a vigorous state of growth under thirty years of age; consequently, under skilful management, pruning may be advantageous to trees in such a situation at any time under that age; but in all cases pruning should be avoided as much as possible as the trees advance above ten years of age. I have seen foresters practise the pruning of fir-trees; such a practice is, however, the worst imaginable. The value of a fir-tree is greatly deteriorated by its being pruned; where the branch was cut off, the tree generally loses much of its sap, and is very apt to fall into bad health; and when such a tree is cut for timber, the pruned knots always fall out of the wood, causing holes, and consequently rendering such timber almost of no value.

In all cases pruning operations are seldom found necessary to any considerable extent, where the plantations are attended to in the way of properly thinning them. When hard-wood trees are grown pretty close to one another, and particularly with a proportion of firs to nurse and draw them up rather tall than otherwise, we always find the most perfect and sound timber trees; therefore it is from this circumstance that many foresters have

maintained that pruning should not be practised at all, and such a state of management is unquestionably the best. But how can this be maintained in all cases? I have known many plantations wherein firs and hard wood were planted originally, but in consequence of the firs having died out, the hard-wood trees were left alone upon the ground at a pretty wide distance from one another, and in this case they spread themselves widely to branches; consequently, in order to check such a tendency, pruning was absolutely necessary, and this I have frequently done myself, and found its effect most beneficial. Hence many foresters, from having only such sort of plantations to deal with, and not having experienced the effects of a more healthy state of things, have recommended pruning as necessary in all cases. And this brings me to say in conclusion upon this head, that a forester, in order to be so profitably, should be able to judge for himself how far pruning is advisable in one case and not so in another; he must take into consideration the situation the trees are growing upon—and if it be a high one he should prune very little indeed, and if a low situation he may use the knife more freely. If the plantation to be pruned has been attended to formerly, there will be very little difficulty in putting it into proper order; but if it has been neglected, great caution must be exercised in order not to expose the trees suddenly by taking off too

many branches at once. If the plantation be a young one, the trees may be made to improve although they may have been previously neglected; but if an old one, the chances of improvement by pruning are small.

CHAPTER IV.

SYSTEM OF THINNING AND REARING UP OF FIR PLANTATIONS—SYSTEM OF THINNING AND REARING UP OF MIXED HARD-WOOD PLANTATIONS—REARING UP AND THINNING OF OAK PLANTATIONS.

SECTION I.—SYSTEM OF THINNING AND REARING UP OF FIR PLANTATIONS.

IN order to point out properly the manner of proceeding with the thinning of fir plantations, it will be necessary to give a detailed account of how the work should be done at the different stages of the age of any plantation; and, as I have already stated that no particular age of a young plantation can be given as that at which thinning operations ought to commence upon it, the observation of the operator must always be his guide in such a case. Every man who has given his attention to the rearing of forests must have observed, that on some particular soils and situations a young plantation may be in a fit state for thinning at eight years of age, while another, composed of the same sorts of trees, and planted at the same time, may not be ready for this operation at twice that age—

all depending upon the elevation of the situation, and the nature of the subsoil, whether that may be open or retentive, dry or damp. Therefore it is, that observation upon the spot is the only decisive way of ascertaining when a plantation is in want of being thinned.

For the guidance of those who may not have had much experience in the thinning of plantations, I shall here lay down a few hints of practical utility, from which, I am certain, a cautious, intelligent man may be enabled to lay the foundation of future experience in this art. In examining the state of a young fir plantation with the view of ascertaining if it be in a condition so far advanced as to admit of being thinned, it will be necessary first to walk very carefully through its whole extent, and mark well the bearing that the young trees have one upon another. If the points of the branches of the young trees be merely touching, or slightly interfering with one another, thinning would be premature, and ought to be put off for a year or two longer; but if, upon examination, the lower side branches of the trees have the appearance of having been considerably stunted in their growth, and are actually becoming deadened in the extremities from the want of freedom and air, and if the higher side branches of one tree are spreading widely, and actually encroaching about half their length upon those of another, it is high

time that thinning should be commenced. If the lower branches of the young trees have a brown and deadened appearance, and the upper are spreading so widely that in many instances the points of the strongest of them touch the bolls of others, thinning has been delayed too long, and from the trees being heavy topped, and light in the lower parts, many of them would be apt to be blown down if thinned suddenly; therefore, thinning should never be delayed so long as to allow the last-mentioned feature to manifest itself upon the trees.

Having, in the manner stated, gone through the young plantation, and determined as to whether it ought to be thinned or not, and supposing that it has been found necessary to thin, it will be necessary, previous to commencing operations, to examine which sort of tree has thriven best upon the ground, and has the appearance of becoming the most valuable for a permanent crop of timber; that is to say, if the ground has been originally planted with a mixture of Scots, larch, and spruce firs, examine each district of the plantation as it may naturally divide itself into height or hollow, sloping banks or level ground, and ascertain which variety appears most healthy, and is most likely to come to perfect maturity as a timber tree in each separate district. In each district spare that species which, from general appearance,

is most likely to succeed well; and, when thinning, remove those sorts which have not the appearance of becoming good timber upon the soil.

In commencing to thin any plantation, it is also necessary to have in view its situation. The operator should keep in view that, if the situation be a high one, he must thin sparingly at first, for fear of checking the growth of the trees. At the same time attention ought to be paid to ascertaining what winds prove most violent and destructive in the neighbourhood of the plantation; and having ascertained the quarter from which the most injurious winds come, it is wisdom to thin most cautiously upon that side, and thin more severely in the interior of the plantation. But if the plantation be sheltered, either naturally or artificially, by older plantations upon other heights, then less caution is necessary, and the trees may at once be allowed more freedom in order to develop themselves quickly and perfectly. The operator having fully informed himself upon each of the points above stated, he will next proceed to have those trees marked which it is considered should be taken out.

In the act of thinning, particular attention should be paid to leaving, in all cases, the healthiest trees upon the ground, and to cutting out those that are most weakly, as the nature of the thinning may require

In thinning a plantation, many foresters think that the principal object to be aimed at, is that of giving the whole a regular systematic appearance, by leaving the trees as nearly as possible at a given distance one from another, without taking into consideration the ultimate welfare of the plantation. Such a method of conducting thinning operations may, indeed, have the effect of pleasing the eye and taste of the inexperienced for a time; but the effect of such a system is certainly ruinous to the proprietor in the end, and is never practised by the forester of extensive experience—but only by the inexperienced, who think that if they can but please the taste of their employer at the time, all will be well. If the trees in a young plantation are all equally healthy, then it is but proper to thin them out to a regular distance from one another; but where many of the trees appear of an unhealthy cast,—which is frequently the case in a high situation,—the healthy trees should be preserved without respect to a nice regularity in appearance. Wherever two trees may be found growing together, the one having a healthy and the other an unhealthy appearance, and according to regularity in the act of thinning the unhealthy tree may be found to occupy a proper place and the healthy one an improper, yet, for the sake of the future welfare of the plantation, no hesitation ought to be entertained as to which should

be cut down, but in all such cases at once cut out the sickly and leave the healthy.

In the thinning of young fir plantations for the first time, it may be asked at what distance the trees should be left the one from the other? In answer to this, I have to say, that no certain distance can be specified: and the reason is, that the young trees do not all grow alike in the same plantation, neither to height nor to breadth of branches; consequently, they do not all occupy the same space upon the ground. In the first thinning of any plantation of considerable extent, it will often be found prudent and necessary to pass over some parts altogether, without taking out almost one single tree, and this will happen upon a part of the ground which is of a poor thin nature; and again, wherever the ground is of a stronger nature, with a little shelter from the higher grounds, it may be found necessary to take out nearly one third of the trees in order to give proper air and room: and all this must be regulated by observation more than by any rule that could be given. However, as to rule in this case, I may say thus far, that my method of procedure generally is, to leave the trees, as nearly as possible, *free from one another* after the thinning has been performed: that is, when a plantation of young trees has been newly thinned, the extreme points of the branches of one tree should do no more than touch those of

its nearest neighbour; and in all cases where fir trees are raised for timber, as well as for shelter, they should be kept rather closely together than otherwise. And upon observation, the most advantageous distance will be found, as I have formerly mentioned, to be about one third of the height of the trees generally. When firs are kept growing at a distance less than one third of their height, they become tall, slender, and weakly; and if grown at a distance from one another greater than that mentioned, they become branchy and do not increase proportionately in height, and the timber is generally coarse. No pruning of fir trees should be allowed; pruning invariably injures the quality of the wood of fir trees, and besides, the health of fir trees is much injured by pruning. If the trees are kept as nearly as possible at the distance specified above, they naturally prune themselves as they advance in height; for as soon as the lower branches of the fir and pine tribe become confined, and a want of free air ensues in the body of the plantation, they gradually die and fall off without in the least injuring the quality of the timber. In the act of thinning, great care should be had to see that no large open space be left among the trees, which in any direction would in length measure more than the height of one of the trees growing by it; and this can be easily avoided by proper attention in the disposal of the trees upon the ground, not to

have them running in rows, but in such an alternate manner that, which way soever the eye can look from any given point, there may be always a tree to intercept the view within a short distance : and this, indeed, is a point of the utmost importance in the art of thinning plantations, and can only be attained by careful observation and experience. If open spaces be left for any considerable distance, the wind gets play among the trees, and has a tendency to cause havoc among them, particularly after being newly thinned, and more so if the plantation has been formerly neglected. As soon as the young trees which were marked to come out have been cut down, they should be carried out entire to one of the nearest roads in the plantation, and pruned of their branches there. This is not, indeed, always done ; but still it ought to be the method of going to work among young trees, the health of which requires, for its maintenance, free circulation of pure air among them. I have often had occasion to remark that plantations in a young state are much benefited by having a dry wholesome air circulating through them ; and being aware of this fact, it must appear evident, that if the prunings of the felled trees be allowed to lie upon the ground when they are cut, the gases arising from their natural decomposition must prove injurious to the health of the standing trees. And this, I have had occasion to observe, is particularly the case when

plantations are composed entirely of one tribe or family of trees; that is, if a plantation be composed entirely of the different sorts of firs, the gases arising from the decomposition of their own kind is injurious to their health, whereas the gases arising from the decomposition of firs are favourable to the health of hard-wood trees. And again, the gases arising from the natural decomposition of hard-wood trees are injurious to the living plant in the neighbourhood, but the same gases prove beneficial to the health of fir trees. The reason of this I do not pretend to explain, as a question of chemistry is involved in the answer; still, from my own observation, I am satisfied of the truth of what I here assert, although I do not remember of ever having heard that any other forester had observed this phenomenon: and it is to be regretted that, generally speaking, foresters are not allowed time and expenses to keep young plantations in the clean healthy state which their ultimate value demands. I have observed, in several places of note in Scotland, where men of first-rate abilities acted as foresters, that the plantations under their charge, although generally well conducted in other points, were, notwithstanding, always in a confused state from the prunings of all felled trees lying upon the ground; and upon inquiry into the reason of such a state of things, I have always learned that, the operation of keeping plantations clean

being an expensive one, they were not allowed strength of men sufficient to keep all right. And I beg here to remark, that proprietors of plantations often lose much valuable timber by this state of things being allowed to go on in their plantations: it does, no doubt, demand a few more pounds of outlay at the time, but ultimately that would be paid to their successors ten times over, from the effects of a superior system of management.

Supposing that a plantation of young fir trees had been thinned in the manner as above recommended, when about twelve years old, the trees would then, probably, be from eight to twelve feet high, according to soil and situation; and supposing that the same plantation was then in a fair state of health, and to have continued so for another period, say of eight years from the time that it was first thinned, it would, at the end of this second period, be about twenty years old, with the trees from twelve to twenty feet high, and they would, in all probability, be ready at this age for another thinning. In the thinning of the same plantation for a second time, the same practical points relative to the work must in all cases be attended to as have already been recommended for the first thinning: consequently these need not be repeated here again. But there are one or two points which must be observed by the operator in the thinning of plantations at or above

twenty years old; and these are, first, to see that the standing trees are not injured by the falling of those that are cut down. I have seen much damage done to the trees in a young plantation, where the falling down of the cut trees was allowed to take place in a careless and thoughtless manner; therefore it is that I here beg to recommend to all operators, in the act of cutting down any tree of considerable size and height, to be most careful in the operation. When a fir tree happens to lose its top by a felled neighbour coming in contact with it, such a tree seldom or never increases any more in height, and very frequently dies. The operator, in the act of cutting down any tree of such weight of branches as may be considered dangerous to let fall against any of its neighbours, should, if he has not a sufficient opening for its safe fall, provide himself with a pruning chisel, having a shaft proportioned to the height of the tree, and also a mell; and with these he should lop off all the heavy branches from the tree to be felled, previous to its being cut; and when it is thus made bare of all its branches, any ordinary-sized tree may be at the command of a man's strength, in so far as he may be enabled to push it down to one side or another as he may see fit to suit an opening among the standing trees. I beg to observe here, that the lopping off the branches from a tree of any considerable size, is an operation requiring considerable

time, consequently it need not be adopted excepting in extreme cases, where there is evidently danger to the young and growing trees.

In most cases an expert woodsman can, from observation and practice, make a tree fall very nearly to any given point he may choose as an opening of the safest description. The method practised by expert woodsmen in this sort of work is, to observe, first, toward which side the tree he may be about to cut has naturally its centre of gravity. Having ascertained this point, he proceeds to judge if the tree will or can be made to fall into a proper opening among the growing trees; and being from observation well assured as to the side to which the tree can be made to fall with the most safety, he commences to cut first upon the side to which he wishes it to fall: after cutting the tree rather more than half through upon that side, so as to throw the centre of gravity in the desired direction, he next applies his axe to the opposite side. As he gradually weakens the perpendicular attitude of the tree, he observes now and then if the centre of gravity in the tottering tree is likely to take an unexpected turn upon him, and if so, he checks the same by cutting oppositely; and by these means alone I have had men who could lay down trees upon the ground to almost any given point. But, notwithstanding all this, I have frequently had to do with

instances in the thinning of plantations where the coming down of a heavy-topped fir tree would have done much damage ; and in such cases, when I applied the chisel in the manner as above stated, the work was safely accomplished.

At the age proper for the second thinning of any fir plantation, it should never be too severely thinned ; because, at such an age, say at about twenty years old, the trees are generally in their most healthy and rapid state of growth ; and if they should happen to be checked at such a stage, the ultimate value of the whole plantation might be materially impaired, and it is even possible that the whole might be ruined ; therefore it is requisite, in all cases, to thin with experience and caution.

It is in all cases better to thin frequently, and take out a few trees at a time from any given plantation, than to thin at distant periods, and then to do so severely. Many foresters recommend to thin plantations at regular intervals of ten years. To such a method of procedure I cannot agree, because it is evident that no specified time can be given as an interval between thinnings : plantations do not grow with equal vigour every year—in some years trees will make strong healthy shoots of young wood, and in others much less. Trees grow more rapidly in a warm season than in a cold one, and, as has been already stated, they are

very much affected by variety of soil and situation ; and being aware of these circumstances, it is folly to say that a plantation of trees can be thinned advantageously at any definite period. After any young plantation has been thinned for the first time, it is advantageous to its welfare to go over it and take out a few trees in the way of thinning, at intervals of four or five years—in all cases judging upon this point according to the appearance of the trees, whether they may have grown rapidly or not since they were last thinned ; and at such thinnings I would advise every proprietor merely to take out such trees as are really doing injury to others. By this method, which I always practise myself, plantations never experience any sensible check, and consequently they are kept in a constant quick-growing state ; whereas, by the method of thinning at regular intervals of ten years, the trees in a plantation are by that time generally hurt to a very great extent from the effects of confinement ; and as soon as they are thinned, in such a manner as to relieve each tree for another period of ten years, the whole plantation must be very much cooled down in temperature and shelter from what it was before the operation was performed, and the natural consequence is, that the trees thus receive a severe check, which in too many cases they never recover. A plantation thinned at intervals of about five years, will yield one third more

timber at the end of sixty years, than one of the same extent thinned at intervals of ten years.

Every fir plantation, whether that may be composed of larch, Scots, or spruce, ought to be gradually thinned as the trees advance in height and breadth, until they be about forty years of age, after which period no fir plantation which has been properly managed, should be at all disturbed by the operation of thinning. At forty years of age, the trees in a fir plantation should stand at such a distance one from another, as may be considered sufficient to bring them to confirmed maturity upon the soil upon which they are growing; and this distance of the trees one from another should, as I have formerly stated, be about one third of their height; and, indeed, this ought to be as nearly as possible the rule for distance among fir plantations at all stages of their growth, commencing our calculation with the time the trees receive their first course of thinning.

In many high-lying districts, the trees in a fir plantation may, at forty years of age, be about thirty feet high; therefore, the distance of such trees at that age, should be as nearly as possible ten feet: and, again, in a more sheltered situation, with a dry and favourable subsoil, they may, at forty years of age, be about sixty feet high; and in such a case, the distance of the trees one from another may be about twenty feet.

At sixty years of age, the wood of the pine and fir tribes is generally considered to be in its most valuable and solid state as timber ; it is then heavier, and more full of resinous matter than at any other stage of its existence ; consequently, at that age, if the object be a crop of valuable timber, the tree should be cut down, and disposed of as may seem best. But if the proprietor have in view the giving of shelter to his lands, which is generally one end aimed at by improving proprietors, the plantation may be allowed to stand for other twenty years, after which period the trees will begin to become lighter in their wood, and many will then be showing marks of natural decay, and the whole plantation will of course be generally speaking of less value than it was at sixty years' standing. However, this is not always the case ; for very much depends upon the nature of the soil and situation upon which the crop of wood may be growing, as to whether that may be high or low lying, dry or damp. In a high situation, with a good dry bottom, I have seen excellent fir trees at one hundred years old ; while, upon the other hand, I have seen firs beginning to show symptoms of rapid decay at fifty years of age, and in many cases even at a much earlier age, which was in a low and rather moist situation, and without a free circulation of air.

It very frequently happens that fir plantations

have to be dealt with which have been much neglected; and although they in many instances be past any good hopes of recovery, and might in so far as regards the value of their timber be very properly cut down; yet, it is very often the wish of the proprietor to have old fir plantations preserved, and not altogether cut down, particularly if such a plantation should happen to be placed upon a part of his estate where, from its evergreen appearance, it proves ornamental from a certain point of view, as well as a shelter to the neighbourhood around it. In such a case, profit and ornament should be combined. It would not be profitable for the proprietor of an old neglected fir plantation to leave the ground entirely occupied by a few trees only in a fair state of health, with many others dead and dying; therefore, the profitable way of going to work in such a case would be to plant anew with other trees all vacant parts, and, for the sake of ornament and shelter, all good old trees could be left for a time.

I have frequently been called upon by proprietors to give my opinion relative to the state of fir plantations upon their estates, which had grown up under utter neglect; and requested to say whether I thought that such a plantation would recover by any means I could suggest. Where I have found such plantations young—say, at or under thirty years of age—and spoiled merely from

the want of having been thinned in proper time, I have very often seen them recovered by a very cautious and gradual course of thinning, and that especially where the trees grew upon a dry bottom; but wherever I have found thinning neglected upon a damp soil, I at once pronounced that there was no hope of recovery for the trees. In many such cases I have seen a gradual course of thinning with draining tried for the purpose of recovery, but all to no purpose. If ever the pine or fir tribe have been much affected by dampness in the soil, the sooner that the trees are cut down the better; after which, draining and replanting can be got done in a proper manner.

Where the trees in a neglected fir plantation may happen to be old—say, at or above sixty years—and where, in such a case, it is the wish of the proprietor to extend the existence of his plantation as long as possible for the sake of shelter and general ornament, it is a very good method to cut out gradually all the trees which have the appearance of decay, and to leave the best trees standing at wide distances, and as nearly regular as possible. Say that good trees are left at seventy feet distance one from another, from a distant view the plantation would seem good; and then the open spaces between the old trees could be replanted with a crop of hard-wood trees, which, from being sheltered by the old firs, would grow

very rapidly; and in the course of ten or fifteen years from the time of this replanting, and when the hard-wood may be expected to be pretty strong, the firs might with propriety be dispensed with altogether, or at least, a few of the best trees might be left, according as the taste of the proprietor might suggest.

SECTION II.—SYSTEM OF THINNING AND REARING
UP OF MIXED HARD-WOOD PLANTATIONS.

The rearing up of hard-wood plantations to any thing approaching natural perfection, requires much more attention and practical knowledge from the manager than that of fir woods does.

In a fir plantation, the trees are alike of an upright habit of growth, from which circumstance they are very easily regulated and kept in proper place and order; but in a plantation consisting of many different kinds of hard-wood, all growing in a mixed state—some, as the elm, inclining to grow much to horizontal branches, and others, as the ash, tending to an upright growth—much attention is necessary for the first twenty-five years, in order to keep the rambling sorts within due bounds, and from over-topping and injuring their neighbours which may be less hardy in their young state. And as it is in the young state that hard-wood plantations may be made to do

well or otherwise, according as they may be attended to, to train them up as children in the way they should go, it is a matter of the first importance in good forestry, that the manager be well acquainted with the circumstances which retard the progress of young trees, as well as those which are known to be favourable to their healthy development. Being myself well aware from past experience of the extensive damage which is done to young hard-wood plantations in consequence of their being neglected in their young state, I shall here lay down at some length the method which ought to be pursued in order to have healthy and valuable hard-wood trees—dwelling more particularly upon the system which ought to be adopted in rearing till the trees attain twenty-five years of age; after which time, if they have been properly attended to, little care is required as regards trees individually, except to give them room as they advance in size.

Suppose that a tract of ground has been planted with a mixture of young hard-wood trees at ten feet distance from each other, and that the ground between them has been planted with firs for the sake of giving shelter, in such a manner as to make the plants over the whole ground stand at about three and a half feet distance. If the ground thus planted have been properly drained previous to the trees being planted, and the situa-

tion is one of a moderate exposure, such a plantation will, at ten or twelve years' standing, very probably be in a state requiring to be thinned for the first time. In examining the state of such a young hard-wood plantation, with the view of ascertaining whether it may be proper to thin or not, go carefully through among the trees, and mark particularly the state of the hard-wood plants, observing if the branches of the firs are not encroaching too far upon them, either so as to overtop them or to confine them too much upon any side. My method of proceeding in the management of young hard-wood plantations at the stage above stated is as follows:—

About two years before I consider it necessary to begin thinning out any of the firs, I go over all the hard-wood plants, and prune from them all strong branches that may have the appearance of gaining strength upon the top shoots, as also cutting away with a hedge-knife any of the fir branches that may be encroaching upon the hard-wood trees. This being done, the hard-wood trees, having the advantage of shelter all about them after being pruned, make strong and vigorous shoots during the two succeeding years. By that time they are in a confirmed healthy growing state, and have completely recovered from the effects of any pruning that they may have received: consequently they are then in a fit state for being exposed to more free air, as is always the case after being thinned for the

first time; and in fact, if young hard-wood trees be properly attended to in pruning them in this manner, and at this stage of their growth, they seldom or ever require much pruning afterwards. The great error which generally prevails among foresters at the present time, in the management of young hard-wood plantations at the stage above mentioned, is, that they both thin and prune at the same time. Now, no system of management can be more injurious to the health of any plantation than this; for, when a few branches are lopped off a young tree, it will often die when exposed suddenly to a temperature below that which it formerly used to exist in; and this invariably ensues when pruning and thinning are executed at the same time. But if, when a young tree is pruned, the temperature be increased rather than otherwise, the tree is immediately improved by the operation, and decidedly attains a more vigorous constitution than it formerly possessed; and this again is exactly the case when pruning is done in the early part of spring, and a considerable time previous to thinning: this at once pointing out the evil of both pruning and thinning at the same time, and the great propriety of pruning trees a considerable time before exposing them suddenly by thinning.

Having pruned the young hard-wood trees in a plantation, as has been stated above, and having allowed them to remain among the firs undisturbed

for two years after, and finding them at the end of that period in a healthy and vigorous growing state, I next thin away all firs that are pressing too much upon the hard-wood, without, in the first place, having any respect to the thinning of the firs among themselves; for the hard-wood trees being of the first importance, the firs are in this instance only a secondary object. But as soon as I have the hard-wood plants all properly relieved, I next thin out a few of the firs also; and in doing so, I aim at keeping them close rather than thin, and that with the view of giving as much shelter to the hard-wood plants as is properly consistent with the health of the whole. But, to be more particular upon this point. It shows a great want of judgment in the manager of plantations wherever firs are severely thinned from among young hard-wood trees, particularly in that earlier part of their existence relative to which we are now speaking. The firs were planted among the hard-wood with the view of giving them shelter in order to nurse them up quickly: now, if they be removed away many at one time, the hard-wood plants will, no doubt, suffer much from the check: if they be once checked by a severe thinning, the trees never will afterwards attain that state of health they would have had, had they been otherwise dealt with; and of course, in such a case, the future value of the whole as a plantation will be much lessened. Therefore, in all cases of thinning

away firs from hard-wood for the first time, great caution is necessary not to overdo this point, more particularly if the situation be much exposed. Another advantage gained by keeping young hard-wood trees rather close among firs is, that from being confined rather than exposed, the plants are more drawn up to height of boll than to breadth of branches; and from the circumstance of the side branches being confined, and not allowed to expand upon account of the firs, they do not grow rapidly, and of course the top soon gets the lead in the growth, and in a great measure does away with the necessity of pruning—which is, properly speaking, an unnatural operation, and ought to be avoided as much as possible. When once the top of any tree has fairly got the lead of all the branches, it will keep it ever after, unless any unforeseen accident should befall it. When young trees have too much free air and room to spread out their side branches in a plantation, there must be much waste of ground; and in order to check such a free growth of side branches where such is actually the case, pruning must be adopted, in order that one tree may not injure another. But under good management this is seldom found to be the case; where young plantations have been neglected, the case is altered, and a system of pruning must be adopted.

The firs growing in a plantation among hard-wood trees, which are intended for the ultimate

crop upon the ground, should be gradually thinned out as the hard-wood trees advance; and not so much attention should be paid to the thinning of the firs among themselves, as to see that they do not encroach too much upon the hard-wood trees; as soon as they do so, attention should be directed to having such cut down immediately.

As I have already said, when referring to the thinning of fir plantations,—many foresters are in the habit of thinning at stated intervals of from five to ten years;—but I again, in this place, beg to caution all who wish to produce healthy hard-wood plantations, against such a dangerous system of forest management. Because, if a young plantation, whether of hard-wood or firs, after receiving its first course of thinning, be allowed to grow on undisturbed for a period of say eight years, the trees in it must be in a very confused and confined state, and certainly too much drawn up; and when such a plantation is thinned, in order to give each tree relief, many must be taken down. When this is done, the whole plantation is suddenly cooled; and if the ground be of a damp or cold nature, many of the trees are blown down, and such a plantation very often is ever after left a mere wreck.

The great art of thinning and rearing up of hard-wood plantations is, to go carefully and regularly through them every third or fourth year at farthest,

and never to cut away many trees at one time, but merely such as are actually doing injury to others of more value than themselves. By this method of procedure, the plantations so dealt with never receive any sensible check, and are kept in a constantly healthy growing state, and always produce much more timber at the end of any given period of years, than plantations managed upon an opposite principle.

When a young hard-wood plantation has arrived at the age of twenty-five or thirty years, it is very probable that the firs may be dispensed with altogether, in order to give the hard-wood all justice for the expansion of their trunks; but if the situation happen to be an exposed one, it will be a point of wisdom to have a considerable portion of the firs left standing upon the most exposed side or sides of the plantation—they are more hardy than the hard-wood sorts, and, when growing upon the outside of a wood, they form a protection to more valuable trees in the interior.

I have already stated elsewhere, that hard-wood trees, when growing in a forest, should stand at a distance corresponding to about one half the height of the trees respectively; but, properly speaking, there can be no specific rule laid down for guidance upon this point, for much depends upon the nature of the soil. In a strong loamy soil well adapted to the rearing of forest trees, I have seen excellent

timber growing eighty feet high and not more than twenty feet tree from tree ; while upon the other hand, in a light poor thin soil, I have seen trees not thirty feet high, scarcely able to maintain existence although they were standing twenty feet one from another. But upon a moderate calculation, and upon a soil of moderate capabilities, one half the height of the trees may be reckoned as a fair distance at which one tree should stand from another, at all stages of their growth, after they have received their first course of thinning.

I here beg to caution all who have not had thorough practical experience of their own, not to be guided by any universal rule of distance which one tree should stand from another, in the act of thinning. The great point to attend to is, to keep the trees, at all stages of their growth, after the first thinning has taken place, merely free one from another, in the top branches—not to allow the trees to grow so closely together as to be drawn up weakly in the boll, nor to be allowed so much room in the forest as to spread out their branches horizontally, and take up too much space in the plantation.

If the plantation have thriven well, it is likely that, at thirty years of age, a few of the hard-wood trees may require to be taken out, in order to relieve others of more value, and which may have grown more rapidly ; and in the same manner, a

few should be taken out now and then, without much respect to stated intervals, wherever they may have the appearance of being too close one upon another. And this should be gradually done till the plantation is about forty-five years old, when it should have a final thinning, making every individual tree stand as nearly as possible free of its neighbour; and in this state, the trees may be allowed to stand until they attain perfect maturity, which, with the generality of trees, is about sixty-five years old, when they may be either cut down or allowed to stand, according as the taste or inclination of the proprietor may suggest; but where valuable timber is the object of the proprietor, the trees should be used as such when between sixty and seventy years old.

In all cases, during the progress of rearing up hard-wood for timber in a forest, where pruning may be found necessary, let that be done one or two years previous to commencing any thinning operations. The reason for this advice I have explained already; and were this point properly attended to, we would soon see a great improvement in the quality of our timber trees.

There is also the case of neglected hard-wood plantations to be taken into consideration; and, indeed, cases of this nature too often come under the observation of the forester who may have extensive practice. In many cases I have had to deal with

plantations consisting of hard-wood and firs, mixed and growing together in the proportions formerly mentioned, which had never been thinned up to the time that I examined them—and they were then thirty years old. The hard-wood plants were then about ten feet high, and from two to three inches in diameter; and the firs, which had grown rapidly, were large, massy trees, fully thirty feet high. Upon consideration, I concluded that no remedy could be used in order to recover the hard-wood plants, seeing they had been so much stunted and crushed down. There was, indeed, one way in which the hard-wood trees might have been made to grow to advantage, but it must have been at the expense of the firs; but as they were good trees, the operation would have been a decided loss to the proprietor. The only way to have saved them would have been, to have cut them all down to the ground, and to have made them all spring from the root afresh; but in order to have given them a proper recovery, one half of the firs must have been sacrificed. In several instances where I have had to deal with plantations consisting entirely of hard-wood plants, so old, and so much drawn up together from the want of thinning, that they had actually become mere poles of thirty feet high, and not more than four inches diameter, I have cut the whole plantation over to the surface of the ground, because thinning was out of the question; and in such cases, I have had an excellent

plantation of young trees from the old stocks, and which, in ten years after, formed a first-rate plantation of trees, having been all thinned out to regular distances in due time, and not allowed to rise too thickly again.

In all cases of neglected hard-wood plantations, where it may be considered advisable to cut down the trees, in order to cause them to send up fresh young shoots to form trees, care should be taken to see that the ground be made perfectly dry, by a proper course of draining; for if this point be not attended to, disappointment may possibly be the result.

Wherever hard-wood plantations are found to be in a bad state, from having been neglected for a period at or beyond thirty years, there is little hope of their recovery by any course of thinning, however cautiously it may be gone about, unless the trees evidently show symptoms of a sound constitution, which may be the case where the soil is good and dry. Therefore, in all such cases, unless symptoms of health be remarked in the trees, the proper and only way is to cut all down and plant anew; and if the situation be one exposed to the view of the mansion-house, or pleasure grounds, where a complete clearing away of the mismanaged plantation would cause a bad effect, a few of the best and healthiest trees might with propriety be allowed to stand for a time, in order to give effect to the

landscape, until such time as the young trees had attained a considerable size.

What I have said above, relative to the rearing up of hard-wood plantations, is only applicable to such when grown for the sake of their timber; but upon proprietors' estates, hard-wood plantations are more generally raised with the view of being ornamental upon the lawns and home parks, than simply for the sake of the value of their timber.

Every proprietor who lays out new grounds in the neighbourhood of his mansion-house, if no plantations exist upon those grounds at the time, will, in accordance with good taste, and with the view of affording shelter, plant extensively upon them. And every proprietor of sound natural taste will, in a case of this nature, plant the different sorts of hard-wood, with the view of their becoming ultimately his permanent standing trees, and make up with firs, simply with the view of acting as nurses, until such time as the hard-wood sorts may arrive at a size sufficient to insure their welfare, independent of the firs; and not plant firs in a body by themselves, in any plantation near the mansion, or in the grounds immediately in view, for these always give a place a mean and highland appearance.

I am aware that many proprietors in Scotland, whose seats are upon high-lying and rather moorland districts in the country, are of the opinion that hard-wood trees will not grow with them to

a size worth cultivating with the view of becoming ornamental lawn-trees. Upon this point, my experience points to quite a different conclusion. In all high-lying situations in Scotland, where the Scots and spruce firs are found to succeed well—the former on the heights and the latter in the hollows—the beech, elm, and ash will thrive well also, and become trees of no mean magnitude. This I have observed through Aberdeenshire, and other northern parts in Scotland, as also on the highest-lying districts in the south of Scotland; therefore no proprietor in Scotland, if he can produce upon his estate Scots firs of good size, should hesitate to plant the sorts of hard-wood trees above named. All that he has to do, in order to insure success, is to plant firs as nurses, along with the hard-wood, and remove them by degrees as the others advance.

It is allowed by all people possessed of good natural taste, that firs, when planted in a mass, and forming a plantation near to a gentleman's mansion, without a proper body of hard-wood trees, give that place a cold, heavy, alpine appearance, although it may be situated in the most fertile part of the country. And it is my opinion, that every proprietor of land should endeavour, as much as possible, to cultivate all the different sorts of hard-wood within the range of his home parks, which will give his grounds a fertile and cultivated aspect, although the situation he may occupy be naturally one of an

opposite character. All fir plantations should be kept out upon the poor high grounds of an estate; and by the arrangement of having the hard-wood trees in the centre of the property, and the firs upon the outer grounds, the whole will have a most natural and imposing effect.

Wherever a young plantation is made of hard-wood and firs, with the view of their ultimately becoming ornamental lawn trees, they should, in every respect, be treated in the same manner as already advised for forest hard-wood trees, until they arrive at the period when they require to be thinned for the first time. The hard-wood which are intended for lawn trees should also be brought into shape by receiving a judicious pruning previous to being thinned for the first time, as has been advised elsewhere; and when the hard-wood trees which are intended for lawn standards are thinned, they should have, at all stages, much room and space to spread out their branches and develop themselves according to their nature, which is the state in which trees always appear to best advantage. And in order to allow the young hard-wood trees to attain their natural shape as much as possible, the firs which may be planted about them, with the view of giving shelter for a time, should be kept well off them, and never allowed even to touch their branches, but placed so as merely to stand by their sides, and give the benefit of their shelter.

As soon as they approach each other too closely, the firs should at once be sacrificed. At the same time, however, attention must be paid to see that this be done gradually; perhaps looking over and taking out a few firs every year, as occasion may require, and as the hard-wood trees advance.

The great art in rearing up hard-wood trees for lawn scenery, is, first, not to prune off any branch after the trees are fairly established in the ground, and about eight or ten feet high. Second, the firs, which act as nurses, should never be allowed to spread themselves upon the branches of the hard-wood, but should merely stand by, for the sake of shelter. Third, observe what sorts of hard-wood trees appear to thrive best upon the ground, and encourage those most which appear to do best; and, at the same time, wherever any particular sort of hard-wood does not appear to do well upon the soil, leave firs in their place. A few good specimens of firs look well among hard-wood. Fourth, when the hard-wood trees have advanced so far as to require all the firs to be removed to give them room, and when they begin even to encroach too much upon each other, cut out several of themselves also, and continue to do so until the trees have attained the age of forty years, after which period it will not be found necessary to thin much, if they have been well attended to formerly. Fifth, in the act of thinning out trees intended for park and lawn scenery,

care should be had to see that picturesque openings be made here and there, of distant views from the mansion; such as a particular plantation upon a height, a romantic view of an old ruin, or a sheet of water in a neighbouring hollow;—all of which are beautiful objects in landscape scenery, and should never be hidden from the mansion and grounds of the proprietor; for, however beautiful trees may be in themselves upon a lawn, they form but a dull and monotonous scene, if well-chosen openings be not left among them, through which other interesting objects may be seen.

SECTION III.—REARING UP AND THINNING OF OAK PLANTATIONS.

The oak being the most valuable of all the timber-trees grown in Great Britain, it is generally cultivated with more care and attention than any one else; therefore, I consider it necessary and proper to treat of the manner of rearing it under a distinct head.

Three different systems of rearing young oaks are practised among foresters of the present day; each of which is advocated and upheld by a considerable number of practical men, who put each his own system into operation, according as his own views of the matter direct him, without paying due consideration to place and circumstances.

The three different systems are these:—First, that of sowing the *Acorns* or seed at once upon the ground where it is intended the trees are to grow up and become timber: second, that of transplanting the trees from the nurseries in the usual way, and, in one year after being planted, when their roots are established in the ground, cutting each tree over by the surface of the earth, and allowing the *stump* so cut to stand for two or three years, when a number of young shoots are produced immediately from the earth, strong enough to allow a choice to be made of one to stand for a permanent tree, when all the others are destroyed: and, third, the system of planting the young trees in pits, as is usually done, and allowing them to come away in their own natural way. Each of these systems has its peculiar advantages and disadvantages; and, in order to point out these clearly, and in such a manner as to render the statement of them practically useful to the forester who wishes information, it will be necessary to make a few observations upon each of the systems referred to.

With regard to the first,—namely, the system of sowing the *acorns*, or seed of the oak, at once upon the ground where it is intended the trees are to grow up and become timber,—this is, undeniably, acting according to the laws of nature, to which we ought always to attend in the rearing of forest

trees to any thing like perfection. Those who advocate the general introduction of this system say, that the best specimens of oak trees to be found in Britain are those sown by the hand of nature. But this assertion seems to be far from fully authenticated; for, of the many famous oaks mentioned in the history of our country as having existed until lately, it is uncertain whether they might have been remains of an old natural forest, or whether they may have been planted artificially by the hands of man. The managers of the Government forests in England have adopted this method for the rearing of their oak for the supply of the navy; and I understand that the trees so raised are doing well, and likely to become trees of the first magnitude: but still, I am not aware that they are succeeding better than transplanted trees would have done, had they been planted instead of the acorns at the same time. I have sown acorns in the forest grounds, with the view of ascertaining if plants raised in such a manner did grow much more rapidly than those brought from the nurseries and transplanted in the usual manner; and from what experience I have gathered upon this point,—which, be it understood, has been but upon a small scale (upon five or six acres of ground), where they were merely intermixed among transplanted trees, and the experiment was made simply with the view of satisfying myself as to the utility of the system,—I am convinced that

the trees raised from the *acorn* sown in the forest ground, grows, for the first few years, more rapidly than the others, and is brought into the proper form of a tree with very little artificial aid as regards pruning; but I have found also, that where much game exists, as is almost always the case upon gentlemen's estates, it is almost an impossibility to get the young tender shoots of the plants, as they rise above the ground, kept from being eaten down by hares and rabbits. About four years ago, I was very much inclined to commence the sowing of acorns in all our plantations where oaks were required to be raised upon the estate of Arniston; being convinced, from a former trial, in another situation where I was, in which I was very successful, that they, when got up without any damage befalling them, formed the handsomest and fastest growing specimens, I was the more bent upon making another trial upon an extensive scale. Having communicated the scheme which I then had in view to an old forester of forty years' experience, asking his opinion previous to making the attempt, he advised me strongly not to sow acorns immediately in forest ground, with the view of raising trees in any new situation, until I had proved the utility of the system, by sowing first upon a small scale. Acting upon his advice, for he was a man of the soundest judgment in all forest matters, I sowed *acorns* in pits dug by the spade for the purpose, and had the pits, in the act

of making them, well cleaned from all root-weeds, so as to give them every chance of success; and the soil being a fine dry sandy loam, I calculated upon success. I sowed the seed in the month of February, and, upon looking over the ground in a week or two afterwards, I was mortified to find that rabbits had visited the fresh earth of the pits before me, and had fully one-half of them burrowed through; upon looking for the acorns, I found the shells indeed, but the mice had eaten the kernels; and upon examining the state of the pits generally, in which the acorns had been sown, I found that very few of them had escaped the ravages of vermin of some sort or other—I even caught pheasants in the very act of scraping up and helping themselves to an acorn. Upon seeing all this, I was indeed thankful to my old friend, the forester, for his cautious advice, and was also happy that I did not sow extensively upon ground which was so much overrun with game and other vermin. As I had sown only about an acre of ground in the manner above stated, I could indeed easily have prevented the ravages of the larger animals, but against those of the mice there was no possible resource. Therefore, this being only a trial upon a small scale, I determined to give nature her own way in the whole business, and consequently did not go back to inspect the state of the pits in which the acorns were sown till about the middle of May,

when I found great difficulty in tracing out the exact spots where they had been sown—the grass and weeds which were natural to the soil had grown rapidly, and almost hidden the red earth. I immediately had the weeds, &c., all cut away from about the pits, and at the same time had the surface of the pits weeded by the hand; but there was no appearance of any oaks as yet in them. About the middle of June I again had the surface of the pits weeded, when I observed about twenty young oak plants rising upon a whole acre of ground; and before the autumn, there were none left excepting two, which I protected, which are indeed doing well now, but not a great deal better than others which were transplanted about the same time, in the usual manner, from the nurseries.

Besides what I have detailed relative to my attempt to rear oaks from the acorn in the natural forest ground, I have also since then sown in many places of our woods without digging the ground at all, merely paring away the turf from the surface of the ground slightly, and then putting in the acorns with a common garden dibble; and I did this with the view of disturbing the natural soil as little as possible, thinking that the rabbits and mice would not be tempted to burrow in the soil when they found it firm. The ultimate issue, however, was the same; for what plants were allowed to come above ground, and

had escaped the ravages of the mice and pheasants, were greedily sought after and devoured by the hares and rabbits when they came into leaf. Therefore, in the mean time, and until I have further experience upon this point, I am induced to think, that the system of rearing oaks at once from the acorn in the forest ground is not at all adapted to the present state of forest lands. I confess that I am convinced of the propriety of raising trees in the forest at once from the seed, in order to have the best specimens of timber trees; but it is very likely that a period of fifty years must elapse before our forest grounds are put into a proper and fit state for raising trees to advantage by such a system. Were it practicable to have all our forest ground ploughed and cleaned in the same manner as in agricultural operations, I would at once say, that all forest trees ought to be raised from the seed at once sown in the ground they are intended to occupy; but until then, the system is quite impracticable.

I conclude my observations upon this head by remarking, that the *advantages* of the system in question are, that the trees so raised never receive any check in their growth, as must be the case with all transplanted trees; they grow much quicker, and come sooner to the size of trees, than those raised by transplanting; they grow taller in habit from not having their *tap roots* cut, and are seldom

found to require much pruning, as is the case with the others.

The *disadvantages* of the system in question are, that the seed when sown in a detached form in pits in the common forest ground, is extremely liable to be destroyed by vermin before it vegetates; while, after the plants appear above ground, they are in equal danger from hares and rabbits eating them over. They are also liable to be destroyed from the effects of rank-growing grass and other weeds choking them while in their young and tender state; and in order to avoid this, much expense is incurred in keeping the plants clean. Trenching the ground for the reception of the seed, would be the proper plan; but the expense of such an operation to any extent is out of the question.

I now proceed to the second system of rearing the oak when young—viz. that of transplanting the young trees from the nursery into the forest ground, and in one year after, when their roots are fairly established, cutting them over by the surface of the earth; and when a number of young shoots are produced from the stumps, choosing the strongest and healthiest for a permanent tree in each plant.

This system is very much practised by foresters who have to raise hard-wood plantations in high-lying districts of Scotland, where it is well

known that young hard-wood plants are apt to suffer a severe check when newly lifted from a sheltered nursery, owing to the cold, cutting winds which prevail in such quarters. Indeed, in all cases, young hard-wood trees which may have been reared in some of the public nurseries near large towns, when they are removed to and planted in a high moorland county, seldom do much good for three or four years after their removal. The whole part of the plant situated above the grass or foggage of the ground, becomes stunted, and gradually dies down to within two or three inches of the surface, which part remains fresh, because sheltered by the foggage from the winds; and, indeed, if the plants are left to themselves in such a situation, they, about the third year after being planted, and after the roots have properly established themselves, send up a number of young shoots from the live part about the surface of the ground, which young shoots ultimately become trees of inferior magnitude; but if those young shoots be thinned out to one individual, a tree of the usual magnitude will be the result. Now, this system of cutting over is only assisting nature; and if, instead of allowing the young trees to lie dormant for three years, as is the case when left to nature, the forester cuts each tree over by the surface one year after they are planted, he places himself, by his art, two years

in advance of nature as left to herself; for as soon as the trees are cut over, they each send up from three to six vigorous young shoots, which, when they are of sufficient age, can be removed, with the exception of one, which is left as a permanent standing tree. I have, by adopting this method, had strong, vigorous young shoots of two feet high the second year after planting; and where I have not had them cut over, four or five years elapsed before I had shoots of the same strength.

I was acquainted with a forester who had the management of extensive plantations in Aberdeenshire, who, upon receiving his young hard-wood plants from the nurseries, of whatever species they were, cut each down to within three inches of the roots, and planted them in this state in the pits which were prepared for them in the forest. His reason for doing so was, that he asserted he gained young shoots a year sooner than if he had allowed the plants to remain for one year in the ground previous to being cut over, as is the usual way. But upon examining the state of his young hard-wood plants, which had been planted one year before I visited him, and inspected his system of going to work, I found that all his young trees which had been so cut previous to planting them produced but very weak shoots the first season, and, as I appre-

hended, they in fact made no vigorous growths till the second year. In this case, therefore, something was lost instead of gained; for until the roots of the young plants are fairly established, very little young wood can be produced. The plants require the first year in order to establish their roots, and if they are forced to make wood during the first year,—as is the case when they are cut over at once,—the wood seldom or never ripens, but is weak, and apt to be nipped by the first frost of winter; but when the plants are allowed to have their own natural way for the first season after being planted, and when the stem is allowed to remain, and push out a few leaves in order to elaborate any sap drawn up by the roots, these roots become during this period properly and firmly settled in the earth, and are rendered strong and vigorous for being called into action the year following. Hence it is, that young trees cut down the year after being planted, always make more vigorous and stronger shoots in that one season, than trees of the same character cut down when planted, and having two years' growth upon them.

In conclusion, this system ought always to be practised with oak, or indeed with any other hard-wood plants, when planted out in a high district, and after being removed from a

sheltered nursery; but in no other case is it necessary.

The third system of rearing the oak when in its young state, as formerly mentioned, is that of planting the young trees in pits, as is usually done, and afterwards allowing each to come away in its own natural way.

This is the system practised in all moderately sheltered districts, for the planting of oaks as well as all other sorts of young trees, and need not be enlarged upon here. I may mention, however, that in all moderately sheltered districts, young trees of any sort receive very little check from being transplanted, if they are not above four feet high, and if the soil is one adapted for the growth of the trees planted, and the work carefully and properly done; but if the soil be not of first-rate quality, and the situation one much exposed, the trees always receive a violent check, and, consequently, the bark upon the young trees becomes hide-bound, and will not carry on its natural functions; but the roots being as healthy as formerly, they, when the old tops are gone, send up young shoots to supply the place of the former, which, as they grow up, become habituated to the climate and situation, and consequently form trees adapted to it. Therefore the planter, when he meditates to bring up a plantation of young oaks, or other hard-wood, must judge for himself

as to which of the two last-mentioned systems he should adopt; and that, of course, must be regulated by his grounds being exposed or sheltered.

Suppose that a tract of ground has been planted with oak at seven feet apart, and the intermediate spaces made up with firs, to such a closeness as to leave the whole plants over the ground at three and a half feet distance from each other; and suppose that the oaks in such a plantation have been planted and managed in one or other of the two last-mentioned ways, as may be found most suitable in the case of the situation planted—the oak trees will, when the plantation is about eight years old, require to be carefully looked over, and pruned in all cases where found necessary, but not severely: for the oak, at no stage of its growth, agrees with much pruning; the wood is of a hard cross nature, and any severe wound made by the knife is not easily healed, even although the plant be young; therefore, pruning should be sparingly practised upon them. All that is necessary in the case of pruning the oak trees at the stage above mentioned, is to prune away one top in all cases where two exist, or where more than two tops appear upon one individual tree, to choose the best, and prune away all the others; to lop off a part of any strong branch that may have the appearance of gaining an undue strength upon the regular proportions of the

tree; and to clear away any small spray shoots from the lower part, so as to form a clear stem or boll. If this pruning be properly done when the trees are about eight or ten years old, when the wood is in its softest stage, no damage will be done; and if the work be properly done at this stage, little or no pruning will ever be afterwards required.

The oak not being a rapid-growing tree at any stage of its growth, as compared with many other sorts of hard-wood trees, the young plants will not, at eight or ten years' standing in a plantation, have attained a large size, probably not above five or six feet high; but if the firs which were planted among them for the purpose of giving shelter have thriven well, the oaks will be deriving benefit from their shelter, and progressing rapidly. In fact, young oaks never do come away well until such time as the firs rise up around, and afford them shelter; and more especially if the situation in which they are planted be an exposed one, or the soil naturally of a cold bottom. As an instance of the great advantage gained by planting firs among young oaks, in order to shelter them in their young and tender state, and to bring them away as rapidly as possible, I may mention a case which I witnessed myself in one situation where I acted as assistant forester. There we had about twenty acres of rather stiffish clay ground converted into a plantation, and it was situated upon what was con-

sidered rather a level and sheltered part of the country, although there was no other plantation near it. The ground was fenced by a young hedge all round, protected by a three-barred paling; and as the proprietor wished the plantation to be one of oak, without any admixture of other trees, the ground was planted entirely with oak plants in the usual way, and at three feet apart, but without any firs whatever to act as nurses. The oaks thus planted remained in a dormant state for three years after they were planted, not only making no young shoots whatever, but, upon the contrary, fully one-third of the plants died out. Upon seeing this state of things with regard to this plantation, the forester thought that the whole would turn out a failure upon his hand, set us to work, and had fifteen hundred Scots fir plants planted to the acre of the ground, mixing them regularly among the oaks. In two years after this planting of the Scots firs, or five years from the time that the oaks were planted, the former began to make considerable shoots, so much so as to give a little shelter over the surface of the ground: the oaks now began to throw up healthy shoots from the tops of their roots, or rather at that part where the roots are thrown out from the stem: and in many instances, where it was thought that the young plants were dead, they sent up excellent young shoots as soon as shelter was produced.

In fact, after this period, the whole plantation throve remarkably well, and the oaks kept pace with the firs during all the time that they stood among them; but in a few years they were mostly cut down again in order to give the oaks room as they advanced.

Now, from this example, I would draw the attention of the planter to the great necessity, in all cases, of planting firs among oaks in order to nurse them up while in their young and tender state, and having the firs thinned out by degrees as the oaks advance in strength.

Having pruned the young trees in the plantation of oaks in the manner formerly referred to, and that two years previous to requiring any thinning of the firs from among them, the next step in the rearing of such a plantation is to thin away any firs as soon as they encroach upon the oak plants; and this thinning of the firs, in the rearing up of oak plantations, must at all times be more severe than when thinning away firs from among the common kinds of hard-wood. And, indeed, this particular forms the only difference worth mentioning between the cultivation of the oak and the cultivation of hard-wood in general; that is, the oak-trees, after they are once properly established in the ground, and brought into proper shape by a judicious pruning, must, through the whole course of their culture afterwards, have more room and air than any other

species of hard-wood trees. The reason of this difference as regards the cultivation of the oak is this:—The oak is a valuable tree both upon account of its wood and bark: the wood is more valuable when grown of proportionable diameter than when of great length, and it is also of more durable quality when freely exposed to the air than when drawn up weakly and to a great height; thence arises the necessity of giving the trees free circulation of air in order to have valuable wood. The oak is also valuable upon account of its bark, as I have already mentioned; now, in order to produce bark, a tree must have extent of wood, whether that be in the form of trunk or branches. I have seen an acre of oak trees, one hundred years old, cut down and sold for the sake of both wood and bark, which had been cultivated upon the principle of drawing up the trees tall and without branches; and according to my note-book, which contains an account of the transaction of the sale, that acre of ground, which contained two hundred trees, sold for L.360. On the other hand, upon a neighbouring estate, I attended a sale of oak trees only ninety years old, and which had been cultivated upon the principle of giving free air and room to the trees as they advanced; and upon one acre of ground, which contained a part of those trees sold, I counted one hundred and four trees, which trees brought altogether L.868, making the oak trees which were

cultivated upon the principle which I have recommended—namely, that of giving free air and room—nearly three times the value of those which were drawn up weakly. When oak trees have free room for expanding themselves, the lower branches form into bends for ship-building, which is a valuable object; the trees also, being more branchy in themselves, produce a greater surface for the production of bark, and the bark itself, having free air, becomes thick and heavy upon the tree. Indeed, perhaps, it is not generally known that oak bark, produced upon trees having free air about them, weighs almost double that of an equal surface taken from a tree confined and not having air; and at the same time, bark of such weight is always more valuable, because containing a greater proportion of tanning matter.

What I have here said relative to the cultivation of the oak, I regard as sufficient to convince any proprietor of the necessity of keeping his oak forests thinner of trees than any other of his woods: and need only add, in conclusion, that in every other respect oak plantations are to be managed upon the same principles as other hard-wood ones. Oak trees are never reckoned of full age till they have attained from eighty to one hundred years; therefore, after a plantation of oaks has received its final thinning, it should be allowed to stand until that age before cutting down.

CHAPTER V.

THE MANAGEMENT OF OAK COPPICE-WOOD.—CAUSE OF DISEASE AMONG LARCH FIR PLANTATIONS.—HOW TO FIND THE VALUE OF YOUNG PLANTATIONS AND OF FULL-GROWN TIMBER TREES.—A FEW PRACTICAL REMARKS RELATIVE TO THE MANNER IN WHICH WOOD OUGHT TO BE PREPARED FOR PUBLIC SALE.

SECTION I.—THE MANAGEMENT OF OAK COPPICE.

PLANTATIONS of the description termed oak coppice, are now so common in Scotland, that there are few landed estates of any considerable extent upon which there is not less or more of them. In the West Highland counties there are many extensive plantations of oak coppice; and within the last thirty years many fine old oak forests have been cut down in the midland counties which also are, for the greater part, now converted into plantations of this description—the same being trained up from the young shoots which have arisen from the stocks of the old trees which were cut down. And seeing that this description of wood crop is upon the increase upon the estates of landed proprietors, I consider that it may not be out of the way for me here briefly to detail the best modes

of management of the same, more particularly with the view of pointing out the most profitable manner of going to work in the converting of old oak forest ground into healthy young coppice-wood.

When a plantation of old oak-trees is cut down, and when it is the intention of the proprietor to convert it into an oak coppice-wood, for the purpose of raising a crop of oak bark upon the ground, after the old wood has been disposed of, the work must be proceeded with in the following manner :—First, the whole of the wood of the old original trees, when cut down, should be removed immediately, as also all the bark taken from them — and this, in order that no damage may be done to the young shoots as they arise from the newly-cut stocks; for, if the wood be allowed to lie long upon the ground after it is cut, the young shoots will have grown to a considerable height, and they, being extremely tender, will be easily broken in the act of removing the wood at a late period. Therefore, in order to prevent this state of things taking place, if the wood have been sold to any neutral person, say about the 1st of May, he should be bound by the articles of sale to have the whole of both wood and bark removed by the 1st of July at the latest; and if this be not done, much loss will no doubt be sustained in the after crop of the coppice-wood, secing

that it is impossible to remove heavy timber from the ground without rolling it over the suckers in their tender state.

This part of the work is always best done by the proprietor's own servants, and under the superintendence of an experienced forester; because in such a case, the people who cut the wood are paid by the proprietor, and being so, will look more to the interest of the work, or at least will attend more to the orders given them, than strangers from a distance would do, whose only interest is that of getting the wood cut down at as little expense as possible, without any regard to the future value of the plantation. It is also necessary to notice here, that in cutting down any large oak tree, the stock of which is intended to push up young shoots for the formation of coppice, great care is necessary to see that the bark is not injured below that part where the tree is cut over; for if the bark be hurt and ruffled there, so as to separate it from the wood, moisture will be lodged between it and the wood, and consequently a rot at that part will be apt to take place. In order to prevent this, it is always a good plan, previous to commencing the operation of cutting down the trees, to employ a cautious trustworthy man to go before the woodcutters, who, with a *hand-bill* and wooden mell, should be instructed to cut the bark right through to the wood, in the form of a ring all round the cir-

cumference of the tree, just about three inches above the surface of the ground. This first ring being cut all round the bottom of the tree, three inches above the surface of the ground, another should be made in like manner about twelve inches higher up on the boll of the tree, when the piece of bark situated between those two cuts can be removed, and the woodmen made to saw each tree across exactly by the lower mark, or bottom of the peeled wood; this forms a guide to the men not to injure the lower part left with the bark upon it, as well as, when any difficulty is experienced in bringing the tree down, avoiding all waste of bark.

As soon as the wood and bark have been removed from the ground, all rubbish and useless underwood should be carefully cleared away, excepting any young healthy shoots, or young plants which may be considered worth leaving upon the ground with the view of their ultimately becoming trees. And immediately after the ground has been cleared of rubbish, the stocks or stools of the old trees will have to be dressed with the *adze*, in order to cause the young shoots to come away as low down, and as near to the surface of the ground as possible. If the young shoots of the oak, which are intended to grow up into coppice, be allowed to proceed from that part of the old stock which rises two or three inches above ground, these shoots will always par-

take more of the character of branches than of trees, and never will make a valuable plantation; but if the shoots be made to come away from that part of the stock where the roots join with the main stem, and which lies immediately under the surface of the soil, they will partake of the character of trees, and independent of the nourishment that they will receive from the parent stock, they will also send out roots of their own, and derive nourishment from the common earth, and form pretty large trees if desired. Now, in order to cause the young shoots to issue from this point, the long grass should be all cleared away round the stock, and itself dressed off with an adze. In executing this, care must be taken that the part where the roots issue from the main stem be not injured; but supposing that three inches of wood have been left above ground upon the stock, the workman will commence by levelling his tool upon it fully two inches down upon the wood, and hew off this part all round, gradually lessening the depth of his cut as he nears the centre or crown of the stock, which is left untouched, thus leaving a fall from the crown of the stock to its circumference of fully two inches, and forming a convex crown. This form prevents the lodgment of moisture, as well as causes the young shoots to come away as near to the earth as possible, which should always be aimed at; and in this manner, each and every stock which may be

intended for the rearing up of coppice-wood should be managed. The sooner that the operation is done after the trees are cut, the better is the hope of a good crop of healthy shoots; therefore, the forester ought not to delay this until all the other work of clearing away the trees and rubbish be finished; the whole of the work ought indeed to be gone on with according to the time that I have above stated, but still, the whole may be proceeding simultaneously. My way of proceeding with work of this kind is:—I have a party of men with horses and carts, who begin upon one side of the ground, and clear away all the valuable wood as they proceed, which is delivered to the sawyer, or otherwise as the case may be: immediately following this first party, I have a second, consisting of women and boys, headed by a man to superintend them, who gather up all the rubbish that is left by the men with the carts, and carry it to convenient openings, and burn it at once, unless some other more valuable use can be made of it: the ground being cleared by this second party, I have a man, or men if the grounds be extensive, following them dressing the stocks in the way described;—and in this manner the whole work can be made to go on at once without losing any time.

If the stocks of the old trees which were cut down are not numerous upon the ground, as is more than likely to be the case if the trees were of

any considerable age, there will not be enough for a permanent crop upon the ground. If, for instance, they were eighty years old, there will not be more than one hundred and twenty trees to the acre, making them about twenty feet one from another. Now, to have a piece of forest ground with that number of stocks upon it to the acre, would never pay the proprietor the common rent of his land: therefore, in order to take advantage of the ground forming the vacant spaces between the stocks, and to make the whole pay ultimately as any other plantation would do, the ground should be properly drained wherever found necessary, and a crop of young oak-trees planted all over it wherever there is room. In this case, the young oaks which may be put in, together with the old stocks, may be made to stand, as nearly as possible, eight feet apart: and again, all the intermediate spaces between them should be filled up with larches, so as to make the trees over the whole plantation stand about four feet one from another; that is, taking the old stocks into account also.

By filling up the ground in this manner, the old stocks will ultimately become of more value than if they had been left in an exposed state; and again, from their growing more rapidly than the young trees, they will produce shelter to the latter in their young state; so that, putting the whole together, a plantation of this kind grows more

rapidly than one altogether planted with young trees.

When the young shoots from the old stocks have been allowed to grow undisturbed for two years, they should then be carefully looked over, and all small ones removed, leaving the strongest all round the circumference, not closer than six inches one from another : these again should be left for other two years, when a second and final thinning should be made, choosing the strongest and healthiest shoots to remain, and in no case leaving more than six shoots to stand as a permanent crop upon any individual stock, or fewer still if the health and strength of the parent require it.

I am aware that many foresters are in the habit of not thinning their oak stools at all, until such time as the shoots have attained a large size, when they thin them out and peel the bark from them, supposing that by this system there is a gain from the sale of the young bark produced. Now, as regards this system, I am quite of a contrary opinion ; for, when the shoots are thinned out as I have advised, they very quickly attain a large size, whereas, when they are not thinned out until a late period of their growth, the shoots become stunted, and shortly indicate a want of vigour in their constitution ; consequently, at the end of a given number of years, instead of an advantage being gained by letting the shoots grow up until they

are fit for peeling, there is a decided loss. I have compared two plantations which were managed upon these two different systems, and found the one managed upon that which I have recommended, at the end of twenty years, worth nearly a half more than the one managed upon the opposite system.

When the young trees have received their second course of thinning, as has been pointed out, they should at the same time receive a judicious pruning, and that in the same manner as has already been recommended for the pruning of young oak trees: the larch firs, as they grow up, should be thinned away by degrees, in order to give room to the oaks as they advance, whether that may be to relieve the old stools or the young trees; and in every respect this thinning of the firs should be done as has already been recommended for the management of oak plantations generally.

Seeing that the value of oak bark has fallen so much during the last twenty years, I do not consider the growing of oak coppice so profitable a crop as it has been. About twenty-five years ago, the price of oak bark was £16 per ton, while this year (1847) the highest price that has been given in Edinburgh is £5, 10s.—making its value at the present time only about one-third of what it was twenty-five years ago, and consequently reducing the value of oak coppice plantations in the same ratio; and, upon this consideration, I

do think that proprietors should not, at the present time, rear up oak plantations with the intention of converting them into coppice, as has in many instances been done of late. I have seen plantations of healthy oak trees, about thirty-five years of age, cut down for the sake of the bark they produced, and with the view of converting them into coppice-wood, so as to have a crop of bark every twenty-five years afterwards. Now, had those trees which were cut down at thirty-five years of age, been allowed to grow for other forty or fifty years, they would, of course, have attained their full magnitude, and been worth to the proprietor, at the end of that period, more than three times the money that he could get as the produce of the same plants if cut down and disposed of in the form of coppice-wood, at periods of twenty-five or thirty years.

The safest and the best plan, with regard to all plantations, is, to allow the trees to attain their full magnitude in the usual way, when the timber will in all cases find a ready market, and at a fair price. No doubt, where old plantations are cut down, it is right and proper that the stocks of them should be converted into coppice-wood; for this is taking advantage of growths which can be converted into use, and which would otherwise be lost; but to raise up trees to a certain age, and then cut them down prematurely for the sake of their bark, is, at

best, an enormous loss to the proprietor, as well as to the country in general.

SECTION II.—CAUSE OF DISEASE AMONG LARCH FIR
PLANTATIONS IN SCOTLAND.

It is my opinion, that there is no tree cultivated in Britain more worthy the attention of landed proprietors than the larch. I am not aware of any purpose for which oak is now used, for which larch would not answer as well. It is a rapid-growing tree, and attains maturity long before the oak. I have seen larch trees, little more than thirty years old, sold for 60s. each, while oaks of the same age, and growing upon the same soft of soil in the same neighbourhood, were not worth 10s. each; and this at once points out the advantage of planting larch where immediate profit is the object. The larch has been held in high estimation in former times, as we learn from several old authors. The first mention made of the cultivation of this tree in England is by Parkinson, in his "Paradisus;" in 1629; and Evelyn, in 1664, mentions a larch tree of good stature at Chelmsford, in Essex. It appears to have been introduced into Scotland by Lord Kames, in 1734. But the merit of pointing out to the proprietors of Scotland the valuable properties of the larch as a timber-tree for our climate, appears to be due to the Duke of Athol, who planted

it at Dunkeld in 1741. The rapid growth of these, and of others of the same species, afterwards planted in succession by that nobleman, as well as the valuable properties of the timber of the trees that were felled, realised the high character previously bestowed upon the larch by foreign and British authors, who were followed in their opinion by others, such as Dr Anderson, Watson, Professor Martyn, Nicol, Pontz, Lang, and Monteith—all confirming, and further extolling, the valuable properties of the tree. It is no wonder, therefore, that the larch has been planted so extensively in Scotland of late years, in almost every kind of soil and situation, and under every variety of circumstances capable of being conceived in forest management, seeing that its culture has been so much recommended by men in whose opinions landed proprietors put much confidence as regards forest matters. I say that it is in a great measure owing to the advice of such men as I have above named, that the larch has been so extensively planted within the last fifty years in Scotland. According to their opinion, it was one of the hardiest, and most easy of culture, among our forest trees; and proprietors, relying too implicitly in this matter upon the soundness of the opinions of such authors, planted larch too indiscriminately, upon all kinds of soil, without having due respect to the nature of the tree; for the larch, as well as every other tree, is influenced

by a natural law, which restricts it to particular states of soil, in order to develop itself fully and perfectly; and it is upon this point that the cause of the disease now so prevalent in the larch rests. It is well known that, in many instances, whole plantations of larch trees have died, I may say almost suddenly; and, in many instances, plantations of it have failed in making a return of the expected advantages, far inferior even to the Scots fir.

For some years past, much has been said and written relative to the nature and cause of that disease, now so prevalent among our larch plantations, generally termed the *heart-rot*, or, as some writers term it, *dry-rot* (*merulius destructor*); but, for all that has been written upon the subject, I am not aware that any thing as yet really satisfactory has been the result, at least in so far as to cause any likelihood of a really permanent improvement in the cultivation of the tree for the future: therefore, in consideration of this, I may here be allowed to give my opinion, as a practical forester, of the cause of a disease which appears still to prevail extensively among the most useful of our timber trees. Many who have written upon this most important subject assert that, from the circumstance of the larch not being a native, it is fast degenerating in our country; and, in illustration of their argument, they point out the healthy development of many old original specimens yet remaining

in different parts of the country. Such a weak argument as this is scarcely worthy of being confuted; for we may as well say that the *plane tree*, which is not a native of Scotland, ought to be fast degenerating also, which we know is by no means the case. Another argument against this assertion is, that in many places we find healthy larch plantations, and in other places unhealthy, both, nevertheless, being of the same age. Now, I would ask such as hold the above opinion, if the larch be degenerating, why is it found to succeed well in one place and not in another,—and that, too, even within the bounds of the same gentleman's property? The only reasonable answer that they can give to this question is, that, wherever the larch is found thriving well, it must be growing in a state of soil agreeable to its constitution; and wherever it is found not thriving, it must be growing in a state of soil not agreeable to its constitution. Therefore, in our further inquiries after the cause of the *rot* in the larch, we must first ascertain the nature of the circumstances which affect the tree in both cases.

The larch is a native of the south of Europe, and also of Siberia. It inhabits the slopes of mountainous districts, in the lower parts of which it attains its largest dimensions. In its native mountains, the larch is never found prospering in any situation where water can lodge in the ground in a stagnant state; nor is it ever found of large dimen-

sions in any extensive level piece of country having a damp retentive bottom or subsoil. Upon the other hand, the larch in its native localities is found luxuriating upon a soil formed from the natural decomposition of rocks; for there the surface soil rests upon a half-decomposed stony subsoil, through which all moisture passes freely in its descent from the higher grounds. In this state of things, the roots of the trees always receive a regular supply of fresh and pure moisture, and, at the same time, the ground in which the trees grow is kept in a cleansed and sweet state, not having any stagnated particles of gas or water lodging in it; and this forms, in my opinion, the perfection of soil for the cultivation of the larch.

On making some inquiries at a gentleman who travelled among the mountainous districts in Germany, where the larch is found in its native state, I am informed that, upon level and dry-lying parts of the region mentioned, the larch does not succeed well, being upon such parts always more stunted in its growth, and apparently not enduring so long, as when found with moisture passing freely among its roots; and this assertion is exactly in accordance with the state of our larch plantations in Scotland, for, wherever disease is found to prevail, there is either a want of or too much moisture in the soil.

Now, until upon inquiry I was made aware of these circumstances relative to the larch as found

in its native localities, I never could satisfy myself as to the cause of the disease which has appeared among the larch plantations in Scotland; but since I have been made aware of the above circumstances, and have compared them with examples of healthy and unhealthy plantations upon several estates, where I have had the opportunity of examining for myself, I am now perfectly convinced as to the cause of the disease in question; and I am further convinced, that any man who will compare the state of the ground upon which a healthy plantation of larch is found in Scotland (that is to say, one which has arrived at a considerable age, and is in a sound state) with what I have stated relative to the healthy state of trees of the same species as found in their native regions, will at once see the same circumstances acting in each case. Thus:—In all cases of healthy larch plantations in this country, where the timber has attained large size, and is sound in quality, we find them growing upon a soil through which the water that may fall upon it can pass away freely; as for instance, upon the slopes of hills, and even in hollows, upon a strong clay soil, but where there is a proper drainage for the ready and free passage of the superfluous water; and I have even cut down larch timber, of large size and sound in quality, growing upon a light sandy moss, two feet deep, which rested upon a stiff clay. In this case the moss was drained, and the water passed freely

through the light soil; and the situation being upon a slope, there was a continual circulation of moisture passing along upon the top of the sub-soil, or clay. In short, I have found good larch timber growing upon almost all varieties of soil; but I never found it upon one which had not its particles constantly cleansed by the continual circulation of water passing through it, either by natural advantages or by artificial drainage. Upon the other hand, in all cases of diseased larch plantations, where the trees have become stunted and rotten in the hearts prematurely, we will find that the soil has either been badly drained, or not drained at all. There must be ingredients lodging in the soil, which act against the health of larch trees growing upon it, and which can alone be carried off by an effective system of drainage, in order to make it fit for the healthy rearing of larch.

In a plantation on a level piece of ground upon the estate of Arniston, I had occasion to cut down some larches, in the way of thinning; the plantation is about forty years old, and consists of a mixture of larch and Scots firs. Upon cutting a number of larch trees in the central parts of this plantation, I found them without exception all rotten in the heart, which was exactly what I anticipated, for the soil had never been drained; and upon cutting some trees upon one side of the plantation which formed a sloping sandy bank, I found

every tree sound, and of excellent quality of timber; while at the same time, every tree in this position was at least three times as large as those planted in the interior level parts of the plantation, although all were of the same age. Now, the cause of this superiority of the trees which grew upon the sloping bank may at once be seen, from what I have already said upon the point. Again, another side of this plantation was bounded by a deep ditch, forming a fence upon the edge of a field; and all along this ditch upon the side of the wood, larch trees of excellent size and quality were growing. Nothing can be more convincing than this, that in order to grow larch timber of sound and good quality upon land which formerly grew diseased trees, all that is required is to drain it, when success will be the result.

I have always found larch trees succeed better when growing among hard-wood trees, than when growing by themselves, or among other firs, even although planted upon soil in the same state in both cases; and the cause of this, I conceive, to be that the roots of the hard-wood, from their penetrating deeper into the earth than those of the fir, have a tendency to divide the soil, and open it up for the more ready circulation of the water through it. It is, indeed, well known to almost every forester, that the roots of the hard-wood trees will penetrate through the stiffest soil, and considerably break up and improve it, to the depth of about two feet; and when the

trees are of any considerable age, with their larger roots spreading far and wide, I have often seen the water running along the beds of such roots in considerable quantities, showing that they acted as conductors for the water though the soil: it is to this, that I attribute the superior health of such trees found growing among hard-wood, as compared with those among their own species upon the same quality of ground.

Upon the south lawn, at Arniston House, there are about twenty larches yet growing, of very large dimensions. They are generally above eighty feet high, and a few of them contain upwards of a hundred cubic feet of timber; one in particular contains one hundred and fifty cubic feet, and the tree is apparently in good health. The soil upon which these trees are growing, is a light sandy loam of about fifteen inches deep, and resting upon a stratum of yellow sand; they are, as nearly as I could calculate from the appearance of one which was cut down lately, nearly one hundred years old, and must have been among the first of the species which were planted in the lowlands of Scotland.

These fine specimens are growing among older hard-wood trees, as tall as themselves, but probably at least twenty years older. My opinion is, therefore, that the hard-wood trees had been a considerable length before the larches were planted among them; and owing to this circum-

stance, the ground would be well prepared by the roots of the hard-wood for the reception of the larches; which must, in a great measure, be the reason that most of our original specimens are the finest trees of the kind at present in the country, —they having always been planted in favourable localities, and near the residence of the proprietors.

From what I have said above, it will appear evident, that the disease in the larch is attributable to the want of proper drainage of the soil. Since I came to Arniston, to act as forester, I have recovered a considerable extent of young larch plantations, which were fast going back, and that simply by draining the soil, in order to draw away from it superfluous water, as well as to cleanse it from bad qualities which were natural to the soil, and formerly prevented the healthy development of the larch tree. These young larch plantations were under fifteen years of age when I drained them; but I cannot say if draining would recover plantations of an older standing. In all cases where it is desirable to cultivate sound larch timber, the land should be drained with open cuts at eighteen feet distance, and not shallower at first than eighteen inches deep; and as the plantation advances in age, the drains should be gradually deepened, and kept properly clean, and stagnant water never allowed to remain in them: for however well land may be drained at

first, if those drains are not kept in a clean running state, in order to prevent stagnant water lodging in them, they will ultimately be of very little benefit to the rearing of healthy larch timber.

SECTION III.—HOW TO FIND THE VALUE OF GROWING PLANTATIONS, AND OF FULL-GROWN TIMBER TREES.

The valuing of plantations is a point in forestry which, to be done properly and justly, requires the exercise of the judgment of a man who has had long practical experience in the matter. He who gives himself out as a valuator of plantations, in the settlements and divisions of landed property, must be possessed of an accurate knowledge of the prospective value of all the plantations that can possibly come under his notice, under the age of full-grown timber. He must have an intimate knowledge of the habits of growth of the different species of forest-trees, and of the influence of soil and local climate on their periodical increase of timber; these properties being absolutely necessary in the valuing of young plantations, while they are under the age of full-grown timber trees: and seeing that such properties are only attainable by a pretty long course of experience as a practical forester, I shall here state only the general method of going to work in valuing plantations.

In taking the present transferable value of plan-

tations, they are divided into three different and distinct classes, namely:—

1st, Plantations not thinned for the first time.

2d, Ditto, which have been thinned, but are under full-timber size.

3d, Ditto, full-timber size.

As each of these classes of plantations is valued in a manner different from the others, I shall here treat the manner of valuing in each case separately. With regard to the first, then—were I called upon to give the transferable value of any young plantation which had not been thinned for the first time when I saw it, I would in the first place calculate the original expense of fencing and planting; and having ascertained this point, I would next measure the extent of the plantation in acres, and put upon it a rent per acre, corresponding with the land in the immediate neighbourhood, but in all cases making an allowance for inaccessible heights and hollows. Then, the rule for finding the valuation is—to the cost of fencing and planting, and the rent of the land occupied for the time, add the sum of compound interest on the amount of these, and the result will be a fair transferable value between two parties.

With regard to the second class of plantations mentioned above, namely, those which have been thinned, but are under full-timber size:—

When trees attain a size when it is necessary to thin them for the first time, they will then afford

certain evidences on which to found calculations of their ultimate produce and value. Therefore, at the time when young trees show evidence of their future health, and until they have attained to a full-timber size, the valuation of all plantations of such trees ought to proceed on the principle of prospective value, and the rule for doing so is this:—first, Determine the number of years the trees will require to arrive at maturity; second, calculate the value of all thinnings that are likely to be taken from the plantation before it arrives at maturity, and that in periodical thinnings of five years from the time that the valuation is taken; and third, estimate the value of all the trees which will arrive at perfection of growth; and from the total amount of these sums, deduct compound interest for the period the trees require to attain maturity, and the result will be the present transferable value of the plantation.

With regard to the third class of plantations as above stated—namely, those which have arrived at full-timber size:—

As this is a class of plantations which every forester ought to be able to value at sight, I shall be more particular in pointing out the method of going to work in the valuation of such. Few foresters are ever called upon to value the two first-named classes of plantations, but the case is altogether different with regard to full-grown trees: these are the harvest of their labours, and they are almost every

day called upon to cut down and value trees of full-grown dimensions. In this case it is not the transferable value of the unripe crop as found upon the land that we have to do with: it is the simple value of wood itself, the value of each tree in its perfect state, in so far as the ground is qualified to produce it. It is often necessary that full-grown timber trees should be valued previous to their being cut down; and particularly in the case of a transfer of property, it is absolutely necessary to have this done, seeing that the trees are a part of the property to be sold. In taking the value of timber in its growing state, two methods are in practice among wood-valuators: the one is to measure the height of each tree by means of a measuring pole with a ladder, and by actually girthing the tree in the middle with a cord, and finding the contents in the usual manner of measuring round timber: the other method is, that of judging by the eye the number of feet that each tree may contain.

With regard to the first method—namely, that of measuring the trees by means of a pole with a ladder;—some suppose that this is the most correct way of going to work in the valuation of growing timber; and in consequence of this opinion having for some time past prevailed among the older class of valuers, much precious time has been lost by them, as well as useless expense entailed upon the proprietors who have employed them. I have my-

self seen three men, apparently busily employed for the space of ten days, in the measurement of four hundred trees, by the method in question; and even after all their labour, their valuation was disputed. A friend of mine being called in to make a second valuation, he did so by estimating the size of each tree by sight, and did the whole work in about half a day; and when those trees actually were cut down and measured, his report of the valuation corresponded to within five per cent of the truth, while the report given by the other party was thirty per cent beyond the truth;—this instance at once pointing out the possibility of being very incorrect in the valuation of trees measured with a pole and cord. From the many obstacles that are apt to come in the way, it is almost impossible to measure correctly any large tree in its growing state; and by a short sketch of the manner of proceeding in this kind of work, the impossibility of correctness will at once appear. In measuring trees in their growing state, the valuator has with him two men—the one carrying with him a pretty long ladder, in order to get upon the trees from the ground; while the other bears with him a measuring pole, generally about ten feet in length, divided into feet and inches for the sake of measuring the length of the trees, and a tape line marked with feet and inches for the purpose of taking the girth of the tree in the middle. With these

assistants thus furnished, the valuator proceeds by causing the man with the ladder to hold it to a tree, while the other goes upon it, and with his rod measures the height of the tree as he proceeds upwards. Having ascertained the entire height, as far as may be considered measurable timber, he again measures downwards, one half of the height of the tree, in order to take the girth at that part, for the calculating of the side of the square; and in this manner the valuator proceeds from one tree to another, noting down the dimensions as he proceeds. Now, as to correctness, this method would do very well, provided that there were no branches upon the trees; and, no doubt, the operators always choose that side of a tree which is most free from branches; but notwithstanding, there are few trees which, in taking a straight line from top to bottom, have not several branches to intercept the object. And this is what makes their measurement so very incorrect; for when the man with the pole has his line of measurement intercepted by one or two branches, he generally has to change his position upon the tree, and this often many times in the ascent of one tree;—often causing consequently a defect of several feet in the value of one tree, either less or more. Mr Monteith, the well-known author of the *Forester's Guide*, invented an instrument which wrought with a wheel, in taking the height of a tree, and with

this instrument he himself practised, in the valuation of forest trees. But for the same reason that I have already mentioned,—that is, from the wheel being interrupted by the branches of the trees,—it soon fell into disrepute, and is now scarcely or ever used: besides, the time and labour necessarily required for accomplishing the work of valuation by the method above referred to, is very much against its being used by active valuers of the present day. Such men, in almost all cases, accustom themselves to value any standing tree simply by sight—which is, indeed, when done by an experienced man, the method most to be depended upon. The eye is not easily deceived in the comparative magnitude of any two or more objects; and more particularly, if the action of the eye be long accustomed to compare the relative sizes of different objects of the same form, its judgment, if I may so speak, becomes almost indisputable: at least, a man is very seldom deceived by his eyes in the viewing of an object, if he have but accustomed them to act in accordance with his judgment; and this is all that is required in order to give a correct idea of the size of any tree. It merely requires that the eye should be accustomed to the work, and never to pass judgment on the size of a tree, until the mind be actually satisfied of the truth of the impression produced.

Every forester ought at once to be able to

estimate the size of any tree upon first sight of it. But a course of training is necessary before being able to do this; and as I myself, in all cases of valuing growing timber, pass judgment of the size simply by sight, I shall here point out the course of training necessary to those who may wish to become active in this most useful point in forestry.

Those who never have accustomed their eyes to compare the relative sizes of different objects, may at first be led to think that it is impossible for any man to give a correct judgment of the exact bulk of one tree as compared with another. This opinion, at first sight, is natural; but the power of habit is well known to be incredible; and to those who may entertain the idea of there being great difficulty to overcome, I beg to say, that a few weeks of persevering practice will overcome all the difficulty. When I first commenced to train myself to value trees by sight, I was engaged in the thinning of plantations from twenty to forty years old. For a few weeks, I, in every case of cutting down a tree, first eyed it from bottom to top, and from top to bottom, and passed my judgment as to the number of cubic feet it contained, before I cut it down: and as soon as I had the tree cut down and pruned, I measured the length with my rule, and took the girth in the middle, and upon casting up the contents, I compared the truth with my previous judgment of the matter: and at the end of three weeks, which time

I was employed in the thinning of the plantations mentioned, I could have told, to within a mere trifle, the actual number of feet and inches in any individual tree, before I cut it down. And in like manner, I practised myself when cutting down large trees, embracing every opportunity of improving my judgment upon the point, until I came to have perfect confidence as to the correctness of my decision.

But there is one remark which may be useful for me to mention in this place, relative to the correctness or incorrectness of the judgment of the eye in taking the size of a tree—and that is, the mind must be perfectly at ease. A valuator, with his mind uneasy upon any point foreign from his present purpose, is certain to commit errors; and this I mention, in order that any young beginner who may read this, and may commence his learning in the way I did, may be upon his guard at all times when valuing.

Having thus pointed out the way by which any forester may acquire the useful habit of valuing trees by sight, I shall now give a statement of the manner in which I generally go to work in the actual valuation of the trees in a plantation.

When called upon to take the valuation of a plantation of full-grown trees, or, as it may be, a thinning of trees from a plantation, I provide myself with a pretty large pass-book, containing, as usual, money columns on the right-hand side of

each page, and the spaces upon the left-hand side of the money columns I divide into four equal parts, parallel with them; the first space upon the left-hand side is for entering the numbers to correspond with these as intended to be marked upon the trees; the second for entering the species of each tree as it is numbered; the third for entering the number of cubic feet contained in the tree as marked; and the fourth contains the price, per cubic foot, of each tree as numbered. The following sketch of this form of book will more readily assist the learner:—

Number of each Tree.	Species of each Tree.	Cubic feet in each Tree.	Price per foot of each Tree.	£	s.	d.
			<i>s. d.</i>			
1	Oak	90	3 6	15	15	0
2	Ditto	30	2 6	3	15	0
3	Ash	82	2 0	8	4	0
4	Ditto	20	1 6	1	10	0
5	Elm	73	2 0	7	6	0
6	Ditto	30	1 8	2	10	0
7	Beech	75	1 6	5	12	6
8	Ditto	25	0 10	1	0	10
9	Plane	87	3 0	13	1	0
10	Ditto	26	1 6	1	19	0
11	Larch	64	2 0	6	8	0
11	Ditto	32	1 4	2	2	8
13	Scots Fir	58	1 6	4	7	0
14	Ditto	18	1 0	0	18	0

In the act of valuing trees in the forest, I do not, of course, take time to sum up the value of each tree, but leave the money-columns blank until I have the work finished, or at least until the evenings when I get home, and then I have leisure to do so correctly. Having provided myself with a book of the description mentioned above, all ready and ruled, with the numbers filled in, and the uses of the columns written along the top of each page, I next engage three, or perhaps, if the trees are hard in the bark and difficult to mark, four men of active habit, each provided with an *iron* adapted for the marking of figures upon the bark of trees: one of the men I cause to begin by marking No. 1 upon the first tree to be valued, a second man marks No. 2, a third No. 3, and the fourth No. 4; and in this manner the four men follow one another, each of them marking his own number next in succession upon another new tree: that is, if the first man mark No. 1, his next in succession will be No. 5, if the second mark No. 2 his next in succession will be No. 6, and so on with the rest. When the men are properly arranged at their work of marking the trees, I next commence myself with the tree having the mark No. 1 upon it, and write opposite the same number in my book the species of the tree, next the number of cubic feet that I think it contains, and lastly, the price per cubic foot of each tree, as I think it would really bring in the market

at the time of valuation—and in the same manner I go on with each and every tree that is to be taken value of.

I may remark here, that every valuator of growing timber, previous to entering upon the valuation of it in any locality with which he is not well acquainted, should in all cases make himself properly aware of the general prices of wood in that district; for if he do not, he will unquestionably commit gross errors in his work. If, for instance, a valuator were to be called from Edinburgh to value wood in the county of Peebles, or any other inland district, and he proceeded to value the same according to the rate of wood-sales in the neighbourhood of Edinburgh, his valuation would, of course, be about one-half too high; because, in the county of Peebles, or indeed any other inland district, there is little or no demand for wood: consequently, before the wood could be sold, it would require to be carted by the purchaser a great distance to reach a market; and seeing this, the valuator should always regulate his prices per foot according to the prices that he knows will be given at the nearest seaport, deducting the expenses which will be necessary to carry the timber between the place where it is growing and the seaport where it is to be sold.

SECTION IV.—A FEW PRACTICAL HINTS RELATIVE
TO THE MANNER IN WHICH TREES OUGHT TO BE
PREPARED FOR SALE.

In order to the disposing of wood growing upon gentlemen's estates to the best possible advantage, a few practical hints may not be out of place here.

All sorts of hard-wood, the bark of which is not used for tanning purposes, should be cut down for sale from October till March; during those months the sap of the trees is in a dormant state, and when wood is cut in such a state it is of better quality for any permanent use than when cut in the summer months.

All oak, larch, and birch, the bark of which is used for tanning purposes, should be cut down and peeled just when the buds of the trees are expanding into a green state; but in all cases where the wood of these trees is wanted for permanent use, the trees should be cut from October till March.

All sales of wood should be conducted upon the principle of *public roup*. At public sales there is always a competition of purchasers, who generally set up the wood to its proper value.

Where there is a saw-mill upon a gentleman's estate, for the cutting up of trees for valuable purposes, and where there is a good demand for wood, private sales of wood after being cut at it generally

pay the proprietor better than when the wood is sold in its rough state and without measurement.

In preparing wood for a *public sale*, each sort should be arranged into separate lots by itself, and no individual lot should contain less timber than twenty-five cubic feet, in order that there may be a cart-load for the purchaser.

All timber of good quality should be lotted separately from that of indifferent quality. Let good timber be sold in lots by itself, and bad timber in the same manner; and if possible, whatever number of trees may be put into a lot, let them be nearly of an equal size.

All oak timber should be sold in its growing state, unless the proprietor wish to have the cutting and peeling of it kept in his own hand, which is advisable, seeing this sort of work is more likely to be done to the general advantage of the stock than when done by strangers. At all events, in all cases of taking down oak trees, the cutting, at least, ought to be done by the proprietor's men, not only with a view to the safety of the stools, but also for the sake of other trees that may not be intended to come down. In the case of thinning out among large full-grown oak trees, I have seen much damage done to the standards from carelessness in allowing the fallen trees to smash the branches of those which were to remain; and in that instance the purchaser cut down the trees himself, and,

not being a conscientious man, he had no respect to the remaining trees. Now, in all cases of like nature, were the work done by the proprietor's men, it would be done with care.

All trees for sale should be cut down with the saw, when of a size above six inches diameter at the bottom; and all trees under that size may very properly be cut with the axe. In cutting a large tree with the axe much valuable wood is lost at the bottom part; but when cut with the saw, all the available wood may be preserved.

When trees are laid together, in the way of letting out for sale, the bottoms and tops should all be laid one way, and that in a regular manner.

The lots, as they are prepared for a sale, should be all numbered, and entered to a corresponding number in a book kept for the purpose; at the same time stating the kind of wood that each lot consists of, with the number of trees in it, and the value of the same. When this necessary precaution is used, should any dispute take place relative to the lots afterwards, such may be at once adjusted by referring to the *roup roll*.

All lots of wood prepared for public sale should be carried out of the plantations, and put upon road-sides for the conveniency of purchasers getting to them with their carts.

Collected +
and
complete
K. P. B. Quaitch
13 2/78

BOUND BY
W. H. & E. M. O.

