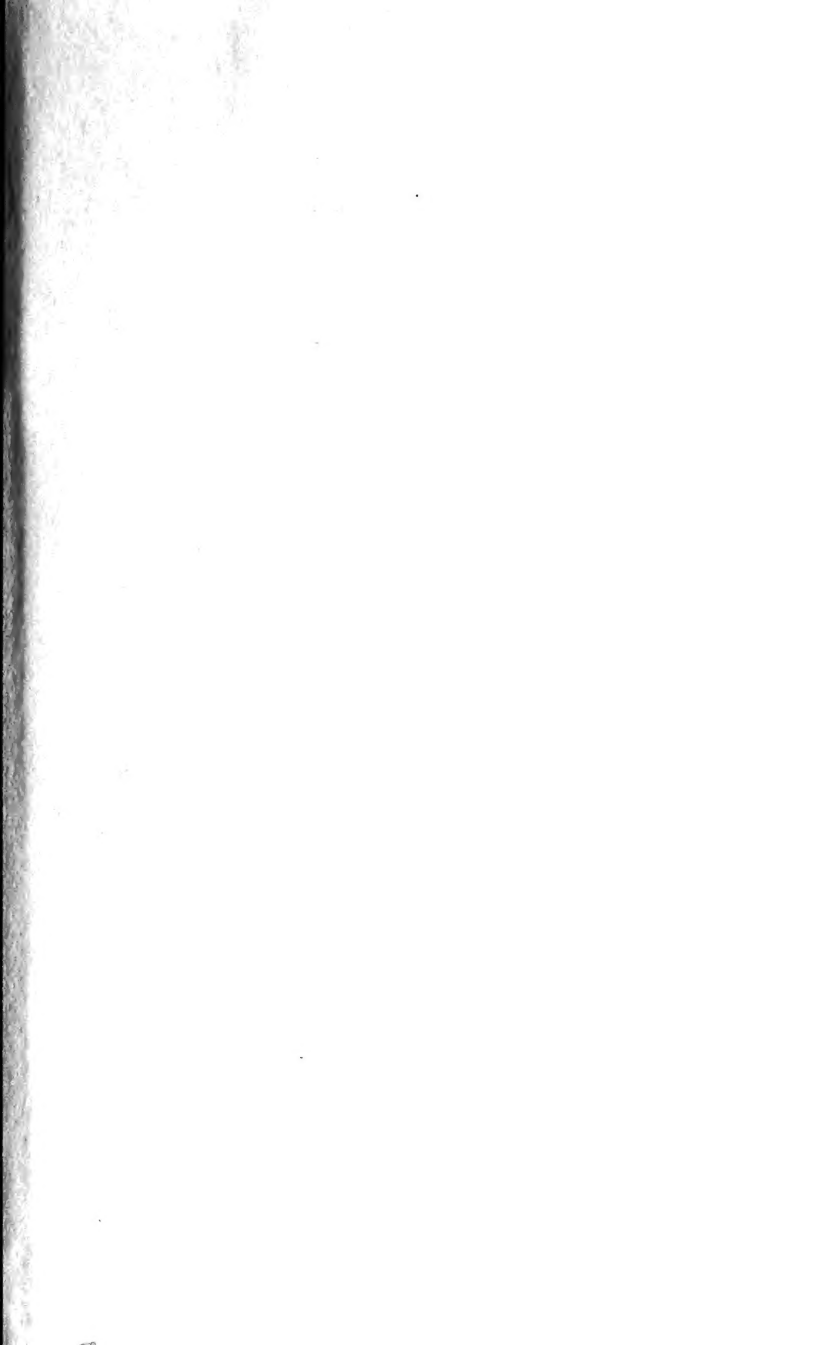




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*Frontispiece.*

PINUS SYLVESTRIS—OXSHOTT, SURREY.

*Photo by Edward Step, F.L.S.*

# PRACTICAL FORESTRY

AND

*ITS BEARING ON THE IMPROVEMENT  
OF ESTATES*

BY

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Fourth Edition



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## PREFACE TO FOURTH EDITION

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SINCE I wrote the preface to the Third Edition twelve years ago, Forestry, as a profession, has passed out of its atrophy to a period of national activity and usefulness. The nation's call for an unlimited supply of timber has resulted in the depletion of vast areas of our limited forest lands. The lessons to be learnt from this are manifold, and I hope they may be treated so seriously and effectively as to allay the natural anxiety as to future supplies of timber.

There is a call still for home-grown timber, and this call will continue and grow greater; and it is for the landowners to respond to this, and promptly, as the demand is imperative. Foreign-grown timber can no longer be placed upon our shores, as it has been in the past, and the quality of even this supply may not reach the standard we have been accustomed to, not at least until new areas are tapped.

The demand for timber for housing, and for almost every commercial project, will grow with leaps and bounds, and we, as a nation, cannot supply it. The neglect of one of the primary productive industries has been carried through centuries, and now we experience the evils of this long apathy,

There is but one road whereby we may reach the

desired epoch, when supply will meet demand, and that road is immediate and continuous planting. Planting is the keystone of Forestry, and it is the one stone that has been neglected. Trees cannot be grown in a year; time must be counted by generations, therefore no time should be lost if we are to benefit those who will follow us in due course. One generation plants for the next, and not for itself; but one reaps what the past has planted, and so runs the plain path of duty.

Planting should not be considered as a purely financial concern. "Will it pay?" should not be asked. It is a duty which is inherent; it is an obligation of land ownership, and also the prime principle of Forestry. Every landowner who sells timber should remember that he is reaping the crop his forefathers planted, and he should plant that his successor should reap also.

It should not be a case of money, because naturally, when selling, a percentage would be set aside for replanting. Let the Government be asked to aid in the planting of the vast area of waste land, but do not allow this aid to usurp the inherent duty of the landowner.

The lessons we have to apply from those we have learnt during the war may be summed up as follows:—

1. Planting should follow cutting.
2. That all planting should be conducted on a commercial basis, and Forestry be treated as a means of supplying commercial and economic needs.
3. That trees should be selected which will meet

those needs, due regard being paid to soil, site, altitude, and local demand.

4. That the chief demand will be for the Coniferæ, and that the following, in order of merit, should be selected: Larch, Scotch Pine, Sitka and Common Spruce, Silver Fir, and Douglas Fir.

5. That large areas should be planted, with the object of supplying quantity and quality, and that thinning should be limited to the production of long, straight, and matured timber.

6. That no area of woodland which is not yielding a full interest upon its capital value should be allowed to stand, but be cleared and replanted.

7. That every tree felled should be allowed to lie in its full length.

8. That regard should be paid, when laying out new plantations, to arrangement of roads necessary for future removal of timber.

9. That for maintaining supply all sums received for timber should be liable to a deduction, whereby a fund may be created for replanting.

10. That where principles of Forestry have been strictly followed the best results have been achieved, and the future prospects secured.

11. That every landed estate of reasonable magnitude should possess its own nursery, and that the seeds of trees required should be sown.

I have not thought it necessary to change, or even modify, the text of this modest book, it being based on principles which do not allow of such; but every forester, who knows his work, will modify and adapt according to the circumstances of his case.

Neither have I considered it necessary to alter the figures in the calculations given as examples, because there are no fixed figures which can be accepted. Each example may be brought up to date to meet increased wages, cost of seedling trees, and other items. It should be borne in mind that, though costs have increased, the value of timber has increased in like proportion.

Finally, I may express the hope that Forestry may in the near future become a more practical and necessary industry, on lines similar to those of agriculture, and that landowners may recognise their woodlands as one of their chief assets.

CHARLES E. CURTIS.

BROCKENHURST, HANTS,  
*1st January 1920.*

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# PRACTICAL FORESTRY.



## CHAPTER I.

### *PREFATORY REMARKS.*

IT is exceedingly difficult to avoid the too common practice of generalising on the now threadbare subject of agricultural distress and depression when writing about any matter affecting the management and improvement of landed property. To some extent, undoubtedly, this failing is a necessity, as approach in any direction we will the subject of improvement, be it ever so far removed from agriculture, the effect of the depression is manifest. The sinews of war, so to speak, have so far arisen from profits and rents arising from agricultural lands; and these having partially failed render it impossible to carry out improvements of any kind, except by the expenditure of capital drawn from the land by mortgage, or by the withdrawal of capital otherwise invested. Hence improvements are less general, and hence, too, arises the cry for employment from nearly all agricultural areas. No fault attaches, or, at least, no fault can be

located anywhere; it is but the outcome of low prices and keen foreign competition.

We have no intention, however, of giving way to this depressed state of writing; but rather, taking the standpoint of an optimist, endeavouring, in the following chapters on Forestry, to point out how, in the not very remote future, such a state of depression may be met, and, to some extent, defeated.

Landowners—*i.e.*, owners of purely agricultural land—have been too dependent upon rents emanating from the land, and not partially independent, as they might be, in such an emergency, on account of the profits arising from well-managed woodland.

Few will be inclined to cavil at the following statement—that our woods and plantations are not such a source of income and wealth as they might be. If the same enterprise bestowed upon our agricultural land in the expenditure of landlords' capital had been manifested in the expenditure of capital upon our woodlands, there would have been that proverbial second string so useful when found. Few landowners, however, have been able to meet these periods of depression by drawing upon their woods, without injuring very largely the interests of their successors. And yet where true forestry has been carried out the land has been found capable of yielding an annual return equal, if not superior, to arable or pastoral land of somewhat similar quality; and with this advantage, that the yield is present when wanted without a large yearly expenditure, and without the risk arising from fluctuations and seasons. Too often, however, as is manifest to even a casual observer, our



woodlands are like banks, often overdrawn upon, and are not treated with that consideration which they deserve. The wholesale destruction of valuable timber to meet pressing demands has greatly marred the beauty and wealth of our woods; and if every proprietor were free to cut and sell as he pleased, *i.e.*, if he were without legal restraint, it is possible to believe that a very much smaller area would now exist.

What is required is to encourage the judicious planting of new areas, and to preserve and improve carefully those in existence. To do this requires the employment of skilled foresters, and to obtain this class must be the mainspring from which all future success will arise. Efforts hitherto made by many landowners have been nipped in the bud by failure, and nine times out of ten these failures have arisen from deplorable ignorance in the men employed. Until the idea is exploded that any fool can plant a tree there can be little hope of success.

Perhaps of all branches of culture arboriculture is the one that needs most culture in the individual. He is not called upon to sow a crop which he will reap the following season, but to sow, tend, and judiciously thin a crop which is to stand through future and distant generations. He must be cognisant at least of the principles which govern plant life, although he need not be deeply learned in vegetable physiology. He must understand the nature of soils and their preparation for tree life; and, above all, must he be aware of the trees adapted to each. Wherein can a greater failure lie than in the wrong selection of trees? We venture to assert that, take

the country through, a really sound forester or woodman is but occasionally found. Many practical men there are who have acquired the knowledge they possess by simple practice, but who are otherwise absolutely disqualified from taking a leading part in large forest transactions. Until by thorough and sound teaching such a class is obtainable there is little hope of any great improvement in our system of arboriculture. Nothing succeeds like success, and if some extensive plantings could be carried out, and if they proved successful, no doubt many would follow suit, and a sylvan era would ensue.

We are a tree-loving people, and we revel in our beautiful glades ; but we are not a progressive people in this respect. We have not, in an equal degree, that energy manifested by our ancestors in the introduction of useful trees ; but we need not seek far for the reason. In those remote times they were dependent upon their own production, and were lavish in the use of it. Now we are supplied from countries east and west, north and south, and have thereby lost to some extent our independence. If this supply were stopped the old love of forestry would revive.

Our object, however, is not to moralise, nor to induce landowners to believe that this foreign supply is likely to cease, but to induce them, if possible, to improve their estates by planting for profit, for shelter, or for ornament. That the foreign supply will decrease, from an increased home demand, from recession from the port of embarkation, and from rise in freights, is a foregone conclusion ; but a conclusion remote enough to excite no alarm.

With regard to the objects of planting, direct profit is the most inductive; but shelter, wisely arranged tends greatly to improve land for agricultural purposes, and undoubtedly increases the yield of wheat and other cereals, and also materially improves the condition of our flocks and herds. Ornament, too, is no mean factor in rural economy, and perhaps tends more to increase the capital value of land than either of the foregoing.

The principal hindrances to planting are, perhaps, the large capital required and the deferred return therefrom; the difficulty in obtaining qualified foresters, and the inertia in our landowners. The two former can be overcome by the sweeping away of the latter. Few improvements yield a speedy return, many never return any—*i.e.*, direct return—and few are so certain as well-conceived and well-executed planting. We do not for one moment recommend planting areas fit for profitable cultivation or grazing, but we do strongly recommend planting those areas now lying idle or unremunerative. We recommend it because we know by long personal experience that a return is certain and not unreasonably deferred. A man of middle age may plant with a reasonable hope of reaping some share of his enterprise.

We have just visited a large covered yard, the timbers of which were of larch, all home grown, and all planted by men now engaged on the estate. If soil and site are well chosen, thirty to forty years will bring larch to a useful maturity, and yield a large pecuniary return over and above the yearly income

derived from thinnings. If the above facts were well weighed by landowners, it would probably incite them to plant more than any sophistry.

Our object, then, in the following pages, is to endeavour, in a concise and practical way, to lay before the landowner and agent, and, we hope, the *bonâ fide* woodman, the true principles of practical forestry,—to eliminate science as science, but to merge it with practice, because we hold that, to ensure success, the two must run together. Neither can stand alone, and a forester possessing one or the other, but not both, is from a practical point of view a useless incumbrance. If we succeed in the most trifling degree in promoting a desire to learn, and so advance the grand scheme of national and private education in forestry, we shall be more than repaid.

Our object will be to carry the reader through a series of seasons and periods, and through the various operations in the plantations and woods; to describe the processes of drainage, planting, thinning, pruning, and final realisation. To consider the selection of sites, soils, form, and size of plantations; the selection of trees, and the objects of planting. Also to consider the necessary pains and precautions to secure beautiful and ornamental specimens.

At the same time, our object is to interest the forester, and to induce him to search further into the intricacies of this magnificent study by referring to standard works, which deal more thoroughly with detail than a work of this nature is capable of.

## CHAPTER II.

### *OBJECTS OF PLANTING.*

To meet with success in any undertaking there must be an object in view. This is only stating an abstract truth. So it is in forestry: the landowner will have an object in view when he decides to plant. It may be to create new areas or to increase those existing; to provide shelter in exposed situations, to ameliorate climate, to beautify scenery, or to provide a source of future income and profit—to invest, in fact, a sum, with a view of its accumulation. One and all of these objects will present themselves to the mind of the planter, and if carried out with skill and with a true knowledge of forestry will undoubtedly succeed.

Let us analyse these objects somewhat, and endeavour to show how real they are, and how free from speculative dangers. Few will risk an outlay in times like these which will not, *prima facie*, show a reasonable prospect of return. Some there certainly are who will sink money unwisely, and find out too late that their so-called improvement has proved a delusion. These years of agricultural adversity have, however, checked this, and now there is a tendency to really develop to the full the latent properties of our landed estates. Perhaps of all improvements, as before

stated, planting is the most certain of success, and future generations will have cause to bless those who now invest their money in this way.

To plant a tree is one of the duties of every Englishman, and it is rapidly becoming recognised as a duty in all our colonies, with a view of replacing those vast forests denuded of trees. Consider the case of a treeless tract; what is more dismal and dreary? Those who have travelled over wide areas without a tree to break the monotony of the landscape, and who, after days of travelling, have found themselves in vast wooded districts, can appreciate true forestry. Apart from the actual value of the timber upon the land (which in itself does not increase the capital value of land, it being capitalised as an additional item), the increase in value which arises from its presence is a factor not to be lost sight of. It is a striking factor, as all know who have purchased or sold landed estates. There can be no greater inducement to purchase or retain an estate than the fact of its being well covered with ancestral timber. It is something which the millionaire cannot obtain at will; something which he may covet, but which, except by purchase, is beyond his reach; and although he purchases trees at so much a foot, the inherent value of their presence is the mainspring on which hinges the value of the estate.

On likely building sites, what gives such a value as the presence of timber? Timber not present cannot be placed there except by planting and the lapse of years. On bleak estates, or on such as would be bleak but for the presence of timber, does the timber

bear a simple market value? We need not multiply such instances. The fact that the presence of timber affects the value of landed property much beyond its commercial value is beyond dispute.

The object, however, will vary in accordance with the nature of the estate ; whether it is flat and fertile, hilly and sterile, exposed to winds, or liable to flooding, and so on. Planting more or less affects all these conditions. If land is flat, and fit for profitable agriculture, the benefit is reduced to the minimum. The income derivable from the estate will probably not be increased by the creation of woodland. The object then will probably be ornament, or shelter for stock.

If the estate is hilly and partially unfit for agriculture, the object will be to clothe the sterile hill-sides with wood, which will assist materially in improving the rest, by the effect upon climate and moisture. Land of this kind, yielding now, probably, no return, may be made, not only profitable, but a source of wealth. If exposed to cutting winds, shelter will be the object ; and this shelter, when obtained, will be equivalent to the removal of the estate many miles southward. If liable to sudden floods, owing to the presence of bare and unclothed hill-sides, the mischief will be stayed by judicious planting.

However, the main object, the main incentive, has been, and will always be, that of direct profit. Timber, as a crop for commercial purposes, is what is wanted, and the minor incentives will follow as a natural result. The one may be obtained from the other.

We know, personally, of tracts of land in the south of England, almost valueless, from a cultivation point of view, now yielding a handsome return from the wise planting of larch fir. If still in their naked state, these tracts, through the long period of depression, would have been as barren and useless as the Sahara itself. They now yield an income, and will continue to do so for many years; and when the present crop is reaped the land will be enriched and rendered fit for replanting or other purposes. Reclamation, as this implies, is by no means a mean object in many cases, and may especially be the case when dealing with dry and sandy tracts.

Objects then are manifold, and, if correctly estimated and carried out, the landowner and the nation will be benefited.



## CHAPTER III.

### *CHOICE OF A FORESTER.*

THE first thing that a proprietor will do, after having determined his object, will be to secure the services of a forester. This often is a difficulty of no mean character. As before stated, there are few really qualified men, but many so-called woodmen. This is only a natural result of lack of requirement. Where there is no demand, there is, as a rule, no supply; and few will take the trouble to acquaint themselves with a full knowledge of forestry who are not likely to be in a position to practise it. If once the land-owners show a determination to extend their plantations, and manifest an interest in the conservation of their existing woods, there will be an expressed desire by a class to obtain the necessary education.

Again, the wages or salaries given to foresters or woodmen have not been such as to secure the services of educated men. Men having a knowledge of chemistry, entomology, geology, vegetable physiology, and so forth, are not satisfied with £50 to £70 a year; and it is seldom that the return from our woods will meet a more extravagant salary.

Nevertheless it is possible, and not improbable, that

this false economy has had something to do with the unsatisfactory condition of our woodland. Perhaps, if more intelligence had been exercised we should not now see so much that is really wanting in the sense of a true systematic course of forestry.

We have, in our somewhat long experience, seen forestry at home and abroad, and have seldom seen that display of knowledge and system which we all desire to see. We have seen, too, the deplorable state of large areas of woodland through absolute neglect on the one hand, and extravagance and ignorance on the other. The former is apparent in the weakly timber, the decaying and moss-grown stems, the drains stopped and overflowing; the latter in the sweeping away of all good timber, to meet pressing emergencies, and in the existence of ill-grown and faulty timber of little or no commercial value. When called in to advise we have too often had to find fault with past mismanagement, and to point out the necessity of a long series of years of reclamation and improvement, unattended by present remuneration.

This state of things can only be remedied by the introduction of a class of men really intelligent and possessing a fair knowledge of the sciences attaching to the subject, as well as a practical knowledge of ordinary field-engineering and woodmen's work. More than this, the forester must, if he is to organise and control large forest operations, qualify himself in nursery work. Forestry on a large scale can never pay without a forest nursery, and to place this in the hands of an ignorant man is folly of the greatest

magnitude. Nothing can be more fatal to success than planting ill-developed and meagre-rooted trees. To purchase the trees, or to plant by contract, are also means to ensure failure. The latter plan, however, if really good nurserymen are employed, is better than employing unqualified home men.

There are different grades among foresters. There is the professional expert—unfortunately too few in number; the land agent, often very ignorant of this special branch of his profession; the head gardener, often employed on estates as head woodman (if, however, he has not been specially educated for the class of work, his ignorance is very apparent); and, finally, the labouring woodman. This class we have all over the three kingdoms, and it consists of most excellent and able men. Their skill, however, is to carry out instructions, and not to initiate; and men of experience able to direct are what we really need.

The professional expert, if he deserves the name, is a factor in woodland economy of the greatest importance. The principal drawback to his employment is the remuneration which he naturally expects; but this, though large, is not necessarily a continuing expense. His advice on the whole or on any part may be sought and obtained without his services being retained. His experience is wide, his knowledge extensive. True economy would be often exercised if this class of forester were consulted.

The land agent, whom we would naturally expect to possess the necessary skill and knowledge, is often deficient in it, in fact he is seldom proficient. It is not his fault, it arises from the lack of opportunity to

gain the knowledge. His knowledge consists principally of measuring and valuing.

The gardener, as a rule, is a faulty woodman. His services, however, may be found useful in the nursery, and in the ornamental planting near the mansion.

Among the ordinary woodmen we have found the most willing and able men, men anxious to learn and willing to carry out directions. Many of them make most excellent foremen; and we would rather carry out extensive plantings, and other branches of forestry, with their direct aid, than employ a more advanced woodman as intermediary.

What then should guide the proprietor of a landed estate in his selection of a forester? It must depend greatly on what his intentions are. If he is himself fairly qualified and willing to conduct the operations, he will find one of the latter class the best, and sufficient. If he has not the necessary skill, he will do best to consult and employ a professional expert, who will on his part employ probably one of the same class. If his agent is qualified, he will consult him, and place confidence in him. The choice of a gardener we do not under any circumstances recommend. Then, he will naturally ask, what are the qualifications needful?

The true forester should be a man of education, possessing a fair knowledge of, at least, elementary science,—and this term is comprehensive, *i.e.*, it should include botany, vegetable physiology, geology, and entomology; also a knowledge of land drainage, simple surveying, timber measurement, and of commercial values and uses of hewn timber. He must

also be skilled in nursery work, and in all the practical duties of a working woodman. He should be able to wield the axe, and use with skill and judgment the pruning-chisel or knife; and, above all, he should possess that common sense which is absolutely essential in the control of men.

A man cannot be perfect, and we do not imply perfection; but we do urge, and strongly, the necessity of employing able and intelligent men. The work to be performed is work of a high order, failure is a matter of grave consequence, success means prosperity to future generations. If the actual planting is successful—*i.e.*, if the trees planted live—the work is not complete, the work is progressive. All cannot continue to grow together like a crop of corn; there must be skill in the thinning, skill in the pruning, skill in the training throughout.

We recommend all those seeking a working forester to apply to one or more of our best nurserymen; and there are many. They will probably be able to recommend a good man, who, from their personal knowledge, has been well and thoroughly trained.

Certificates of merit they can seldom obtain, except from private sources; but we hope the day will come when planters will seek and employ only those who hold some certificate of professional knowledge emanating from an acknowledged source.

## CHAPTER IV.

### *CHOICE OF SOIL AND SITE.*

IT would be possible, under this heading, to write very fully of the subject of geology, but we fail to see the benefit which would accrue from it. As before stated, it is of great importance that the forester should possess an elementary knowledge of geology; but that he should be a geologist, in the true acceptation of the term, we do not for one moment imply.

It stands to reason that he should know something of the earth's crust with which he has to deal; how this crust has been formed, and how, by volcanic agency, each separate layer has been brought to the surface for the use of man. He should know, too, sufficient of the subject of structural or solid geology to follow intelligently the various diversities of surface soils.

He should be able (when called upon to deal with areas outside his own locality) by reference to a geological map, to obtain an idea of the nature of the soils likely to be found thereon. Not that structural and surface geology are so closely analogous as to render it possible to infer that one exists on account of the presence of the other, but that there will be a

modified resemblance, the knowledge of which will be of service when dealing, in the first instance, with large pending operations.

The origin of soils has been so often written about, that it seems unnecessary to reproduce the subject here; we may, however, remind the reader that soils, so called, are the disintegrated surfaces of the underlying formations, not necessarily partaking of the exact character and ingredients of that immediately underlying or adjacent; because most of our deep soils are the drifts from the detritus of the denuded or exposed surfaces of the stratified rocks, which have been collected and arrested from time to time by natural agencies, thus filling up the crevices caused by the unequal and diversified surface of the crust below. For an example we may turn to the soils of the chalk formation, where we find a great variety, and of various depths. These soils are mainly composed of the plastic clay and sand of the tertiary formations which have filled up the pits and fissures of its surface.

It must be clear that if every exposed surface of stratified rock, by its disintegration, yielded a universally similar soil, as it would do if not exposed to further action, we should have, in place of the diversified soils, soils of fixed type and character, often of little or no value. It is the blending of the various ingredients which give the value to the surface soils, and which we take advantage of in all our acts of culture.

This natural blending, attended by the accumulation of the residue of organic substances, yields fertile

or unfertile soils in accordance with the presence or absence of one or more of the ingredients; and in accordance, too, with the amount of that vegetable residue, the absence of which would render the most perfect mechanical mixture of little cultural value.

The agriculturist, dealing as he does almost entirely with the top or surface soil—*i.e.*, the soil which has been exposed to mechanical and climatic influences—can by inquiry find out what his soil contains, and also what the plant which he desires to grow requires, and by adding the ingredient or ingredients which are wanting grow pretty much what he desires. Not so the arboriculturist. The subsoil to him is of almost equal value, and will require his consideration quite as much as the surface soil. Neither can he, by adding chemical compounds, fit the soil for growing trees otherwise unadapted to the purpose.

It is nevertheless important that each should know whether he is dealing with fertile clays, rich loams, sandy loams, sands, or thin calcareous soils; and also know that all soils, of whatever nature, are formed of clay, sand, and calcareous matter, in varying proportions, and that in accordance with these proportions we have clays, loams, sands, and marls, and other intermediate classes of soils.

Clays may be fertile or barren in accordance with the plant-food which they contain, and in accordance with their mechanical condition. If well drained, they become a very storehouse of good things, and are the backbone of husbandry. If not, there is no class of soil so useless.

Loams are a mixture of clay and sand, and vary as



these preponderate, ranging from clay loams to sandy loams. They differ, as a rule, from fertile clays in possessing less organic matter, iron, and alumina, and more phosphoric acid, carbonic acid, and silica.

Marls are a mixture of clay and lime, and vary as above, as one or the other ingredient is in excess.

Calcareous soils are usually thin, and are composed of the *débris* of the underlying stratum, with a greater or less amount of organic matter.

With all these soils, and their modifications, the forester and agriculturist have to do; there is, however, this essential difference, the latter has greater command of it than the former. The latter may choose the soil to the plant, or the plant to the soil, but the former can only adapt the trees to the soil. Herein is a great difference. The agriculturist, too, as long as the subsoil is porous, naturally or artificially, thinks or concerns himself little about it. He deals with the surface, which is his storehouse. The forester, on the other hand, must concern himself with both, and especially with the subsoil. It will not be sufficient to examine the surface and then decide upon the tree to plant; he must seek lower, and ascertain what the trees will have to draw upon in years to come. As an instance of this, and to show the importance of it, we may mention a case in which we were personally concerned. On inquiring into the death of an ornamental tree, we found the top soil to the depth of about eighteen inches perfectly dry sand, not sand in the true sense of the word, but a dry fine soil like dust; immediately below this, and with no blend, the soil was a yellow clay, wet and

cold. This shows that without investigation the one cannot be judged from the other.

It is seldom that the forester will have to deal with the best and most fertile soils; these are otherwise profitably employed. He will be called upon to plant hillsides, rugged slopes, poor soils, unremunerative under the plough, cold clays, swamps, heath-lands, and so on. He will have, in almost every instance, to select his trees to the soil and site arbitrarily chosen for him; and herein will be the foundation of future success or failure.

Too much stress cannot be laid upon this important initial step. Let him, by not recognising the class of soil and its condition, or by choosing trees unadapted to the soil and site, fail in this respect, and his reputation as a forester is lost. The money he has expended will have been thrown away, and the whole work brought into contempt.

For instance, let him plant in a dry exposed site a spruce fir, and what is the result? A tree not known to its species. On the other hand, let him plant a spruce in its natural habitat, a low-lying damp spot, free from stagnant water, and he will have a tree which will delight future generations.

Again, let him plant the soft-wooded, fast-growing trees, on poor soils and in exposed sites, and what will he obtain? Stunted and distressed specimens of noble trees. When if he plants the same on well-chosen soils, he will secure those lovely specimens which go so far to render our woods and glades such centres of beauty.

Site and soil in this respect run together, and he

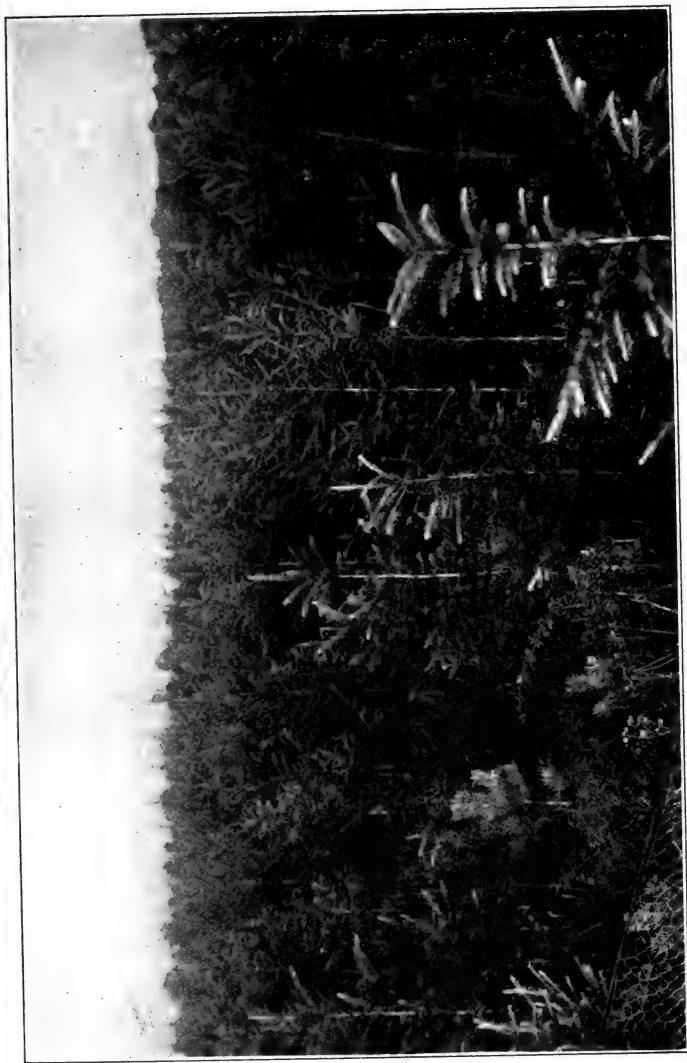
must adapt his trees to each. In planting slopes he will choose his trees not only with regard to the soil, but with regard to the aspect; also with regard to exposure to prevailing winds. The object, too, he will consider in his selection of trees, whether that object is ornament, commerce, shelter, or for prevention of floods. He must bear in mind that he has little control over the soil, so that he cannot undo by future action an error committed in the present. The control which he possesses over the soil will be mechanical only—*i.e.*, by the change of condition brought about by drainage, by retention of water through planting, by the retardation of the drift of soil on hill-sides, and so forth. Chemical changes will, of course, arise through these natural and artificial agencies, but not by direct application of chemical dressings. True, to some extent, direct application of manures may be made in cases of planting special trees for ornamental purposes, on land naturally unfit; but on a large scale this cannot be done.

## CHAPTER V.

### *LAYING OUT OF LAND FOR PLANTATIONS.*

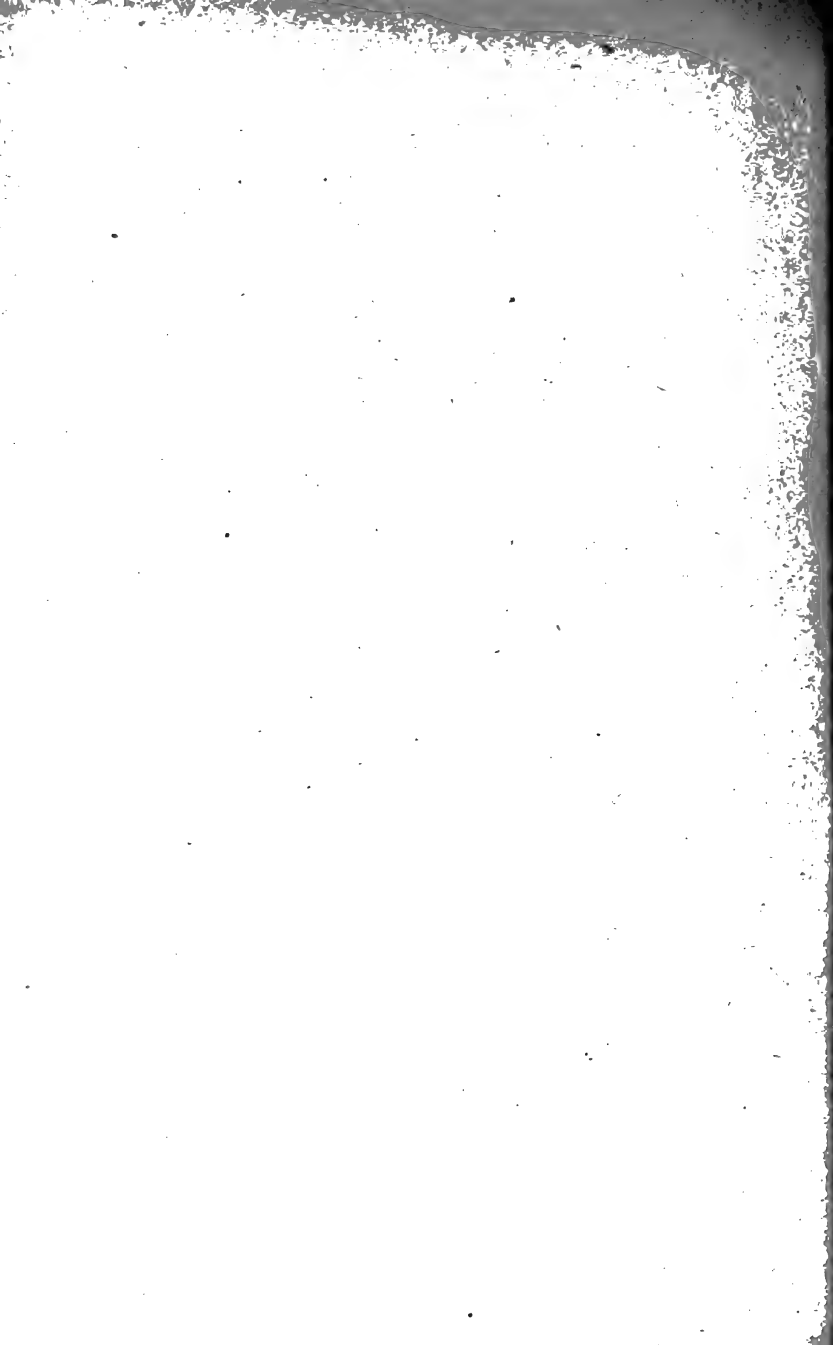
IT may be as well before proceeding with this section to point out the meaning of the various expressions, *forests*, *woods*, and *plantations*. The term *forest* in this country can only be correctly applied in a few instances—viz., the New Forest, the Forest of Dean, and other large tracts of Crown lands, and perhaps to some of the large tracts of woodlands in the north of Scotland. The exact area which deserves the style of forest is open to opinion. Some say no area under 10,000 acres should be so styled; but this, in so limited an area as this country possesses, is perhaps excessive. The term forest in English is synonymous with the Italian *foresta*, and French *forêt*, and the terms are applied to an extensive wood or large tract of land covered with trees. In English law, however, the term implies an open space set apart for the chase, and does not necessarily imply the presence of trees.

The term *wood* implies a tract of *natural* woodland, and area is of little or no consequence. The term *plantation* signifies an area *planted* with trees for commercial or other purposes, and is also independent of area. Forests and woods are already laid out, *i.e.*,



EXAMPLE OF PLANTATION—PLANTED IN 1913. CONSISTING OF JAPANESE LARCH, SITKA,  
SPRUCE, COMMON SPRUCE, AND SCOTCH PINE.

[To face page 22.]



their boundaries are determined; therefore we use the term, "*Laying out of land for plantations.*"

This laying out is a matter of considerable importance, and deserves the careful attention of the forester. It will, however, be determined by the object he has in view, or by the magnitude of his operations. If he is laying out the land for planting large areas for commercial purposes, or for the prevention of floods over large districts, the form of his plantations will be governed only by the natural boundary. If, however, he is planting smaller areas for purposes of shelter or ornament, the outline is of grave consequence.

It should be carefully borne in mind that if fine commercial timber is required the area cannot be too large. Timber of good girth and quality cannot be successfully grown in narrow and exposed lines and belts. From their earliest stages of growth, in these positions, trees never rest, but have to fight their battle with the elements. The roots are seldom quiet, the rind or bark becomes hide-bound, the timber gnarled and stunted. To obtain really good timber the areas must be large, so that natural protection is obtained. To more fully secure this the outline may be so arranged as to throw off the force of the prevailing winds; and trees of thick growth planted on the outsides may still further assist this end.

As before stated, when the areas are large we would allow the boundary to form the outline, only qualifying it when it becomes exposed to more than ordinary winds. But when dealing with large or small masses not necessarily naturally defined we recommend a

form which will serve both to shelter the plantation itself and secure shelter for the surrounding land. This can be done by laying out *convex* lines on the exposed boundaries, Upon these bends, when the wind strikes, the force will be weakened, there being the least resistance. Straight or *concave* lines on these exposed sites would have no power of expelling or throwing off the wind, and it would rush through the plantation, carrying destruction with it. If this once takes place, the success of the planting will be marred throughout the remainder of its existence. Straight lines are unnatural, and seldom beautiful. There is, however, one exception to this almost universal rule, and that is in laying out avenues or vistas. Here it is important that the eye should take in at once, at one glance, the whole of the beauty which it is intended to create. Further, the greatest extent of the new plantation should be laid off against the prevailing winds, and also on the highest and most exposed position.

This being then the form required on the exposed sides, we obtain the reverse, *i.e.*, the concave, on the unexposed sides, which gives the greatest amount of shelter both to the live stock and the cultivated land, and also secures throughout a uniform line of beauty. It may be necessary, from the natural contortions of the ground, to sometimes bring a concave line to the exposed surface; when this cannot be avoided the forester must secure safety by choosing such trees as are deep-rooted and umbrageous, and plant these thickly, say at least six rows deep, along the whole line so exposed. These will resist, rather than



throw off, the power of the wind. The most universally useful trees for this purpose are, in conifers, the Austrian pine, the Corsican pine, and, on the sea coast, the pinaster. In hardwoods, the sycamore, giant maple, and the beech are best.

When laying out plantations on long lines of undulating slopes, it is as well, as far as possible, to follow the natural lines and bends; and when pastoral or arable valleys intervene, draughts, which are so frequent in these, may be overcome or moderated by an occasional convex bend into the valley.

Again, in laying out plantations it is necessary to lay off vistas and roads; the former should be so arranged as to secure at various spots the most beautiful views; and to do this well requires the eye of an artist, which all foresters cannot be expected to possess. We apply the term artist to the person who can see and appreciate the beautiful in nature, not necessarily one who can deftly use his pencil and brush. The laying off of roads must accord with local circumstances and demands. We have perhaps alluded with sufficient explicitness to this important branch of a forester's work. Much of his future success will depend upon the accuracy of his conception; and he will not regret the extra labour involved if he succeeds in averting the evil consequences which arise from winds sweeping through plantations.

## CHAPTER VI.

### *PREPARATION OF THE GROUND FOR PLANTING.*

FOR every corn crop we find some preparation of the ground is made, but for the growth of timber we often find no preparation made at all. Why is this? Is it that it is not needed, or is it on account of the expense? The latter undoubtedly is the chief reason, as the expense attaching to the most simple planting is somewhat heavy, and naturally nothing should be done to increase this which can possibly be avoided.

Nevertheless, we venture to hold the opinion that if more regard were paid to preliminary preparation, even at the risk of adding somewhat to the cost, we should have timber of finer quality, and reaching an earlier maturity. We have, however, to deal with what is practicable, not with what is theoretically right.

When planting for ornament, or for early shelter, too much pains cannot be taken to prepare the ground. It is both expedient and wise to be liberal in the early stages; but when dealing with large areas for commercial purposes, a heavy and unnecessary preliminary expense is unwise. The question of preparation will, when practically considered, fall into

a very narrow compass; and will resolve itself simply into the matter of drainage and clearing of heavy natural herbage.

If the land in question is dry, *i.e.*, naturally dry, and free from heavy herbage, no preparation whatever is needed. If, however, the land is wet, it must be drained. This is a *sine qua non*. No tree will grow on wet land. By wet land, we mean land containing stagnant water, or land which does not permit of sufficiently rapid percolation.

What does drainage do? may be asked by the novice. There is a great deal of ignorance upon this all-important operation. It is known by most that the act of draining relieves the land of its superfluous water, and here, too often, the knowledge stops. What besides does it do? It gives a depth of soil capable of storing up plant food. It allows, as the water percolates, the free circulation of warm air, which assists in the oxidation of the ingredients in the soil. It increases the capacity for the storage of heat, by enabling land to absorb the sun's rays, thereby enabling the soil to maintain tree life and vigour well into the winter, which allows of the ripening of the young wood before the frosts set in—a fact too important to lose sight of or pass by.

Compare this state of the soil with the same in an undrained state. The soil is water-logged, which is equivalent to saying that it contains no air. Plants cannot live without water, but they need air too, and can only thrive where both can be obtained. Full and complete drainage does not render land too dry, for the deeper and more thorough the drainage the

greater the depth of porous soil, and the greater its power to absorb what the rain-water brings in solution. The soil, too, is cold, for the temperature is always low when there is evaporation ; and evaporation there must be if the water can escape in no other way. Heat cannot be transmitted through water, therefore the sun's rays have no power to penetrate the already filled interstices of the soil. To prove this it is only necessary to ask the forester to try by experiment himself. Let him take the temperature by a thermometer six or eight inches below the surface on drained land, and at a similar depth on that undrained, he will find probably a difference of 8 or 10 degrees.

The expense, however, attaching to extensive drainage operations is so great as to render it a matter for serious consideration. It is nevertheless for planting not so costly as that for agricultural purposes, and for the simple reason that we require only open drains and sometimes even only grips. Covered drains for planting purposes are not only unnecessary, but are detrimental. Pipes or stone drains will soon be completely choked with root-fibre, and will in a few years render the whole system absolutely useless. In agricultural drainage the whole system will often become choked by the roots of trees (which follow the flow of water) finding their way into the drains which pass near. We have found this when draining for planting. When we have been seeking for an outlet we have come accidentally upon mains, or main-feeders, of old agricultural systems which have been so completely choked by root-fibre that the whole of that part dependent upon these drains has been water-logged

and completely incapable of performing its functions. The water contained in the soil and drains has been on occasions so great as to render it necessary to stop operations until the flow has ceased. We have known nearly a whole day required for this, which shows the quantity of water stored up.

When meeting with these obstructions, it has been necessary to follow up long lengths of drains before the fibre can be fairly got rid of, which adds considerably to the cost of drainage. This also shows how necessary it is in pipe-drainage to cut down or avoid all kinds of trees near any portion of the system, and also proves the necessity of open drains when draining for arboricultural purposes. It may not be out of place here to quote on this point the opinion of that well-known authority on drainage, the late J. Bailey Denton, expressed in his "Retrospect of Forty Years' Experiences," p. 56:—"The mischief done to drainage by tree roots is very considerable. Within this last month I have known £40 expended in clearing pipes of roots in a property of only 600 acres of heavy clay land. The drainage was executed in the years 1862-3, since which time the tenant has had reason to complain of the want of effect. Had the trees within reach of the drains been removed at the time the drainage was done, all objection might have been avoided, or had the drains been examined as soon as water was seen rising to the surface, the evil might have been discovered and removed. As it was, however, the stoppages accumulated until the cost of the remedy reached the amount stated."

Before treating in detail this important subject, it

may be well to point out the preparation needed on land from which a crop of timber has been taken. When trees of any kind have been thinned to their full extent, and when those left have reached their full growth, it is necessary to cut away completely the residue, and so to leave the land naked, and therefore unprofitable. To grub up the stumps, and clear off the *débris*, requires a heavy outlay; and yet, if the land is to be reclaimed for the purposes of cultivation, this must be resorted to. Nevertheless, in some instances, this may be done to advantage, as the vegetable residue will be found so great, that with an application of lime the land may be rendered very valuable for agricultural purposes. If this is done, it will probably be when the land is fairly level, and in proximity to roads, and so on. If the land is hilly, or naturally of poor quality, replanting will probably be the most satisfactory course to pursue. On land of this character, provided proper trees are selected, planting may take place at once with but slight preparation. If, however, the land is wet or damp from lack of drainage, or from stoppage of drains, drains should be immediately made or reopened, the soil being spread over the surface after the *débris* has been burnt or otherwise destroyed, and the land left fallow for at least a year or two. This will give time for the purification of the over-burdened soil, and for the natural growth of trees that may follow.

All *débris*, whether brambles, fern, deadwood, bark, lop and top, and so forth, should be carefully destroyed, as its presence harbours injurious insect pests and fungi.

One thing, however, is necessary to ensure success, and that is a careful selection of trees adapted to the soil and site. We cannot, to secure this, do better than follow Nature's plan, which is the natural reproduction of its own species. If the primæval forests are examined, it will be found that cleared spaces soon fill up by the growth and development of the seeds deposited in the soil from the trees which have been standing there. And when we consider that this has been the case for an untold number of years, it proves the capability of the soil to grow repeated crops of a similar character; it does not, however, prove that the land is capable of supporting a growth of a new character. Failure, therefore, may be expected, and looked for, if we depart in our new planting from this natural course.

We do not, however, for one moment wish to dogmatise on this point, as we know the rule is not without exception; and that trees of a different kind will follow successfully a reaped crop. Nevertheless, it behoves the forester to bear this in mind, and not to be too sure, that the soil will second his efforts in any vagarious departure from Nature's beaten track.

## CHAPTER VII.

### *DRAINAGE.*

WE will, for our purpose, suppose that the area to be drained is practically level, and that the outfall cannot be determined with sufficient accuracy by the eye. If the land is undulating in character it is often easy at a glance to determine the exact spot for the outlet, and also the precise direction for the main drain or drains. We use the term drains because it is often necessary to make several, both on account of undulations and extent of area. On fairly level ground one sub-main may be sufficient for (say) 15 acres; if the area is greater than this it is usually better to make two or more. It is impossible to lay down any rule as to the number required when the land undulates; but the same rule may apply, viz., that 15 acres, if obtainable, may be made to flow into one drain; but this must be left to the discretion of the forester.

We must also at the outset draw attention to the fact that great care must be exercised in determining the amount of drainage required, both as to depth and frequency of the drains; because the removal of unnecessary earth increases needlessly the cost of drainage, which ought instead to be reduced to a minimum, bearing in mind efficacy. Often too many



or too few are opened, which leads to waste on the one hand, and inefficacy on the other. Returning to our level area, we find it necessary to determine the outfall by instrument, and we prefer to any other the improved dumpy level for this purpose. The method is to place the level in a suitable position near the centre of the piece to be drained, and having adjusted it, send a man round the boundary with the levelling staff. He will hold this up, as directed, at the points judged to be the lowest, and the forester will take the levels, entering each reading upon his note-book, and striking out with his pencil each entry when cancelled by the next or some future higher reading. For instance, let the reading at a certain spot be 7·85, and let the next be 8·32; the 7·85 being no longer required, a lower spot having been found, is struck out, and so on. Having, by taking readings all round the area (if necessary), determined the exact spot for the outlet, it is marked by a twig or a cut in the turf; and the work of determining the *direction* of the main drain will follow.

It is, of course, a foregone conclusion that the forester has, before taking these levels, made himself acquainted with the best means of disposal of the water. He has ascertained the presence or absence of streams, brooks, burns, rivulets, and so on; or of ditches, road-side water courses, or even of main agricultural drains (the discharge of surface drains into closed drains we will allude to hereafter). Into such a means of discharge he will cut his main drain, commencing, of course, at the lowest end, so that the water may flow from the workers. The direction

should be in the line of lowest ascent from the outfall. There being more water to discharge from the mains than from the minor drains a less fall is required, as the greater the quantity of water the more rapid will be the flow. The main drain should never be against a hill, as the flow would be too rapid, and therefore inefficacious.

The correct fall, too, will need the careful consideration of the forester. Water will find its own level, and, therefore, theoretically, the slightest fall will cause a flow; but something more than this will be required to carry off with sufficient speed the discharged water, and to overcome the capillary attraction which would otherwise keep the soil, notwithstanding the drainage, in a constantly wet state. Under no circumstance should the fall be less than 1 in 400, and in clays 1 in 300 will not be found too great. If there is sufficient natural fall, the drains may be of uniform depth; if not, a fall must be made when cutting the drain. This can be done by increasing the depth at the outlet, and decreasing it gradually as the work proceeds.

The length of drains will also engage attention. On flat, or fairly level ground, the main drain may be longer than under other circumstances, so that an increased flow may arise from an increased bulk of water. But main drains, as a rule, should be shorter than the minor drains, and the latter should not exceed 10 or 15 chains in length.

The depth is a matter of great importance, but must be left very much to the discretion of the forester, and in accordance with the soil he is draining.

It is impossible to lay down an inflexible rule, but we may take 3 feet as a minimum, and 4 feet as a maximum. If the soil to be drained rests on an impervious bottom, and is not deeper than 3 or 4 feet, it may be cut through, so that the bottom of the drains may be formed of the said impervious sub-soil.

In draining bog, too, or mosses, it is best to cut through them if possible; but this may be a work of time, as it is not always possible to complete such drainage in one operation, owing to subsidence.

To lessen the expenditure, shallow drains are sometimes, in fact often, cut, and the work performed is inadequate, and failure and disappointment result. If the soil requires drainage it is wise economy to do it thoroughly, as it is only by giving ample depth of porous soil that really good timber can be grown. Every inch in depth of drained land gives something like 100 tons of available soil to the acre, a fact too often lost sight of.

Roots cease to penetrate when they reach the wet stratum, and branch off laterally in all directions. They thus take little hold, and the trees fall with the slightest gale of wind. This is often evident among spruce fir growing on partially drained land. We have seen large areas completely destroyed in one night. This might have been prevented by a greater depth of drainage.

The distance between the drains is another matter of great importance. As before stated, if too near it results in extravagance, if too far apart in inadequacy. It must be borne in mind that depth will not compensate for distance. This has been rendered

unfortunately, only too evident in those areas drained some few years ago, when the reverse was the opinion.

The forester, by trial holes, should find out for himself the exact distance suitable to the soil he is draining ; but the following figures may assist him :—

Strong clays - 4 to 6 times the depth.

Loams - - 6 " 8 " "

Light loams - 8 " 10 " "

If the surface soil is rendered wet by springs, these springs should be tapped by an auger, and the water thus tapped carried off by the drains.

On low-lying land where an outlet is difficult to obtain, the drainage may be secured by digging a hole through into the underlying rock, and draining into it ; but this can only be successfully carried out where the rock or substratum is porous.

The depth of the sub-mains should be always 6 inches deeper than the minor drains, so as to permit of a fall of water into them, which gives an increased impetus and secures the washing away of impediments. If they flow in on the same level there is a tendency to stagnation throughout the whole system, without the fall is considerable.

Another matter of importance is the arrangement of the minor drains. They should be so laid out that they run with the greatest slope, and discharge alternately into the main. If they discharge opposite one another, the *débris* brought down by one is likely to choke the other ; whereas in a correct system each drain in the upper reaches, so to speak, should assist the flow of the next, and so on, thus securing a uniform flow throughout.

By cutting the minor drains against the slope the drain becomes active on each side—*i.e.*, it drains to its full extent on each side ; whereas if laid obliquely, it can only drain the upper side, and therefore more drains will be required. There is, however, a limit to this ; if the slope is too great there must be a slight deviation from the right line, or a sub-main must be cut obliquely, so shortening the minor drains. The width of these open drains at bottom should be from 8 inches to 1 foot ; the former representing the minor, the latter the sub-main drain. If less than this they are difficult to keep clear. At the top they should be such a width as to secure a correct slope ; and this slope will increase with the friability of the soil. The natural angle of repose will follow in due time by the wear and tear of the elements, so that it need not be too closely studied in the first instance. The “batter” or slope of the sides will depend on the nature of the soil, but it will range from 1 in 1 to 1 in  $1\frac{1}{2}$ , *i.e.*, if the drain is cut in a clay soil, and is 3 feet deep and 1 foot wide at the bottom, the sides may slope 1 in 1, and the width of the top will consequently be 7 feet. On land with little natural fall all minor drains should enter the main at an angle of, say,  $67^\circ$  ; this assists materially the uniform flow of water. One thing is obvious, and will greatly assist the forester—that is, the whole of his operations being open, and the flow visible, he can correct his work from time to time as it proceeds. This, however, should not lead to hap-hazard and inferior work. The previous plan and arrangement should be as carefully studied as if he were engaged in covered pipe-drainage.

We have in the early part of this section drawn attention to the discharge of open drains into the pipe system already existing. This may be, and will be sometimes, found the most convenient method of discharging the water from the whole or portion of the forest area to be drained. We strongly advise the forester not to adopt it if he can avoid it. If he cannot, he must take precautions to prevent the *débris* from the open drains stopping the pipes. This can be best done by building with bricks or stone a well at the point of discharge deeper than the inlet to the pipe, which permits of the collection of soil and heavy *débris*; and by hanging an iron grating in front of the pipe branches and leaves are also kept back. These wells should be frequently cleared. If this plan is resorted to there need be little fear of stoppage.

The cost of forest drainage will be a matter of concern, but to say that it will cost so much is simply beyond our power. It will depend entirely upon the soil to be drained, and the obstructions met with, in the form of stones and old tree roots, and the cost of labour in the district. Having, however, ascertained all this, a fair estimate may be formed by arranging a price per rod, and ascertaining the number of rods in an acre, which may be done as follows:—

Divide 29,040, the number of half yards linear at 1 foot apart in an imperial statute acre, by the product of the number of half yards in the rod of which the number is required, multiplied by the given distances apart in feet, and the quotient will be the number of rods in a statute acre. Example.—Required the number of rods, of  $5\frac{1}{2}$  yards, in an imperial acre, the

distance between the drains being 24 feet. The product of 11, the number of half yards in the rod, when multiplied by 24, the distance apart between the drains, is 264; then the quotient of 29,040, the number of half yards linear at 1 foot apart in an imperial statute acre, when divided by 264, is 110—the number of rods of  $5\frac{1}{2}$  yards sought.

Having obtained this, and knowing, by his own observation, what a good man can open in a day and the wages given, the forester can arrive at a fair idea of the cost per acre. It may assist the forester to know that a labourer accustomed to the work will throw out about 12 cubic yards of earth a day where no "hack" is required, and, if 3s. is taken as a day's wage, 3d. per cubic yard will be the cost. Where the soil is light and there are no boulders, 2d. or  $2\frac{1}{2}$ d. may suffice; but where boulders or other obstructions do occur, it may easily run to 4d.

We follow, however, and strongly recommend others to do the same, the principle of day work in most forest operations. Choose good men and pay them liberally, and secure constant and reliable oversight, and the interests of the employer and the future success of the planting will be best secured. The object of a good forester should be to do good work, and not to hurry over it for the sake of cheapness or effect. This is the reason why planting by contract so often fails. There is a tendency to hasten the work, which leads to work of an imperfect character being performed.

We shall have again to allude to this when dealing with planting by and by.

Having completed the drainage, the soil thrown out

should be carefully spread over the surface to be planted. No lumps or heaps should be left lying about ; and if any stones have been taken out, these can, if fit, be broken for roads, or used for other fitting purposes.

If the work of drainage has been commenced and carried on through the autumn and winter, the land should be ready for planting in the early spring ; if not, it will be best to wait until the following autumn. We, however, prefer on such land—*i.e.*, drained, heavy land—spring planting. As a rule it will succeed better than autumn planting, but there is no fixed rule to guide the forester.



## CHAPTER VIII.

### *PLANTING.*

HAVING prepared the ground, by drainage or otherwise, the forester will, when the proper season arrives, commence planting. We will, therefore, now consider as fully as is necessary the processes applicable to the various sites and conditions.

The subject of seasons will perhaps first engage the attention of the forester before proceeding with the actual planting. When large areas have to be planted, he will naturally choose the earliest period compatible with safety. He will have to consider the nature of the soil which he has to plant, and also the state of the young trees in the nursery. On a wide area the soil will doubtless vary, and he will therefore choose that which is dry and friable for autumn planting, reserving the clay land, especially if it has been recently drained, until the spring. The season may be said to commence with November and end with April; but sometimes it is possible to commence during the latter days of October and to continue into the first week in May.

It is, of course, quite improbable that he will be able to plant all through this extended period; but if his plans have been well laid, he will be able to take

advantage of every opportunity, and, in the meantime, employ his men in some other branch of forestry. He will find it impossible, successfully, to carry out the planting of large areas if he is obliged from time to time to discharge his men ; it is therefore absolutely essential that he should so arrange his forest work that, be the weather what it may, he can always profitably employ his staff. If a day, or even half a day, is suitable, he should take advantage of it.

There should, too, in planting, be no fixed plan with regard to regularity. The soil to be planted should be chosen with regard to season—*i.e.*, to secure uniformity and regularity, soil unfit for planting should not be planted. The future success of the plantation depends so much upon the care and skill exercised at this initial step that we cannot dwell upon it too impressively. Each individual tree must be planted with care ; there must be no hurry or undue haste to complete the task. The season must not be forced, and no forester should at the commencement determine where he will finish. He must be satisfied to do what he can in accordance with the strength of his staff and the diversities of the season. It may be well here to mention the importance of employing good men. The forester should, for the actual planting, select his best and most careful men, sending others, not so reliable, forward to dig the holes. Again, he should employ his best man as foreman, and let him be constantly with the planters, not planting himself, but watching carefully each man under his control. He may keep by him some trees, and occasionally, if necessary, replace any ill-formed or badly-rooted tree

with another, or tread in, but not allow his attention to be distracted from his chief employment. If a man plants carelessly or neglects warnings, let him be sent to dig holes. This carefulness applies to all systems of planting. We are, however, digressing somewhat, and must return to the matter in hand, and deal with it in regular order. The subject of planting naturally embraces selection and distribution of trees, transfer from nursery of the trees required, digging the holes or notching, and the actual process of planting. It will, however, suffice for this purpose to consider only the subject of hard woods and conifers, and that of permanent trees and nurses.

The connection between the nursery and the plantation we shall also touch upon briefly when necessary, in so far only, however, as it bears upon the necessity of supplies. Therefore the principal items left are those of preparation for planting and the actual process itself. As we have in previous sections drawn attention to the necessity of selection of trees, it is hardly necessary here to say more than that it is essential to success that this selection should be made, also that the distribution should be based on scientific grounds. We must presume that this has been arranged; that the distance between the hard woods or deciduous trees has been determined; the kinds of nurses chosen, their distances and distribution, and so forth.

With regard to the supply of trees from the nursery, it is necessary to be here a little more explicit, as we may not again have the opportunity of pointing out how important it is that a good organisation should

exist between the source of supply and the work in progress. Previous to the planting the nursery has been, we may, of course, assume, carefully inspected, and its power of supply tested. It is known how many trees of each kind are required, and how far the nursery can supply the want. The trees in the nursery by transplanting have been fitted for this special requirement. The strength of the staff is known, the number of trees they can plant in a day is known, the kind of trees required is known, the method of conveyance has been decided upon, and the men and boys told off to assist the nurseryman. The forester will appoint a careful man on the ground to receive the trees as they arrive, whose duty it will be to supply the planter and carefully heel in those not required. He will allow no trees to lie exposed more than a few hours in front of the men, and at night his duty will be to collect all not planted and lay in by their heels until the morning, letting them be the first to be planted next day. If the area to be planted is large, and the distance from the nursery great, it is a good plan to arrange previously some temporary nurseries on or near the site; but this is not necessary in ordinary cases.

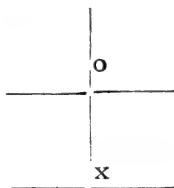
No trees but those well-developed and well-rooted should be planted out, and if any unfit escape the nurseryman they must be thrown out by the planter and returned to the nursery. By care they may be fitted for planting out at some future period.

We must consider two methods of planting, viz., notching and pit-planting: the former is resorted to in hill land, and where the herbage is short and the

soil thin ; the latter, in rich and deep land, or where there is much rank herbage. In the former, small trees are required, say, two years seedlings or one year transplanted ; in the latter, one or two year seedlings, two or three years transplanted. We will first describe the process of notching. The distance apart having been decided (for *distances*, see future section), and the plan of planting arranged, a line should be laid as a base, after which the work may continue by the eye without artificial aid.

Each man is accompanied by a boy, woman, or girl, whose duty it is to hold the trees and place them in the notch. They should have strong sacking aprons in which to carry the trees, so placed that they may be taken out rapidly as required, without becoming entangled. When this supply is nearly exhausted, they will hand over to the man the last dozen, or thereabouts, and proceed at once to the man in charge of the supplies, as already mentioned, refill their aprons, and return.

The man will bring with him a notching-iron or sharp old spade—the latter is perhaps the best. He will make in the turf, or heath, two deep cuts at right angles to each other, thus :—



And at the point x, cut another, say 5 or 6 inches

from the former point of intersection *o*, and by pressing down the handle of the spade the turf will open at *o*; the boy or girl with the trees will immediately place the roots carefully in the opening, and draw the tree towards the centre at *o*. The man will withdraw the spade, when the turf will reclose; and by pressing the whole firmly with the foot the planting is complete, and he will pass on to the next. A man, aided by a boy or girl, will plant in this way from 700 to 1000 trees in a day.

When planting on the side of a slope the planter should stand with his back to the hill; his cut will then be vertical, and the tree will not only be upright, but will obtain, by interception, a better supply of moisture from the descent of water down the slope.

Each tree should be carefully trodden in, and the slit in the turf thoroughly closed; if this is not done, the tree is hung in the hole, and the roots, instead of being incased in mould, are left suspended in space. The man, not the boy, should be held responsible for properly treading in. The process just described is applicable only to the conifers; if deciduous trees are planted in these districts they must be pit-planted, or the seed may be sown. On stony ground, or where the soil is very thin, it may be difficult to notch; under these circumstances the planting-hoe must be resorted to. In this case the man will carry his own trees, and work his hoe with one hand, whilst he places the tree with the other.

The methods described are best adapted to this class of land, and are also the cheapest. The trees, too, do better, and being small and very young they

do not feel the change to the same extent that older trees would do. They speedily recover, and, as a rule, the losses are few. When planting deeper soils, and when there is much herbage, as stated, pit-planting must be adopted, and we will now describe the process. Whether the plantation is to consist of conifers only, or to be mixed with hard woods, is of little consequence so far as digging the holes is concerned. It will be necessary to determine whether all the holes should be dug before planting commences, or whether the two operations should proceed together. If the land is light or fairly friable it may be well to dig all the holes before planting; but if the soil is clay, or has been recently drained, we recommend digging not more than half a day in advance. If this is not done the soil taken out dries hard, and it is impossible to find mould for covering the roots without digging afresh, which adds to the cost and delays the work. Again, if all the holes are previously dug, all the hands must be engaged later in planting, and this necessitates employing men who are unfit for the work, which has been already referred to. We therefore prefer carrying on the two operations together.

The distance between the plants having been determined, say 3, 4, or 5 feet, a line is set out wherever it is considered best to commence. There are several ways of setting out the work, and they will depend greatly upon the shape and area, uniformity of soil, and so forth. Once, however, the base line has been laid down, there will be no difficulty afterwards. A line of light cord, say 100 yards long, should be

marked out with red cloth at the required distances ; and two good men should be chosen to mark the holes in advance of the men. Each marker should have a stick of the right length—*i.e.*, to correspond with the distance apart—and when one length is finished, they should set out the next by these sticks, and re-lay the line so that the red marks correspond with the centre of the holes made, or, if alternate planting is adopted, with every other line. Various methods of laying-out, and various distances are recommended by forest nursery-men, as will be seen on reference to their catalogues. For even distribution the equilateral triangle must be resorted to ; but in practice 4 feet square planting will be found best in the long run.

The men will follow in two sets : the first will, with spades or forks, open the holes, and the second set will follow and complete the work ; or, which is sometimes better, the first set may open and complete the holes, and the second, with forks, follow and loosen the bottom. In this case the former set should be double the latter. Each man should lay the turf on one side of the hole, and the soil on the other ; if mixed, there will be delay when planting.

The holes should be of a size to meet the necessities of the trees—*i.e.*, if they are one-year seedlings two-year transplanted, they may be eight inches square and nine inches deep. This is usually large enough for ordinary plantation purposes. If the soil is turf, the holes should be as square and uniform as possible ; if loose, this is sometimes impossible.



Care should be taken in laying out plantations to arrange, previously to digging the holes, all outside or road side plantings, as the holes required will not probably run with the main lines.

Some landowners object greatly to uniformity, and will not have lines at all. In this case random-planting must be resorted to. We greatly object, however, to this, as the work entailed when thinning is very great, much in excess of thinning uniform plantations. Dragging out the trees where there are no regular lines is heavy and discouraging. If, however, this plan is resorted to, we recommend cutting lines right through at certain distances before proceeding with the thinning ; but of this hereafter.

When digging on hill-sides, cut vertically down and throw the soil on the lower side ; and when planting hold the tree on the low side and back in with top soil. A man can dig under ordinary circumstances 150 holes a day, so if the wage is 2s. a day the cost will range from say 1s. 6d. to 2s. per hundred. We prefer, however, in almost all forest operations to work by the day. Well inspected day labour, as a rule, is more successful than hastily and imperfectly performed task-work.

It will be well, before passing on to the actual planting, to describe the method of preparing for the planting of ornamental trees. These are usually larger than those planted on more extensive areas, and have been specially trained in the nursery for the purpose. Their roots are more developed, and therefore require larger holes ; and the object being to obtain individual symmetry and beauty, greater

care must be exercised. Care should be taken to so prepare each hole that the tree receives the least possible check. As a rule, if a tree intended for ornament, especially a conifer, remains dormant for an undue period, its future beauty is marred. It is possible, if skill is exercised, to prevent this; and as the object in view is so apparent, the forester should spare no pains to secure a regular and uniform growth.

If we examine trees planted for ornament, we too often find that they fail to develop into ornamental trees; and this is almost invariably due to either an unwise selection or to the want of careful planting.

Compare the ordinary specimen, seen in gardens and pleasure grounds, with those with their beauty and grandeur fully developed, and no one will, we are sure, grudge the extra care and expense required to attain to an equal perfection. We always recommend when the object is to secure ornamental trees, whether individually or collectively, a previous course of preparation.

If the soil is a tenacious clay with an obdurate subsoil, the trees should be planted in the spring, and the previous autumn the land should be trenched in the following manner:—Open a trench on one side to the correct depth and break up the bottom; wheel the soil so taken out to the opposite side. Then throw the top soil of the next trench into the bottom of the trench first opened, and the second or under soil on to the top of that, and so proceed until the whole is trenched. This may be performed for 1s. to 1s. 6d. per square rod. In the spring when the trees are planted the roots will come into contact at once

with the turf or upper soil so buried. Between the trees for the first year potatoes may be beneficially grown, the dressing and cultivation will materially benefit the plantation, and assist somewhat towards the initial expenses. During the trenching it will be well to work in with the soil a well-made compost.

If individual trees are to be planted it will be unnecessary to trench more than the hole, say with a diameter of three or four feet. Let this be conducted in the following manner:—Dig out the hole completely to a depth of 2 feet 6 inches or 3 feet, and break the bottom. Throw the turf and topsoil into the bottom and spread the remainder on the surrounding land. Fill in the hole with a prepared compost of soil, leaf-mould, lime, &c.; allow this to remain until the planting season, and plant in a manner hereafter to be described.

We have now explained the various methods of preparation for planting, and must proceed to describe the process of planting. The future success will depend greatly upon the care and skill exercised in this respect; and yet, too often, we find that large areas are planted without even ordinary attention to the most simple rules.

There is a right and a wrong way of doing everything, and this is very apparent in the process of planting. Too often trees are carelessly planted, more with the view of completing the task than that of the future welfare of the plantation. If the foregoing preparation has been carried out with skill and care, and the planting be carelessly conducted, failure, or a partial success only, will result. To save expense,

boys to hold the trees are often not employed, and the men are expected to hold and plant at the same time. This in itself renders the work imperfect, as it cannot, under these conditions, be properly performed.

We recommend then, at the outset, that when pit-planting boys be employed to hold the trees. The forester having determined the distances of his hard woods and nurses, the kinds and distribution of his trees, and set off his areas or districts, will (the trees being on the spot, as already described) lay off his line or lines, and proceed at once with the planting. If he decides upon first planting his hard woods, he will proceed as follows:—A trustworthy man, who will henceforth be employed in laying out the trees, will place them in the holes as arranged. The planters will follow, and the boys will hold the trees in the holes to the same depth as they came from the nursery. If the hole is too deep (as it should be), a layer of cut turf or mould should be put in until the correct depth is secured. The boy, holding the tree in the centre of the hole and arranging the root-fibres, will, as the mould is put in, lift the tree up and down slightly, so that it may penetrate among the fibres; and the planter for this purpose should select the finest mould he can find. *He will then put in the whole of the soil, and not until the hole is full will he tread in the tree.*

This, perhaps, in planting, is the most important instruction that can be given.

The too common practice is to ram in the soil with the heel as the work proceeds, and often crush a lump (unbroken) on to the delicate root-fibres instead of first breaking it up with the spade. The fine roots

are thus crushed and wounded, and, instead of at once commencing to perform their functions, the spongioles have to recover their lost powers of absorption. Trees, too, are often planted too deep, so that the lateral branches of the conifers become buried ; and, in short, the whole system of the plant becomes deranged, and valuable time is lost in the recovery and readjustment.

When planting conifers, especially on exposed sites, it is well to hold them in the lee corner of the holes, as by this means they get an extra support from the firm and unbroken soil ; on clays, if planted in the centre, they are apt to work and form a cup, which in a wet season fills with water, and tends to rot the base of the tree. When planting purchased trees, which may have been exposed for some days, it is advisable to place the fibres in water or damp mould for a day or two previous to planting.

On large areas for commercial purposes little more is needed. The trees being small should not need staking, even in exposed sites ; but later in the season, say a month or two after planting, the whole should be again carefully inspected and trodden in, as the soil will contract and leave the trees loose.

It should be borne in mind that the life of the tree depends upon the vitality of the root-fibres, and every-thing should be done that skill can devise to keep them healthy and active. The chief thing is to bring every fibre into contact with the mould so that the water, which contains the plant food in solution, may be brought into contact with it as it percolates through the soil. If hung in space, water will not reach it without the soil is water-logged, which we have

already referred to as fatal to tree life. When planting larger trees, and for ornament, similar, but still greater care must be exercised with each individual plant. The holes, as already prepared, should be opened sufficiently only for the reception of the tree, because the soil, as we have seen, has been already arranged by trenching. The tree must be set carefully in the hole to the proper depth, and the roots set out in their natural order (not entangled or crushed); the finest compost be placed over the whole, and, instead of lifting the tree as before stated, water should be used to consolidate the mould. If this is resorted to, the fibres will at once settle down to their work, and speedily recover their suspended functions. When completed, each tree should be at once secured by properly arranged stakes.

On hard and obdurate soils it will be well to use the pick-axe in preference to the spade. It should be used freely, both deep and wide. The cost will range from 1s. 7d. to 2s. per 100 holes.

## CHAPTER IX.

### *DISTANCES AND DISTRIBUTION OF TREES IN PLANTATIONS.*

THE forester in all his work must keep in view the future, and a more remote future than the ordinary husbandman. In deciding upon the distance between his trees and the selection to suit soil and site, he will display his skill and knowledge more than in many other branches of forestry. If his object is, as it should be, to grow the greatest amount of good timber in the least possible time, he must carefully exercise this knowledge in the initiatory step, and not by fatuity allow the hopes of an early return to warp his judgment. To secure an early return requires close planting, which has a tendency to draw up the trees, and to destroy the natural proportion between the height and girth, which, in well-developed conifers, should be one foot to one inch—*i.e.*, an inch in girth should represent one foot in height.

Close planting, too, necessitates early thinning, and early thinning discourages development of timber, especially when dealing with conifers. Some trees require more room than others—for example, oaks, though they need protection in their early stages,

require more space than other hard woods, because it is important that they should attain a large girth with a medium height; on the other hand, where height is required, fairly close proximity must be maintained for many years.

With conifers, the distance apart in early growth is a matter of the gravest consequence. As already stated, if too close, the trees become weak and dependent upon each other for support; if too wide apart, they become laterally clothed with strong branches, which is prejudicial to the development of timber of fine quality. A medium distance, therefore, is requisite, and the forester must endeavour to select one that will secure both height and girth in fair proportion. The lateral branches must die off, and not be cut (in fact, pruning of any kind is an evil resulting from the neglect of well-known rules, and should in really good forestry be unnecessary); and to secure this, the trees must be sufficiently close. If too close, however, the branches will die off before they have performed their functions; if too wide, it will be necessary to cut them off, which, as before stated, results in injury to the future timber.

If large timber is desired, 5 feet is not too wide; this yields sufficient protection, and allows the lateral branches to cling long enough to assist in the development of wood. From 15 to 20 years may elapse after planting before any thinning will be required, and this we consider preferable to the common practice of thinning at a much earlier period. It will be found after a lapse of this period that the lateral branches may be broken off sufficiently to enable the men to



work freely in the plantation without being obliged to use the knife at all; it will be found, too, that the trees have attained a proportional growth, and a clean and robust character.

We are, however, trespassing upon future sections, but it seemed necessary here to draw attention to the necessity of carefully weighing this subject before proceeding to plant. Even where there is a demand for the product of early thinning we prefer, to some extent, ignoring it, rather than sacrificing the future prosperity of the plantation to obtain it. We write this advisedly, as, after years of close observation, we are convinced that the future prosperity of the planting will be best secured by keeping the mind fixed upon producing timber, and setting aside in the meantime all minor considerations.

Where the demand for small wood is considerable, as, for instance, hop-poles in a hop district, it can be met by special cultivation. By planting larch or Scotch pine 2 to 3 feet apart a good crop of poles may be obtained in ten years; and the whole may be cut at once or in close succession, and then replanted; and in all probability each successive planting will be more prosperous than the one preceding it. Then, again, it will be necessary to consider the site, whether it is exposed or sheltered. If exposed, some prefer close planting, especially on the side exposed to the prevailing wind, but we venture here, also, to take a different view. More protection will be obtained by the encouragement of branches and foliage than by proximity of stems; and all know who have had experience that belts of conifers, with wide and well-

developed branches, are a greater protection than bare stems, however closely they may be packed.

Take for an example a belt of Austrian pines (*Pinus Austriaca*), planted, say, 5 or 6 feet apart, what better protection can there be? Again, take a belt of Scotch pine or larch, planted  $2\frac{1}{2}$  feet apart or even 3 feet, and what security do they afford after the lapse of a few years? Shelter, as before stated, is so important that too much care and foresight cannot be exercised. In pleasure grounds, too, how many schemes are frustrated by the ignorance displayed in the early stages? Go where we will we see trees that should have been beautiful, and would have been, but for the process of crushing which they have had to undergo, and to the buffeting they have received from want of shelter. These disappointments may be overcome by judicious treatment, and especially in the wise choice of distance. Lateral development is all-important when planting for ornament, and this is best secured by protection; but if the protection afforded is too close or too distant the result will be disappointment. In the first case the laterals will be lost, in the second, the tree will be unshapely.

With regard to hard woods, distance is also of great importance, and must be determined by the class of timber required. If long straight timber is desired, there must be close proximity in the early stages, and thinning must be judiciously carried out for many years. This discourages lateral growth; but, at the same time, encourages, under proper management, a sufficiency of foliage. If, however, girth is required with a proportionate height, a greater distance must

be allowed from the first, and each tree should have ample room. We do not, however, imply from this isolation and exposure.

We must in future sections on thinning and pruning draw attention again to these important considerations, because both these operations, as we have before implied, are dependent upon the choice of distance.

To come to some conclusion, however, which may serve as a guide to the young forester, we may take, when planting conifers alone for timber purposes, a distance of not less than 4 feet and not more than 5 feet. When planting for hop-poles,  $2\frac{1}{2}$  to 3 feet; and for pit-props 3. to  $3\frac{1}{2}$  feet. If our object is the rearing of hard woods, the distance may range from 12 to 20 feet; in which case we should make up with conifers 4 feet apart. We should ourselves, if planting oaks, take 12 feet in medium soils, and 16 feet in the best clay loams. In the case of beech (if artificially reared), we should prefer from 12 to 15 feet; if, as is often the case, beech is naturally reproduced, the distance will be governed by circumstances. In other cases the distances will range, as suggested, from 12 to 16 feet, in accordance with the object in view.

We have to deal now with the distribution of trees. This also is an important link in the long chain which we are endeavouring successfully to forge. The choice of trees in the first instance will depend upon the soil and the local demand. What tree, or what trees, are best adapted to the soil to be dealt with? What timber is there most demand for in the immediate locality? These are questions which will naturally force themselves on the mind of the forester before he

commences to plant. He knows that to plant oak on light or thin soils will result in failure; he knows, too, that to plant ash on poor meagre soils will also result in disappointment; to plant trees loving a moist soil and a sheltered position on exposed and dry soils cannot but bring discredit upon his work. It is therefore clear that he must thoroughly acquaint himself with the character of the soil he has to deal with, and the contour, altitude, and aspect of his site. He must endeavour to distribute the trees so that each variety may obtain what it naturally requires, and not try to force an unnatural regularity for the sake of uniformity. For uniformity in Nature does not exist.

Again, it is necessary in the development of timber to secure a uniform and level growth. Throughout the future the forester should endeavour to obtain an *unbroken leafy canopy*, and this he cannot obtain if the trees are irregular in growth. True forestry greatly consists of this uniform and regular growth, this gradual and even development of timber, this mutual dependence on each other for support. By it is secured the greatest amount of humidity, and the least amount of draught and exposure. Compare it with a plantation of uneven growth, where trees are of mixed character, and of unequal size and development. Here we find a beech occupying great space, to the destruction of more valuable timber; an ash, drawn up to an unnatural height, and totally dependent for support upon its fellows; an oak, so deformed as to be absolutely useless, except for firewood; dead trees, which have died from drip, and from want of air and light; trees with meagre tops like palms, and

stems like whips ; larch, fir, or other conifers covered with lichen and useless. It is a sight to break the heart of a forester, and yet how often is it seen ! This need not be where forestry is understood and appreciated, but there is no cure for this state of things where it exists. No forester, however clever, can rectify the result of past mismanagement ; he cannot bring order out of chaos. Nothing is more hopeless than to be called upon to deal with neglected woods and plantations. This state of things has been produced by unwise distribution and selection, by ignorant thinning, and by an absolute indifference to recognised rules and elementary physiology.

Prevention alone must be looked to, and the forester should endeavour to prevent a recurrence of such a chaotic state of things by carefully studying what we have endeavoured to picture. He should satisfy himself that by studying Nature, and endeavouring to follow on her lines, he may secure that which is absolutely essential to success ; and by ignoring her teaching, and carrying out his own preconceived opinions, he may court failure and future discomfiture.

Another feature not to be lost sight of in the distribution of trees, is that of planting together those of equal development and power. When taking trees from the nursery the nurseryman should always sort the plants, placing those of robust growth, both with regard to stem and root fibre, together, and keeping separate those of feeble or imperfect growth. The planter by this method will plant in accordance with this selection, and so do his best to secure uniformity.

If this is not done, and the trees are planted as they come, the strong and robust overpower the weak, and there is from the beginning irregularity, which, as before stated, leads to disappointment. Plantations well managed should present in their early stages an even top, like a field of corn.

Indirectly distance affects the initial expenditure, both with regard to the number of trees required and the extra labour incurred in planting them; but no true forester will permit this to influence his judgment. Nevertheless, it is by no means a mean factor when other circumstances are unimportant. For instance, if a distance of 3 feet is decided upon instead of 4 feet, 2,000 more trees per acre will be required, and, of course, 2,000 more holes. Therefore, if there is no demand for small wood, and the intention is to grow timber, there is a manifest waste.

We have endeavoured in this section to draw attention to the necessity of giving full consideration to the subject of distance and distribution before commencing large planting operations. When a large expenditure is absolutely necessary to secure the most trifling results, it is clear that too much care cannot be exercised to bring about a maximum of success.

It is, of course, clearly understood that our remarks apply to plantations only, and not to established woods. In the latter we have to deal with natural reproduction, and we must adapt our arrangement to local circumstances, only endeavouring to induce Nature to fulfil artificial demands.

## CHAPTER X.

### *TREES AND GROUND GAME.*

AFTER planting, the work of the forester is not complete ; constant attention must be given, as will be hereafter described. Between the planting and first thinning there are many dangers and causes of failure, which must all be met and combated. Perhaps the most serious of these is caused by the presence of ground game.

It is a fact beyond dispute that ground game and young trees cannot live together. If landlords decide upon improving their estates by planting and thereby incur a heavy expenditure, it is not unreasonable to suppose that they have at the same time decided to reduce or exterminate their hares and rabbits. If they have not, they have, of course, decided upon wasting their money. If they desire to do so, they cannot possibly choose a more satisfactory method of achieving it. Nothing is more disheartening than to plant with great pains and to have all destroyed by these pests.

We lately visited an estate, not 300 miles from London, the owner of which had shortly before his death developed a passion for coursing, and had

allowed his hares to increase enormously. Not only were all the young plantations entirely destroyed, but the large ash were completely barked as high as the hares could reach. The estate presented a forlorn and pitiable appearance. Here the injury had become a perpetuity, and will affect future and successive generations. To an agricultural crop the injury is a passing and temporary one and may be overcome.

This, of course, is an extreme case, but nine times out of ten injury is done, and carelessly permitted to continue, which not only renders the result of the expenditure but a partial success, but often retards even this for many years.

Constant replanting, which is often carried out, results in an uneven growth, and a large percentage of trees never reach maturity, but are killed by drip and want of light. Some proprietors aver that trees bitten off will recover and make a new start with a new leader, or that trees barked will eventually revive, but there can be no greater delusion. They may undoubtedly live, but they will never thrive. In a well-protected plantation, and where the work has been well executed, about 15 per cent. will require replanting the first season after planting, and perhaps from 5 to 10 per cent. the second year. But where ground game has been allowed to live upon them, from 50 to 70 per cent. will need replanting, and often the whole. Some profess to guard their plantations by wire netting, but this we have in every instance found to result in failure. To wire all round extensive plantations is a matter of great expense, and to render it secure requires the constant services of a trustworthy



man. All this adds greatly to the initial cost. Again, when plantations are wired, the keeper's sense of duty becomes dulled. He considers that the responsibility has been taken out of his hands, and he consequently allows both hares and rabbits to increase at will. We have always found that ground game increases with the increased use of wire.

The keeper's interest and the forester's are antagonistic. The one is anxious to show good sport (and although a good sportsman is satisfied with an ample supply of feather, the young and inexperienced novice requires an ample supply of ground game to whet his appetite, which it pays the keeper to foster), the other is anxious to obtain healthy timber as fast as nature will permit unhindered by the injurious bite of these rodents. However, as we have stated, the two cannot exist together, so landowners must take this matter into consideration when they count the cost of planting.

Another plan often adopted (done, too, generally after the mischief) is to tar the stem; this, in our opinion, is most injurious to young trees, rendering, as it does, the bark hard and inelastic, and inducing a hide-bound condition detrimental to tree-life. The patent mixtures sold for the purpose of protection from bite of rabbit we have found useful if newly applied at least once a year. The caustic effect of tar is not apparent.

Of the two, hares, when in excess, are more injurious than rabbits; their depredations are more widespread, and to young larch especially they are most destructive. They are not satisfied with a nibble here and

there, but bite off the stem, about half-way up, as clean as if cut with a knife. Rabbits, although very injurious, confine their destruction to their haunts, so that it is possible to deal with them.

From a money point of view it is impossible to support the undue preservation of hares and rabbits. The money obtained by their sale is insignificant compared with the injury they commit in plantations. On the other hand, the complete extirpation of hares and rabbits is neither required nor desired, in fact such a possibility must be greatly deplored; but young plantations must be protected, otherwise failure is a foregone conclusion, and the cost incurred is actual and wilful waste.

## CHAPTER XI.

### *ATTENTION AFTER PLANTING.*

AFTER planting, young plantations require constant supervision. Often when the work has been completed they are left entirely to take care of themselves, and when visited much disappointment ensues. A gardener, when he plants out his flowers or shrubs, gives them constant attention, and does all in his power to bring about success; but a tree is too often treated as a strong and robust plant, which will take root and thrive as a matter of course. If the planting has been carefully carried out—in accordance with the suggestions we have made—and a man is employed for a few months to tend the plantations, there need be little fear of evil results; but if the trees have been carelessly planted and afterwards neglected, it will be found necessary to replant largely the following season. Taking this into consideration, it is worth the forester's while to employ men to watch the plantations for some months after planting.

On land that has been recently drained, and where the natural herbage is rank and luxuriant, one man will be needed to each fifteen acres. We have found this area as large as one can easily manage. When, however, the herbage is short and the land fairly dry,

one man may manage thirty acres. His work will consist of treading in the trees, which, especially in the former case, will always become loose by contraction of the soil, and cutting the surrounding herbage, be it grass, fern, or scrub. Here and there an outside ornamental tree will need staking, drains will need keeping open, and so on.

The best instrument for cutting the herbage is a short-bladed scythe. A hook is often used ; but, we think, trees are in more danger with this than the former. Care, under all circumstances, is needed, as much injury may result. If the trees are allowed to grow in the midst of this undergrowth, a large number will damp off ; so that the work is really necessary, and the expense should not be considered. We have seen much injury follow from neglect of this simple action on the part of the forester. Let the forester satisfy himself on this point by visiting a plantation where the undergrowth is rank and luxuriant, and where the scythe has not been used, and he will find many of the trees dead and covered with mildew. Under such circumstances as we have described, it will not be found sufficient to cut when full growth has taken place, but it must be cut early and kept cut throughout the season. Many trees, too, as we have stated, would be saved if they were newly earthed and trodden from time to time. If all this is carefully carried out, the necessity for replanting will be reduced to a minimum, and uniformity, as far as possible, will be secured, and at a moderate cost. On heavy land the cost may be put at 7s., and on light land 3s. 6d. an acre. This is so trifling, that,

when the advantages which accrue are considered, no forester is justified in neglecting so important a part of his work. When the trees have become established, which, in well-managed plantations, will take place two years after planting, little attention will be needed until the first thinning becomes necessary. Hereafter there will be a financial return with each operation, a return which may possibly recoup the outlay from the commencement; and the plantations will have become an important factor in the economy of the estate.

The advantages to be gained by planting are considered by many so remote and visionary that our area under timber does not largely increase; if, however, the operation were more systematically, judiciously, and economically carried out, the result would stimulate and encourage the owners of waste land to plant, and so add largely to their resources. There are few finer investments open to landowners than the planting of larch and other trees suitable to their soil, and if taken advantage of many financial difficulties might be overcome. In Ireland especially there is room for most extensive planting. There is no finer soil or climate in the world for timber, and yet the country has become almost disafforested. If the bare hill-sides and the extensive wastes could be reclothed with wood, prosperity would again dawn, and employment would be afforded to thousands who now for the lack of it are living in poverty or quitting the country.

We hear of all kinds of schemes, many of them wild, to promote the well-being of the land, and yet this one absolutely feasible method of reclamation is allowed to pass almost unheeded. We believe that

much rural distress would have been avoided had arboriculture received fair consideration, and planting been steadily carried out. From the want of knowledge, from the failures brought about by wilful ignorance and neglect of common natural laws, capital invested in planting has been wasted, and the work thereby been suspended. It is only by spreading the knowledge of forestry that this desirable end can be achieved, and when this is secured we believe land-owners will willingly make use of the knowledge so acquired.

## CHAPTER XII.

### *THINNING OF PLANTATIONS.*

WE have endeavoured in the foregoing chapters to build up, as it were, a plantation, and have followed carefully the various operations which are from time to time required. There must naturally be an interval of rest between the final replanting and first thinning, during which period Nature is at work and, in her silent way, bringing to maturity what man has commenced. Her work will be more or less rapid and successful as man has carefully and wisely performed his. If the principles of true forestry have been ignored and the work of preparation and planting been carelessly carried out, the first thinning may be required too early or possibly be too long deferred; but if the principles laid down have been followed, the work of thinning may be commenced from 12 to 20 years after planting. This wide space may seem remarkable and halting to the uninitiated, but it simply applies to the distance chosen, the quality of the soil, the aspect, kinds of trees, and so forth.

There is no fixed period for thinning; the forester must exercise his discretion, and upon this discretion will depend very greatly the future success of the plantation. If too early, there will be waste of

material; if too late, a tardy development of timber, and future weakness. Too much stress cannot be laid upon the necessity of wise and prudent thinning. All who have practically followed the fortunes of a plantation will have noticed the rapid development of timber after each successive thinning. Where thinning, too, has been neglected, they will have noticed the weak and feeble growth, the lichen-covered stems, the dead and dying trees, and the unhealthy appearance of the whole. Why is this? Simply because there has been a lack of air and light and insufficiency of foliage to elaborate the sap, and the want of room for the ramification of the root-fibres. Trees, when growing, need air and light and ample room below, otherwise they crush out one another, and the strongest and fittest only survive. Diseases of various kinds prey upon the enfeebled trees, and the result is failure and disappointment. Again, if left too long, they become dependent upon each other for support; and when this support is removed they feel, like the brute creation, the cold and draughts which follow, growth becomes sluggish, the sap circulates slowly, the elaboration is imperfect, the cells become thickened, and the tree, by epicormic branches, makes an effort to relieve itself from the superabundant sap, and finally succumbs. We have seen large areas of both deciduous trees and conifers suffering from this careless management; and it is rendered the more lamentable by the impossibility of fully repairing the mischief.

Where from the earliest period careful thinning has been carried out, very different results are manifest.



Each tree stands firm and independent of its fellow, the lateral branches are retained until they have performed their functions, they do not wind-whip each other, but give support without dependence; the growth is rapid and uniform, and the trees being of equal height, obtain their full share of light and heat. Ill-grown, weak, deformed, or diseased trees have been removed, and there is at once the appearance of prosperous development, which to the landowner is nothing more nor less than an accumulation of capital or a silent influx of revenue.

The great and true principle of thinning (and we look upon the process as one of the most important in forestry) is to encourage the growth of those trees which are left, and not to secure a financial present return. This, though important, is quite a secondary consideration, and should at all times be ignored. Of course, if the thinnings can be sold or made profitable use of, so much the better.

If, as is too often the case, the trees have been planted too closely together, an early thinning becomes absolutely essential; and the thinnings, except larch, will be of little value, which is a proof of the waste in the first expenditure. Larch, as we have before pointed out, may be sold for hop-poles in some districts; but this is almost the only exception. In fact, too close planting is so unwise from every point of view that its continual adoption points to ignorance of the most dangerous type. Dangerous, because it adds to the initial cost, and prevents to a large extent the increase of expenditure of capital in this most important branch of land improvement

and development. We have already drawn attention to the fact that proximity of plants affects directly the initial cost—*e.g.*, if trees are planted 3 feet apart, 4,840 plants are required per acre; whereas if 4 feet or 4½ feet is the chosen distance, 2,722 and 2,151 plants respectively will be required only. If we take these as one year seedlings, two years transplanted, usually sold for 15s. to 20s. per 1000, there is at once a saving of, say, 40s. per acre, exclusive of the cost of planting. If nothing is gained, therefore, by close planting (and we maintain much is lost), this is a case of sheer waste and extravagance.

When we consider by-and-by the cost of planting we must again draw attention to this point; in the meantime it is only necessary to impress upon the forester the necessity of early and gradual thinning, and then to proceed to describe the actual process.

When the period arrives for thinning, the forester will make the necessary arrangements for carrying it out. If the area is large he must commence early, even if by so doing he sacrifices to some extent the thinnings—*i.e.*, without his staff is also large. He should proceed year by year, and section by section, so that the whole work is kept under control. We say section by section, because he has, of course, arranged the plantations in squares of uniform dimension. If planted in rows, there will be little difficulty in deciding what trees to remove and what to leave; but if random planting has been resorted to, greater care must be exercised. Of course, in every case the best and most robust trees must be left, and the weakest and ill-formed removed. Small trees, too, which have

been left behind in the race, should be removed, as they can never recover, and mar by their presence the appearance and uniformity of the whole.

All should be felled one way, so as not to become entangled; and if the work is commenced on the outside, and the trees thrown against the standing timber, they can be drawn out and stripped as the work proceeds, either by manual or horse labour. When stripped, they should be sorted and laid in piles by the roadside so that each lot can be readily removed. The branches of fir are of little use without bricks are burnt upon the estate, when it may pay to tie them in bundles; this, however, will cost 2s. 6d. per hundred. If there is no demand, the best course is to burn the whole in the plantation, taking care, of course, not to scorch any ornamental or outside trees.

The first thinnings will be of little value without they are larch, when, if there is a demand, they may be sold for hop poles at prices according to lengths. They should be cut into 12, 14, and 16 feet lengths, and sorted accordingly, and the price in the plantation may run from 12s. to 20s. per hundred. Small Scotch pine possess really no value, but when large enough, say three to four inches in diameter at the smallest end, both larch and Scotch may be sold for pit-wood. It should be remarked here that the value of thinnings will depend almost entirely upon the proximity of the plantations to roads. When roads are good and near, a maximum value may be anticipated; but when situated in remote and inaccessible districts, a minimum. This rule, of course, applies in every case, and equally to agricultural and arboreal products. There

will, of course, be no thinnings of hard woods at this early period.

The operation of thinning will be much advanced by keeping the lower branches broken off from time to time as they die. If this is not done during growth, it should always be done before commencing the actual work of thinning, as the men are then able to work freely, and the forester can see what he is doing when marking. With regard to marking, it is almost impossible in the first stage to carry it out. The woodman in charge must exercise his discretion as the work proceeds; later, however, when the trees have assumed greater proportions, the forester should carefully mark each tree which he wishes removed. The cost of thinning may be stated as follows:—When 4 inches in diameter,  $\frac{1}{2}$ d. each tree; when from 8 inches to 9 inches,  $1\frac{1}{2}$ d. each. At such task-work as this good men will earn 4s. a day. This sum includes cutting, stripping, and carrying out.

It will be necessary to continue this process of thinning from time to time until the plantation has reached the age of 50 or 60 years. By such time, whether the trees are conifers or hard woods, the ground will be capable of bearing them and carrying them forward to maturity. What number of trees an acre of ground will eventually carry depends upon circumstances, but from 40 to 80 may perhaps fairly represent the number of hard woods, and 200 to 300 pines and firs.

If thinning has been wisely and judiciously carried out from the earliest stages, the trees will at this period be rapidly laying on timber; and from this

time the forester must watch for the period when full maturity is reached, as there can be no question that when this point is reached the whole should be felled. The rule is a universal one, that the proprietor in possession when timber arrives at maturity is entitled to the crop; the harvest period has been reached, and he who holds his hand is not fulfilling the laws of good forestry. The exception applies, of course, to ornamental trees; these, though they have reached their full growth, are still "things of beauty," and must remain. Dryden realised this when he wrote of the oak:—

"The monarch oak, the patriarch of the trees,  
Shoots, rises up, and spreads by slow degrees;  
Three centuries he grows, and three he stays  
Supreme in state, and in three more decays."

It may be asked, When is maturity reached? How are we to know when trees are no longer profitably developing?

There are signs which it is difficult to describe, and yet are visible to the experienced eye. The shoots thrown out each year indicate by their weakness or vigour the state of the tree. If long and vigorous, there is no doubt whatever that wood is being formed; if short and weak, the wood laid on is too slight to be appreciable, and the tree may be looked upon practically as dormant. When shoots show themselves on the limbs and trunk; when branches die; when the leading branches show signs of decay; when moss and lichen take possession, and so on;—these all indicate that the period of ripeness has passed.

If we visit woods in any part of the country we see this, and with regret, and attribute it either to ignorance or to the love of the scenic rather than the commercial aspect of forestry on the part of the landowner.

We could carry the reader to large areas both in England and Ireland where this waste has taken place, and is still going on. The scenic aspect of forestry is too much a matter of fact to be treated with ridicule, but we venture to assert that it is best secured by following closely the rules of good forestry.

## CHAPTER XIII.

### *PRUNING OF FOREST TREES.*

PRUNING may be considered as a necessary evil arising from defective forestry. It is an operation to be avoided wherever possible, and in plantations which have been well managed it is never necessary after the first few years. In the nursery stage some amount of training is of course required, such as the cutting off of a double leader, the cutting back of too robust laterals, clearing the stem, and so forth. After this, if proper distances are selected, Nature will perform the task.

The rule with regard to larch is well known, and the exceptions to the rule are few—it is that no knife or sharp instrument of any kind should touch them. The laterals will die off from close contact when their work is done, and may be broken off from time to time by a blunt instrument. If cut off when still green the tree will bleed, and disease, especially canker, will be developed.

Circumstances may arise when it may be necessary to cut off a limb, and when this is the case care should be taken not to wound the stem; at the same time the limb should be separated close to the stem, if it is not the portion left will die; and as the trees grow

rapidly this dead portion soon becomes embedded in the new growth, and when sawn into planks forms a blemish of a serious character.

When thinning plantations of Scotch pine and spruce fir it is sometimes impossible to avoid the cutting off of green limbs, as these trees do not cast their laterals as early as larch. If not cut off, the woodmen cannot move about and perform their task. In this case, however, if care is taken to cut close without wounding the stem, little or no injury will follow, because these trees do not suffer from bleeding like larch. In this matter of cutting off the lower branches of Scotch pine and spruce our experience is, that if cut off close to the trunk by a sharp upward cut of the axe no harm will follow, as in a few years the wound will heal by occlusion.

With these remarks we may dismiss the pruning of conifers, but the pruning of deciduous trees is a matter of much greater importance and must be further considered.

Pruning means nothing more nor less than diminishing the number of leaves and branches, and as these are necessary to the full development of timber, the question arises—Why cut them off?

No forester should suffer a limb to be severed without he can give, if asked, a good reason for doing so. Random pruning is of all others a mark of ignorance and bad forestry.

Let us follow the various stages of growth, and consider pruning under each. When removed from the nursery the plants should be shaped, *i.e.*, the best leader, if there are more than one, should be selected,



the rest cut off; lateral branches near the base should be cut off close to the stem, but overgrown branches which tend or are likely to destroy the balance of the tree should be shortened. Later side branches should be cut off so that a clean stem may be formed to the extent of one-third or one-half the height of the tree.

Trees which have been planted and have become hide-bound, or which show signs of decay, should be cut clean away to four inches from the ground; at the same time, however, a small stake should be driven in to mark the stool, so that the young shoots which will soon appear should not be destroyed when cutting the herbage. This process should be carried out in April or early in May, and by the following winter the best shoot may be selected for the future tree. Some foresters invariably adopt this plan in all plantations of oaks. Poplars, or other fast-growing trees planted for shelter, may also be cut back when planted, or soon after, as this tends to develop branches and renders the shelter more effective.

Passing on to a later stage, it may be found necessary to prune outside or isolated trees, so as to secure a well-balanced head, or it may be necessary to cut off or shorten branches which have been broken or twisted by wind; these, however, are exceptional cases, for in the main plantations, or in woods which have been carefully tended, no occasion for the knife or saw is likely to be found. In neglected woods, where trees have attained considerable dimensions, much may be noticed which might have been rectified; but it is too late to rectify errors of the past, and all pruning under these circumstances will be worse

We may sum up the foregoing remarks briefly as follows :—

Render by good forestry pruning unnecessary, as far as possible.

When necessary, prune with judgment, not forgetting that the removal of branches and leaves reduces the vital power of the tree.

Prune in summer, as the circulation of sap is then in full vigour, and wounds are more readily healed.

Small branches may be cut with a sharp knife; larger branches with a pruning chisel, with an upward blow from a wooden mallet; still larger branches with a saw, the rough surface being afterwards smoothed and painted.

When necessary to deal with large limbs, shorten back rather than cut off close, and close to a side branch.

Never allow two leaders on any young tree, but where they exist in large trees leave them alone.

Maintain as far as possible the balance of the tree.

Do not prune conifers at all, except under circumstances already referred to.

Poplars, willows, &c., required for shelter or for yearly cutting, may be cut back and converted into pollards.

Trees suffering from disease may be cut back more or less severely, and life may thus be prolonged.

Before transplanting large trees the leader may be shortened, and the laterals reduced.

## CHAPTER XIV.

### *REALISATION.*

WE have now arrived at that period when the forester gathers in his harvest. He, like the farmer, has sown, planted, tended, and trained his crop, and when maturity is reached gathers it in to his garners. Patience, however, is a virtue which the forester must possess in greater abundance than the farmer, for many years must elapse between the sowing of the seed in the nursery and the reaping of the matured tree. Generations pass away, foresters succeed foresters, those who planted are forgotten, and when the axe is laid to the foot of the tree it, too, is forgotten, and the work is complete.

It must not be supposed for one moment that this series of chapters (treating of the creation and after management of a plantation) extends only over the brief period comprised in the life of an average landowner; on the contrary, it deals with a period more or less extended in accordance with the nature of the timber and the nature of the soil in which it is grown. It may be thirty, or it may be one hundred years or more.

But, nevertheless, if each successive landowner follows honestly the rules of good forestry, each one

may realise his full share during his limited occupation. This fact alone should tend to a fuller development of forestry, but it is too often lost sight of; and the love of gain, or necessity, obscures the vision, otherwise clear and honest enough. For each tree felled by impecunious owners a young tree is not planted, and only too often a young heir is not preserved, therefore the yearly growth of remaining timber alone can balance that which is taken; and this we know to be insufficient.

There can be no doubt that the quantity of home timber, by this constant realisation, has been sadly and seriously diminished; and it is only by an extension of the knowledge of forestry and the conservation of existing woods and plantations that the loss can be replaced.

What should we say of the farmer who reaped his wheat and sowed no more? Yet, for generations landowners have reaped and have not planted! Look at our hillsides which at one time were clothed with woods, where rivulets have dried up, and where sudden floods prevail through the removal of timber. This is the result of realisation without replenishment.

Realisation, when full maturity is reached, is, as we have before stated, an act of good forestry. There is no period of actual rest in the growth of timber. When a tree has reached the zenith of its vigour it will begin to decay. It is waste, then, on the part of the forester to stay his hand. It is not necessary, however, always to wait for this period, for commercial maturity may be reached before natural maturity, and probably it will pay the owner best to

take advantage of this period. Again, realisation does not necessarily imply complete dismissal of whole woods or forests, it means possibly progressive thinnings—it applies to the earliest thinnings, to a money return in any form ; but, nevertheless, we apply the term here to the selling of full-grown timber which has reached a saleable maturity, and propose to treat the subject, first, as to *methods of realisation*, and secondly, as to *measurement and valuation*.

We shall endeavour to describe the methods usually employed in the realisation of timber, and then, for the benefit of young beginners, describe fully the methods of valuation of both standing and felled timber, with the rules of measurement applicable. Our remarks will apply only to round timber—to the timber as it is felled and taken from the wood. We are dealing with forestry from an estate point of view, and not from the point of view of the timber merchant. We shall not, therefore, pursue the subject into the mysteries of conversion, for this, though allied to forestry, is wide of our mark, and would carry us into a business which needs the experience of a life. To make the most out of a round piece of timber requires skill unknown to the forester ; and many unsuccessful timber merchants probably trace their want of success to this very failing.

The forester should know, of course, for the purpose of valuation, what each tree is fitted for ; but his work is complete when he has felled, valued, and sold it.

We took occasion in the early part of this book to comment upon the lack of knowledge of forestry in

land agents, but on the subject of realisation they are undoubtedly the very best judges. By long and varied practice they can, and do, measure and value with the greatest accuracy, and if their general knowledge of forestry equalled their knowledge in this respect, our woods and plantations would not now be in the languishing state they are. This very skill has been attained by constant realisation, the result of which, as we have already stated, is so apparent. Let landowners realise that to continue this depletion without replenishment will lead to a timber famine, and set to work with a will to plant their waste and unoccupied land for the benefit of themselves and those who follow them.

## CHAPTER XV.

### *METHODS OF SALE.*

THERE are two methods of sale—viz., by *public auction* and *private sale*. Again, there are two methods of preparing timber for sale—viz., by *marking and selling standing* and when *felled*.

The object of the forester will be to obtain the highest possible value for his timber; and he will exercise his own judgment as to whether he will effect this best by auction or private sale. When the quantity for sale is large, there can be no doubt that auction is the best, as purchasers are brought together from various districts, and local rings are rendered almost impossible. In auction sales, too, especially if the class of timber is varied, there are sure to be a number of lots suitable for small buyers, for men who are doing, perhaps, small jobs; and these men are willing, as a rule, to pay fairly for the accommodation thus afforded. These odd lots, if merged with timber of a large and more valuable size, are seldom calculated in private sales, but, allowed, as a rule, to serve the purpose of an indirect discount. By this process a considerable sum is lost to the seller, as the presence of these odds and ends does not really improve the prices of the more valuable timber.

By auction, too, if the auctioneer has been well chosen—*i.e.*, if he is a man who knows and who is known to the timber trade—a brisk competition is obtained, and varieties of timber, for which, perhaps, there is no local demand, sell freely to men from a distance, who require such.

Different districts represent different trades, and different trades require various kinds of timber, and thus a healthy spirit will pervade the sale.

There are, of course, expenses attaching to sales by auction which are avoided in private sales; but, on the other hand, competition is not rife—in fact, is often entirely absent; and this, when the quantity to be sold is large, will far outweigh the contingent expenses. These expenses, however, to some extent are normal, and attach to small and large sales equally, so that they are little felt when dealing with large figures, but become heavy charges on small sales. This being the case, public auction cannot be recommended when the transactions are small. The question naturally arises—what is the limit? Elsewhere we have named £200 as the minimum, and see no reason to alter this assertion. Under this amount the percentage becomes onerous, and is not balanced by increased prices gained by competition.

Private sales, or *sales by tender*, which is another form of private sale, should be resorted to for sales under this amount, as the least possible expense will attach. At the same time, whilst recommending sales by auction, we do not for one moment condemn private sales even for large quantities of timber. There is much to recommend in private sales; op-



portunities often present themselves to gain high prices for certain timber, owing to an exceptional demand which does not affect trade generally. Timber may lie or stand in remote districts, which would not attract distant purchasers, and for which publicity would not improve the demand. Terms may be made with local men, without incurring the inevitable expenses already referred to.

In a private sale, however, one quality in the forester is absolutely essential, and that is, a thorough knowledge of the timber trade and a knowledge of valuing. If he does not possess this knowledge, he will be more or less at the mercy of the purchaser, who in all probability will understand his business well.

If sale by tender is resorted to, the same knowledge is equally essential, for, before accepting a tender, he must himself know the value. This, however, applies to all the methods named; the value (not necessarily so accurately assessed) must be given the auctioneer as his reserved or upset price, or the forester will be working in the dark.

Lotting timber, whether felled or standing, is a matter of much importance, if the full value is to be obtained. The auctioneer possibly may be a better judge of this, as from long experience he has become acquainted with the requirements of the trade; but the forester, too, must know, and know well, how to best arrange his lots, as to sizes and varieties. As a rule we are of opinion (especially when the sale is a very mixed one) that small lots sell best, as it gives small purchasers a chance, as we have already explained. When, on the other hand, the sale consists

of large, or, at least, uniform timber, the same necessity for small lots does not exist.

The forester, too, will have to decide whether he will sell his timber standing or felled. Perhaps of the two, to sell standing is the most general, especially on small estates where no forest staff is kept. The money obtained is thus clear or only subject to sale expenses.

Where a staff is kept it may answer as well to fell first. If this is done we strongly recommend drawing the lots to a convenient place of sale, as no process will pay better. We do not mean a long distance, but to a roadside or some convenient spot for removal.

Where, too, as on many estates, large quantities of timber for various purposes are required, it enables the forester to select for himself before selling, and enables him also to weed out inferior classes which would not assist the sale.

This is a matter, however, to which it is only necessary to draw attention; the question must be decided upon its merits.

The forester having decided upon the quantity of timber which he has for sale, must ask himself some or all of the following questions:—

How shall I sell, by auction, private sale, or by tender?

Shall I sell it standing or felled?

What regulations will be necessary to ensure careful removal and prompt payment?

How shall I arrive at the correct quantity and value?

These questions we will now proceed to consider in detail.

*Public Auction* having been decided upon, it will be necessary first of all to select an auctioneer. The choice should fall upon one who is known to the timber trade, and who thoroughly understands this branch of his business. Having chosen, it will be well to act in concert with him in the preparation of details. The first step will be to set out and mark the lots, whether the sale consists of standing or felled timber. If the former, the lots should consist of a certain number of trees in juxtaposition, and as far as possible of a similar kind. These should—having been previously marked by the forester—be marked in some way which will render them visible to the eye from all positions; a ring of white paint is perhaps the best.

Then on one side the number of the lot should be clearly painted in large figures, and to divide the lots it is a good plan to mark the following one on the opposite side, and so on alternately. In the latter case, the various trees having been drawn together, as described in the last chapter, the lots may be marked with paint on the butts, or a board with a painted number be fastened to a stake close by. The lots in this case should be regularly laid, with the butts pointing one way, and towards the road.

This work of lotting may be performed by the forester or auctioneer; if the former has had experience, it will save expense if he undertakes it; if he has not, he had better leave it to the auctioneer.

This being done, both the auctioneer and forester should enter the particulars carefully in their books. These should consist of the number of trees in each

lot, the kinds of timber, a space for the name of the purchaser, the forester's estimated value, and a column for the sum obtained. This will furnish full details for present and future use.

In the meantime and for (say) three weeks the auctioneer will advertise the sale in the best timber journals, not forgetting to be explicit as to quantity, varieties, dimensions, and so forth. This will enable merchants to judge if the sale is worth their consideration. If these details are withheld, and for the sake of expense the advertisements are curtailed, it will either lead to a large number of letters of inquiry or deter merchants from attending. During this period intending purchasers will view the lots, and every assistance should be rendered them to make their work easy.

The next matter to engage the attention of both auctioneer and forester will be the conditions of sale. In large and important sales these are of consequence. It is quite unnecessary here to give *seriatim* the rules and conditions of an ordinary sale. They are somewhat stereotyped, but, nevertheless, the forester must see that arrangements are made for careful cutting and removal, that standing trees are not injured by the falling timber—and this is best met by providing that for all trees so injured double the market value should be paid—that the roads specified should alone be used; and other such like provisions. The auctioneer will, on his part, see that arrangements are made as to bidding, payments, and so forth. It should be borne in mind that a deposit must be made by each purchaser at the time of sale

—the amount of such deposit being a matter of arrangement. Good and approved bills should be exacted for the balance ; but the best plan is, perhaps, to induce cash payments by the offer of a liberal discount.

One condition should never be forgotten, and that is, that the lots should all be removed within a specified time ; and if they are not, the right of the purchaser to their possession shall cease. We have often seen lots left lying about for a long while after sale, giving an untidy and unbusinesslike appearance to the woods. At the conclusion of the sale, each purchaser should be required to sign an agreement signifying his assent to the conditions of sale, and his willingness to abide by them. Finally, the auctioneer will render his statement of account, with the balance due, together with the bills for the remainder. The costs, as we have already stated, will be somewhat heavy,—a percentage in accordance with the amount of the sale as commission, lotting, printing, travelling expenses, refreshments, and so forth.

Notwithstanding these charges, auction confers advantages offered by no other method, and in our opinion should be adopted when the quantity for sale is large, without there is some really good reason to the contrary.

The forester should bear in mind that the success of the sale depends largely upon his own efforts, and not for one moment consider that the employment of an auctioneer relieves him of his just liability. One word of advice to both the auctioneer and forester before concluding the subject of sale by

auction, and that is, to dress out each tree to the full length. It is a mistake to saw into lengths, as, by so doing, the object of the purchaser may be defeated.

*Private Sale* is nothing more nor less than private bargain. A certain amount of timber is for sale and the fact soon becomes known, and those desirous of buying make their desire known to the agent or forester; or the agent or forester will seek for a purchaser whom he thinks will require the class of timber he has for sale. The first step will be to mark the timber in the wood or woods where it is standing or lying in the way already described, except that it will not be necessary to lot it. The next will be to measure and value it; and in this case a more careful survey must be made, as there is not likely to be competition to secure the highest possible figure.

Here then the knowledge and skill of the agent or forester comes into play, for without it he is likely to make a sorry bargain. It is impossible to lay down rules or to attempt in any way to regulate private sales, because they are always, as the name implies, open to private arrangements; and private arrangements are necessarily full of vagaries. They are open, too, to bye-arrangements between the buyer and the medium, not always advantageous to the owner. Nevertheless, many private sales are good and sound, especially when the parties engaged are skilful, and their acts *bonâ fide*. The remarks on private sales apply equally to felled and standing timber, only if the latter plan is adopted greater care must be taken in arriving at the quantity and value. As a rule, we believe the measurement of standing

timber tends to a low estimate; but, nevertheless, when properly understood and carefully executed, we believe a really sound valuation may be made which will favour neither the buyer nor the seller. Although this system of selling standing timber is often adopted, we do not for one moment specially advocate it; but we fully recognise the fact that it is often very convenient. Very old oaks, for instance, sold standing, will, we believe, favour the seller as a rule, as they are often very faulty indeed, the defects being most difficult and often impossible to detect when standing. In extensive dealing, nevertheless, with these old trees we certainly prefer, in our practice, felling before selling.

There is, as a rule, less precision in carrying out private sales, which in itself detracts somewhat from the method.

Another form of private sale is *Sale by Tender*. This is a kind of middle course, and by no means a bad one under certain circumstances. The agent or forester having made himself fully acquainted with the timber, the quantity and value, the locality, and so on, will proceed to advertise it in the trade journals for sale by tender; but will take care to make it clear that he does not bind himself to accept the highest or any tender. This advertisement, which should be explicit enough to elicit replies, should state that full particulars will be forwarded on application, and that the lots can be viewed by applying to certain individuals specified.

It is needless to write more fully on such a simple process as this; all that is required is to mark and lot

the timber, measure and value it, draw up conditions, and advertise for tenders. The probability is, if the timber is useful, that the result will be satisfactory, and the expense attending the sale will be very moderate. It will be a good plan when the sale by this method is an extensive one to furnish applicants with printed forms of tender.

These then are the various methods of selling timber. We do not attempt to dictate, or even to give a decided opinion upon one or the other, but recommend those responsible to weigh the matter well ; and then to adopt the plan which will in their opinion secure the highest possible value. This, after all, is the acme of forestry—to first grow the greatest possible amount of timber in the least possible time, and then to sell it at the highest possible price. We shall now explain and describe in detail the various methods of measurement and valuation.



## CHAPTER XVI.

### *MEASUREMENT OF TIMBER.*

THERE is, of course, a theoretical method of measuring timber, but the mathematician would fail to satisfy the parties interested unless he added to his knowledge of mixed mathematics the practical knowledge gained only in the woods. The mathematician would by his process accurately determine the solid contents of the trees, but what is required is the saleable contents; and we shall endeavour to show that there is a considerable difference between the two. We propose confining our remarks to the measurement of round timber, for, as we have before stated, the conversion of timber belongs to another line of business. True, we could, under the head of forestry, easily and correctly merge the two; but we fail to see the necessity or expediency of so doing.

If the timber is sold it passes into the hands of the timber merchant or contractor, who converts it to suit his purposes; if it passes by transfer into the hands of the clerk of the works, he also converts it; the land agent's or forester's duty is complete when he has obtained from one source or the other the value of the round or hewn tree.

The question will naturally arise—*What is timber?* The lawyers tell us that oak, ash, and elm are alone timber, other classes are timber-like trees; but from the forester's point of view all trees are timber which have a quarter girth of six inches under the bark. This custom has become almost universal; and go where we will we seldom find it disputed.

In some districts beech is timber, especially in those counties where it grows largely and is in demand, such as in Bucks, Hampshire, Gloucestershire, and so on. Birch, again, is in great demand in the Northern counties, and counts as timber; in others it is not always so. Again, it is considered by some that a tree is not timber until it has reached a content of nine or ten solid feet; under this they are treated as saplings. But these are the exceptions, the rule is as stated.

The object of the forester, then, is to obtain the *saleable* content of the tree. This quantity lies between the die square and the full contents. The die square measurement represents the largest piece of scantling that can be obtained from a piece of round timber, the full contents is that obtained by taking the full circumference. The saleable contents is obtained by taking the quarter girth, or one-fourth of the circumference.

In measuring standing timber the girth is taken by the measuring strap as high as can be readily reached, and an allowance made for fall; which means that a deduction is made from the circumference thus obtained so as to approach as closely as possible to the true girth in the middle. This is usually taken at six inches from the full measure; but although this is usually

taken as sufficient, it is not so in most cases, as we have more than once proved. Then, again, an allowance must be made for the bark, and this in oak, ash, and elm is usually taken at one inch from each foot of quarter girth. Some prefer a sliding scale ranging from  $\frac{1}{2}$  to  $1\frac{1}{2}$  inch, but 1 inch may in practice be taken as satisfactory. The height in most cases may be taken by a jointed rod, 20 feet in length; or in the case of very high trees one or two may be felled and measured, which will enable the forester to judge of the rest. It is possible, of course, to take the height by the sextant, but this we pass by, as being beyond the power of the ordinary forester or agent. In measuring felled timber the method is to take the length of the entire tree, or, if the length is divided, according to size and shape of each portion, and measuring back to obtain the exact half; here the girth is taken with a string, the string is then folded into four, and laid along the rule, which will give the quarter girth in inches. Here it will be noticed no allowance for fall is required, as the girth in the middle has been taken.

In the case of a larch plantation, we have found it best to assume that all the trees are 20 feet in height, then by taking the girth breast-high and making no allowance for fall, the saleable contents will be approximately found.

Now it will be seen that this method of quarter girth divides the waste between the buyer and the seller. If the die square be taken, a large quantity of saleable waste will be obtained, and which would be lost to the seller; on the other hand, if the full con-

tents be taken the buyer would purchase the waste at a price far above the value. The quarter girth meets this, as already described.

Having obtained these data, the rule for ascertaining the cubical contents from them will be:—*The square of the quarter girth in inches multiplied by the length in feet and divided by 144.*

By the sliding scale it will be:—*As the length upon C is to 12 upon D, so is the girth on D to the contents on C.*

Tables, too, are published, but we strongly recommend all beginners to avoid them and to keep closely to their own calculations until they have become experienced.

If they do not take this step they will never rise above the ordinary level, which should be contrary to the creed of all aspiring agents.

Having given the rules for timber measurement, it will now be necessary to apply them. For this purpose we will proceed to carry out a valuation for the sale of standing timber, may be for sale by auction or for transfer on sale of land—the process in either case will be similar. Some measure a tree here and there, and compute the rest; some experienced men do not measure at all, but set the cubical contents and value by the eye alone; others measure carefully each tree. The latter plan is the most satisfactory, and we strongly recommend all, especially beginners, to take this extra trouble. They will be well repaid for their labours by the knowledge they will possess of the accuracy of their work. We do not, of course, imply that every tree in the wood should be measured, as

there will be many instances, especially where the woods have been carefully thinned, where trees will be of similar size and growth; we allude to the practice of measuring off areas, or counting the trees and roughly estimating the lots.

The quantity is invariably estimated in cubic feet, and sales are usually effected also by the foot; but in certain districts sales are effected by the ton, and then it is necessary to ascertain how many cubic feet of rough timber are required to make the weight. The weight of timber may be roughly estimated at from 60 to 90 lbs. per cubic foot, but the forester should satisfy himself on this point in accordance with the class and kind of timber he has for sale. This he may do by referring to published tables or by weighing a piece for himself. The latter plan is the best.

The measurer should supply himself with a measuring strap, a rod, a small blazing axe or scribe, and a book and pencil. The strap must be well-seasoned, so that it will not stretch, and marked so that each inch shall read  $\frac{1}{4}$ ; thus— $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , 1 inch, &c., up to 8 feet or more, as may be desired. By this means the quarter girth will be seen at a glance. At the end of the strap is attached a weight of lead, so that it may be thrown round by the operator, and caught by the left hand. This is done by standing close to the trunk, and only requires practice. As already described, from this quantity a deduction is made for fall and bark, and the true quarter girth entered in the book in the column assigned to it. The length is then taken by the rod. This is held against the tree by an assistant—his full reach being previously ascertained—and

any remainder judged by the eye of the measurer. This also is entered in the book.

The book should be ruled as follows:—The first column for numbers, the second for kind of tree, and then successively for length, quarter girth, quantity, value per foot, total value, and remarks.

Some enter each tree, of whatever kind, in rotation ; others keep separate pages for each kind. It is also usual, and to be commended, to keep a separate account of trees of 27 cubic feet and upwards, as these possess a higher value.

Trees under timber measurement are entered as saplings, or “tellers,” and are usually valued to 1s. ; below this they are usually allowed to pass. The value of these “tellers” will range from 1s. to 3s. each, according to girth. It is usual in contracts of sale to specify the standard below which no payment will be exacted.

It may be useful here to state that these young trees are the future timber and do not pass as underwood.

Young trees allowed to grow from stools are still underwood until they attain timber size ; therefore special provision must be made if they are to pass as saplings.

The total quantities may be worked out after the work is completed, or by experienced men during the valuation. We have known auctioneers enter the quantity in the book as fast as the figures are called out by their assistants, but this is arrived at only by long practice. It may be useful, however, to the beginner if we draw his attention to the following facts :—

6-inch quarter girth will give contents equal to one-fourth the entire length in feet.

7-inch, one-third.

8½-inch, one-half.

10-inch, two-thirds.

12-inch, equal.

17-inch, twice.

21-inch, three times.

27-inch, five times ; and so forth.

If he can impress these on his memory he will soon get into the way of rapid computation.

Tables are used and can be kept in the book, so that reference is easy ; but before selecting a table, it should be ascertained whether the results given agree with the rule laid down.

If the sliding rule is used more time will be required, and for large quantities we do not recommend it. We do strongly advise, however, the beginner to make himself by practice acquainted with its use, as it is often most useful. As the work proceeds, the trees must be marked, so that they should not be measured the second time, as may easily be done in a large wood. This mark should be on one side only, so that by looking back they may be seen. If marked at random, much running about is needed to satisfy any doubt.

In a large and thick wood, some care will be necessary to avoid confusion. We have found it useful to mark off sections by aid of white rods ; but valuers must adopt their own plan to suit local circumstances. One thing, however, is absolutely essential—

that is systematic regularity. Only those who have had experience know how easy it is to become confused in a thick wood.

In measuring ornamental timber, we are of opinion that it should be treated as ordinary timber, and measured and valued in the usual way. Some, we believe, take it at one-half the value; but we see no reason for this practice, for although it may not be felled by tenants for life, it adds materially to the beauty and capital value of the estate.

If any exception is made in favour of ornamental timber when measuring for transfer of land, it will be necessary to define what is and what is not ornamental.

Ornamental timber is not necessarily that which is left for ornament by a present or past tenant for life, but that which has been planted or left for the purpose by some one having the absolute power of disposition. It is not necessary here, however, to go into the legal technicalities attaching to timber. Having obtained the cubical contents of the trees for sale, whether for the one purpose or the other, the value must be attached according to circumstances. The full value, as if felled, will be taken, as the lop and top will fairly cover the cost of felling. When valuing standing oaks, the bark must be added to the value of the timber. Some make no deduction for bark, and take the extra quantity of timber so obtained as an equivalent; others take, after deducting for bark, so much bark to so many tons of timber. This will range from 1 ton of bark to 3, 4, or 5 tons of timber, according to circumstances. These circumstances are governed by



the situation of the trees, whether in woods, or isolated, exposed or sheltered, and number and size of limbs, and so forth.

At the present time, when bark possesses so low a value, it is questionable whether it pays to strip it. Oak timber, felled in winter, is more durable, and, therefore, more valuable than when felled in spring, and the extra price obtainable will, in our opinion, more than compensate for the bark. For Navy and Government purposes this is imperative. It is well to draw the attention of the student to the fact that when oak is in scantling it is impossible for anyone to tell whether it was felled in winter or spring.

When trees are felled by the forest staff, and then sold, the method of measurement will be as described—a string (whip-cord is the best) will be used in place of the strap, and the length be taken by a two-foot rule or tape. Sometimes it is difficult to run the string round the tree; so the measurer should be provided with a needle for pushing under the log; the string can then be threaded, and the string pulled under.

We will next proceed to describe the methods of valuing larch plantations.

## CHAPTER XVII.

### *MEASUREMENT AND VALUATION OF LARCH PLANTATIONS.*

THE measurement and valuation of larch plantations differs somewhat from the ordinary valuation of timber. When larch or other fir have attained timber size the quantity and value may be determined in the usual way—*i.e.*, by ascertaining the cubical contents, and placing upon it the market value. This value may range from 6d. to 1s. a foot according to size, quality, and kind.

Often, however, plantations as a whole are sold, either for cutting, or for transfer on sale of land. These areas are often of various ages, some newly planted, others approaching maturity, others ripe for cutting. Some have not reached timber size, and yet possess a considerable present value to the timber merchant, or prospective value to the landowner. It is not usual to take into account prospective values when valuing timber, and yet this item cannot altogether be lost sight of in determining the value of land, nevertheless we pass it by here.

Plantations of Scotch fir possess little value until they have attained timber dimensions, and are seldom

sold except when the land upon which they stand is sold. The values are usually then determined by the cost of planting. It is different with larch; these soon reach a commercial value, long before they reach maturity, and are greedily sought after from the first thinnings until finally cleared. No tree, perhaps, grown is so universally useful, or more eagerly inquired for.

The first thinning will take place in ten or fifteen years, according to soil, site, and distance apart; and, as we have before stated, in hop districts they will sell from 12s. to 20s. per hundred.

The next thinning may take place three years later, and the produce be again sold for the same purpose. After this, if the trees grow freely, they will be fit for scaffold poles, and sell as such. Five pounds a hundred is perhaps a fair estimate for this class of larch. From this period until timber size is reached they are usually valued by the hundred, and will reach £15, £20, and £25, according to size; after this they are probably timber, and will be valued by the cubic foot.

Before they reach the first thinning—*i.e.*, when they are quite young—it may be necessary to value them on the sale or purchase of land, and the best course to pursue is to take the cost of planting and add to this the rent, rates, interest on capital, and so forth, for the period which has elapsed since planting. From this, however, should be deducted failures, which may have arisen through neglect or bad judgment.

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On the sale or purchase of land probably nothing is more satisfactory to all parties than the transfer of

really healthy larch plantations. The seller, who planted, receives his money plus a fair interest, and the buyer purchases at a reasonable rate something of certain prospective value. Valuers are satisfied because the value is readily determined.

When, however, these plantations have been unwisely planted, or after planting been neglected, the seller is in the same position as any other person who has unwisely invested his capital.

With regard to the method of valuing and selling standing larch, it is very similar to the process already described. If the whole plantation is to be sold for felling there will be no need to mark, but it should be carefully lotted by the forester or auctioneer into suitable lots, and the lots should be carefully defined, so that they do not intermingle.

If a thinning only is for sale, the forester must himself carefully mark those which should be removed before lotting. For information upon this point we must refer him to the chapter on "Thinning."

As we have before stated, it is not necessary for the forester to take into account the conversion of timber, only so far, at least, as to enable him to set a correct value upon his fall. In larch, perhaps, this knowledge is more necessary than in other classes of timber, as the uses to which it is applied are so numerous as to give it a high value, upon the principle of supply and demand. In accordance with size it is sought after for hop-poles, scaffold and telegraph poles, pit-props, sleepers, flooring-boards, piles, boat-building, wheelwright-work, fencing, and so on.

This long list is quite sufficient to show that it possesses a value beyond any other home-grown timber. It also proves, we think, conclusively that when planting for commercial and investment purposes there is no tree which approaches it where the soil and site are suitable.

In northern districts it has been customary to peel larch, the bark possessing tanning properties; but, probably owing to the low price of oak bark, this is not so common as it was. When this is done the value must be added to the timber, and an allowance made for bark where necessary.

We do not recommend peeling when the poles are to lie long in the wood or elsewhere, as they season better with it on; but when for immediate delivery peeling largely reduces the cost of carriage, and is therefore advisable.

When larch, spruce, or Scotch pine are sold by the ton, the forester may take 70 to 80 lbs. per cubic foot as a fair estimate, which will give him about 30 cubic feet to the ton. This weight will, of course, vary in accordance with circumstances, and applies only to newly-felled and rough timber.

We do not for this purpose enter with accuracy into the subject of weight, as our object is only to enable the forester to place upon his timber a sufficiently accurate estimate for the purpose of auction or private sale.

## CHAPTER XVIII.

### *FIRE LINES.*

IN our moist clime little attention is paid as a rule to destruction of plantations by fire encroachment, and yet past dry seasons have not been unattended by loss—loss which would have been avoided had fire-lines been in existence.

It may be asked by some—What are fire-lines? Fire-lines are lines of deciduous trees, or bare spaces passing through plantations, and dividing the area, like water-tight bulk-heads formed for the purpose of checking the encroachment of water in ships.

In our opinion, when planting large areas bordering on waste land covered with heather or gorse these lines should never be omitted—they are unnecessary only where the plantations are surrounded by arable or pasture land. It is seldom that fires occur inside a plantation or directly, although such is possible where dead branches or *débris* are burned upon the spot. Fires usually arise through encroachment from conflagrations on the surrounding wastes, and if once fir plantations catch, nothing can prevent great loss and possibly entire destruction.



There are three classes of fire-lines :—

- (a) Bare spaces left when planting, or cut down in existing plantations.
- (b) The exclusion of conifers.
- (c) The planting (alone) of certain deciduous trees less inflammable than others.

In the first case there is unnecessary waste of space, and also the extra labour periodically of cutting away the growth of heather or gorse which will grow freely where there are no trees, and which, if left, will feed the fire as well as the fir trees, and prove a danger instead of a preventive. This plan, therefore, we do not recommend.

The second plan may be resorted to with success. The deciduous trees may be planted the same as in the rest of the area, but the nursing conifers excluded—or, which is still better, the third plan may be adopted, viz., that of selecting certain deciduous trees suitable to the soil and site, but less inflammable than others. These are as follows :—Maples, sycamore, alder, hornbeam, walnut, ash, plane, poplars, and birch. The direction and width of the lines is somewhat difficult to define, and must be left to the discretion of the forester or agent. They should run as far as possible across the line of prevailing wind ; but, when the area is narrow, they should take the direction of the shortest length.

This plan will serve to check the advance of a conflagration more completely than if the lines are taken along the greatest extent.

A further preventive will be found in good management—when fir plantations are carefully thinned, and

the lower branches broken off from time to time, there will be less food for the flames, and the fire will be more readily stayed.

To some these remarks may be considered as emanating from the brain of an alarmist, but we have seen great injury done which might have been avoided by such reasonable foresight.

We strongly recommend all land agents who have the control of large areas of fir-plantations on or near waste land, to take the hint and create fire-lines, although it is unlikely that hot summers will occur year by year in this variable climate.

We have so far dwelt upon the prevention of fires, and in this instance prevention is better than cure ; but fires will occur, and differences of opinion will also occur as to the best methods of extinguishment ; and it seems somewhat presumptuous to offer advice. We nevertheless recommend the lighting of lines of fires to leeward and encouraging the advance to windward. This can only be done, however, successfully where plenty of men are available to check the spread to leeward.

## CHAPTER XIX.

### *COST OF PLANTING.*

WE propose first of all treating this important subject from the primary point of view, *i.e.*, the initial cost, leaving for future consideration the yearly payments for rates, taxes, tithe-rent charge, interest on capital, fencing, maintenance, and so forth. To show conclusively that planting will pay, we must very closely examine all matters relating to expenditure, bearing in mind that interest and compound interest on capital expended forms a most important factor in the profit and loss account. Nevertheless, especially in times of agricultural depression, the initial outlay is the item most likely to weigh with the intending planter. By initial cost we mean the actual sum required for the creation of the plantation. This represents actual and immediate expenditure of capital, that which follows more immediately affects revenue. The investment must be viewed in the light of the purchase of a reversionary interest, and this, as we all know, is by no means a favourite method of investing capital. The return, however, is by no means visionary, and, looked at as a reversion pure and simple, is not remote.

Planting, however, is such a visible estate improvement, so tangible, so absorbing to the true lover of

rural life, that if the money can be readily spared little inducement is necessary to promote a wide increase of woodland area. The great question is, How can it be carried out when money is not forthcoming? Money may be borrowed for the purpose, but this creates a further burden, and those who own or manage land know too well that the land is already overburdened, in fact will bear no more. The Settled Land Act, 1882, makes provision by allowing capital trust money to be used for the purpose of planting.— See section 21, sub-section (III.), and section 25, sub-section (IX.). A further question—and by no means a depressing one—is this. Will not wise and judicious planting serve to pay off and clear away much of the existing debt in a comparatively short space of time? If this can be proved, we think even a further burden in the form of a rent-charge will not deter many from planting largely.

If, again, this can be proved and brought home clearly to landowners, we believe a great advance will have been made, and that our area of woodland will soon largely increase.

The difficulty lies in proving this, but we by no means shrink from such a task. Undoubtedly there are soils that it will not pay to plant. Trees of some kind will no doubt grow, but trees alone must be grown which, in years to come, will be saleable—*i.e.*, when we look upon this matter purely from a commercial point of view. These soils, however, we believe to be few and far between. Most soils can be made to carry trees, suitable for home consumption, to a profitable maturity, even if they are incapable of

producing really fine timber—take larch as a passing example.

We know from our own experience that larch plantations, planted thirty and forty years ago, are now producing large quantities of valuable timber, the whole of which may be looked upon as profit ; for the whole expenditure has long since been recovered. This result, too, has been achieved on land which at the present time would be returning nothing whatever in the form of rent if in a state of cultivation. Further, we may point out, as a practical proof of this, that land actually adjoining has been recently capitalised at a nominal rent. These larch have recently produced boards 14 inches wide.

It seems necessary, first of all, to ascertain the first cost of planting an acre of land under various conditions, and then to add to this the accumulation of rent, rates, taxes, and maintenance. The cost must, of course, vary in accordance with the nature of the soil and the class of trees to be planted, the cost of labour in the district, and other such matters. There can be no fixed amount which will apply accurately to all districts.

Take drainage for instance. This is only required under certain conditions as already described, and even then varies as the soil is more or less heavy. It is impossible to fix the amount required for this operation, but a practical agent can readily ascertain the cost applicable to each piece to be planted. Suffice it to say that the operation adds materially to the initial cost, and may render the whole a doubtful act of improvement. Fencing again is a necessary

outlay which cannot be avoided, and the cost of which cannot be expressed at a fixed sum per acre. The expenditure will vary per acre with the size of the plantation. The larger the area the less the cost per acre, *e.g.*, to fence a plot of one acre must cost in proportion much more than a hundred acres. It must suffice then to place a sum per yard or per rod upon the various classes of fencing, and leave the result to the case in question. Fencing of some kind is of course absolutely essential, and men of foresight will adopt live fences, which will eventually become permanent if properly looked after. These fences, however, must be themselves protected, so that the original expenditure will be somewhat heavy.

It is almost impossible to erect the simplest wire fence under 6d. per yard, and if the stumps and strainers have to be bought the cost may be at least 1s.

The class of fence adopted will of course depend upon local circumstances. In some, turf fences may be the best; in others, stone walls, sunk fences, post and rails, wire with wooden uprights, palings, and so forth. For our present purpose the cost may be said to vary from 6d. to 1s. 3d. per yard.

Live fences may consist of common thorn, beech, hornbeam, privet, or holly, the cost of which will vary also; the price of the plants will be somewhat as follows:—Thorns from 7s. 6d. to 20s.; beech, 15s. to 25s.; hornbeam, 15s. to 20s.; privet, 10s. to 15s. per 1,000; holly, 15s. to 30s. per 100.

The number of plants per yard will vary in accordance with the age and size, but will run from three to seven, if planted in single lines.

These few *data* will be sufficient to show how impossible it is to fix any price per acre for planting operations.

Let us first consider the cost of notch planting. This is the cheapest method, and applies to moor or heath land. For our purpose we will take 2,700 plants per acre, *i.e.*, at 4 feet apart.

1,200 pines at 7s. 6d. per 1,000	...	...	£0	9	0
1,500 larch „ 10s. „ „	...	...	0	15	0
Planting	...	...	0	9	0
			<hr/>		
			£1	13	0

*N.B.*—If planted 3 feet apart the cost will, of course, be greater.

Let us now take a case of pit-planting (4 feet apart) applicable to a mixed plantation:—

200 hardwood trees at 20s. per 1000	...	£0	4	0
1,500 larch „ 20s. „ „	...	1	10	0
1,000 pines, silver, and spruce firs, &c. „ 15s. „ „	...	0	15	0
* Digging 2,700 holes, planting and treading in „ 2s 6d., 100	...	3	7	6
		<hr/>		
		£5	16	6

The total amount therefore of £5 16s. 6d. may be taken as the extreme. The price of pit-planting for ordinary plantation purposes will range from £4 to £6

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\* We have taken 2s. 6d. per 100 for digging, planting, and treading in, but in many cases where the trees are small or not heavily rooted, and when the soil is friable, two-thirds of this sum may be sufficient.

per acre, exclusive of fencing and drainage. This sum, too, may be still further reduced by growing the trees in a home nursery. We shall now consider the items of yearly expenditure, together with the interest and compound interest which must accumulate owing to the periods which must elapse between each thinning. Nevertheless this calculation is somewhat imaginary, and is often in practice lost sight of. We do not for one moment hesitate to accept it as a patent fact, but only express our opinion as to its being more chimerical than real.

If then we take £6—the extreme cost—as the initial outlay, and, for the sake of calculation, consider the plantation so far as the conifers are concerned as likely to stand, with intermediate thinnings, for 40 years; then we shall find that it will accumulate, at 3 per cent., to, say, £20. If, too, we take 7s. as the annual expenditure per acre for rent, rates, tithes, and so on, it will accumulate, at the same rate of interest to £26 7s. 9d., or in all to £46 7s. 9d. The thinnings, it will be seen by the table of produce, will in the same period reach the sum of £120 9s. 3d. The facts as shown, if accepted as facts, must be somewhat startling.

#### COST OF PRODUCTION PER ACRE.

Interest on £6, at 3 per cent., will accumulate in 40 years to	... ..	£20	0	0
Rent, rates, tithes, taxes, &c., at 7s. will accumulate in 40 years, at 3 per cent., to		26	7	9
		<hr/>		
		£46	7	9
		<hr/>		



VALUE OF PRODUCE PER ACRE.

The thinnings at the end of 20 years, say 2,000 trees (larch and Scotch fir poles), should be worth £30, which will accumu- late in 20 years, at 3 per cent., to	... £54 3 7
The thinnings at the end of 30 years, say another 300 trees, should be worth £27, which will accumulate in 10 years, at 3 per cent., to	... .. 36 5 8
The value of the final cutting of 200 larch and Scotch firs, should be £30	... .. 30 0 0
	<hr/>
	£120 9 3

To this amount, viz. £120 9s. 3d., must be added the value of the 200 deciduous trees left standing; and, on the other hand, the cost of fencing and (possibly) draining must be added to the £46 7s. 9d., the cost of production.

— These figures we cannot attempt to estimate. We have, however, we think, clearly shown that wise and judicious planting will pay on lands too poor for cultivation in these days of low prices.

Estimates such as the above must be general, and open to criticism; it is quite impossible to deal with exact figures which will meet all classes of soils and local conditions.

A further gain, impossible to capitalise, is the improvement to the soil by the accumulation of leaf mould, the value of which any true forester knows how to appreciate. If the remaining deciduous trees are well managed, the prospective value must be very great. Some may consider that we have thinned too severely, and left too few standing at such an early

period as 40 years ; perhaps so ; if this is the case, the money calculation we have made will not be much affected, as what is lost on the one hand will be gained on the other.

We shall content ourselves with this one example, as if we quadrupled it there would still be room for further. Each must adapt the calculation to his own locality and soil ; *ab uno disce omnes*.

To the above calculations must be added the losses and failures of the first few years, from deaths and imperfect development of many trees, the fluctuations of the markets, the cost of re-planting, and so forth. These risks attach, however, to all things mundane, and are by no means peculiar to forestry.

## APPENDIX.

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### *AN ECONOMIC ESSAY ON THE PLANTING OF WASTE LANDS.*

THAT the planting of waste lands and land unprofitable under cultivation will prove a national benefit cannot be denied. The day is not distant when foreign supplies of timber will decline, for it is already manifest that, through the heavy drain upon the visible sources of supply, the timber line is receding from the coasts. True, there are enormous untapped areas of magnificent fir timber; but to reach these with any chance of profit is for the present impossible. Generations may come and go and the supply may continue; but timber takes generations to mature, so that to bridge over the period of diminution and ultimate cessation planting cannot too soon be commenced.

This question, though a national one, is not under the nation's control, for the land of Great Britain and Ireland is owned by individuals and not by the State, and it is probable that landowners would raise serious objections to State interference. What, however, the nation cannot control it may advance by influence and by sympathy in the form of relief of taxation, advance of money, and so forth.

The first step towards success is, and must continue to

be, the winning over of the landowner to a serious consideration of the subject. To prove to him that the planting of his waste lands will prove a financial success and that such improvement may be viewed as an investment of money. This first step, however, is hindered by the one great stumbling-block—the reversionary principle which underlies the whole question of afforestation.

This is the initial difficulty, and one absolutely impossible to sweep away. A sympathetic Government may aid, but cannot entirely relieve, the landowner.

That planting, if successful, will pay well may be taken as certain, but there can be no appreciable return upon the investment for from twenty to forty years. Here, then, is the crux of the whole matter.

Timber of prime quality can be grown in the British Isles, though under the present conditions it seldom is. It is usually unripe when felled, the quantity available is small and scattered, and the uniformity of size and quality, so essential in large contracts, is often lacking. We want large and well-stocked areas of coniferous timber before we can safely say that we are independent of foreigners. Take our oak supply as an example. It is, as a rule, short in length, irregular, shaken, and deficient in uniform characteristics required by trade. Brown oak of magnitude, which sells at such a high figure, is so uncommon as not to rank at all in the ordinary timber supply.

The most supine planter and most optimistic reformer cannot entertain the idea that we can produce what is required for the nation's consumption to the exclusion of the foreigner under any circumstances whatever. All we can do is to aid or take a greater share in the supply.

## WASTE LANDS.

What is meant by the term waste land? Surely it does not necessarily mean all land not under some form of cultivation? Much of this is useful, and has an indirect agricultural value which would be lost if planted. There are vast areas, however, scattered over the length and breadth of the country which yield no return, direct nor indirect, to the owners of them. These consist of poor heath lands, bogs, marshes, and the like, remote from settled districts, far from roads and railways—wastes in the true sense. To bring these areas by aid of the plough into profitable corn-lands is, as a rule, out of the question. No sane man would recommend it with wheat at three shillings a bushel; but there are many who state recklessly that they should be planted.

This may be so; but if for commercial purposes, the selection must be a careful one or planting will result in a failure which will do much towards retarding the progress of afforestation.

Then, again, many of these wastes lie far away from the busy scenes of life; and the cost of conveying a crop of timber when mature to the market would doubtless swallow up the small profit which might exist under more favourable conditions.

The following analysis of such areas may be useful to would-be planters:—

(1.) Areas of short heath with surface of white moss and lichen, the ground springy to the tread, and carrying with it a sense of sterility.

To plant such land as this upon the visible surface will lead to certain loss, and to pare off the surface and bury it by trenching will lead to a doubtful success. To pare and burn the surface and to trench the soil beneath is the only

possible method leading to success, and the cost of such operation will render it prohibitive. This class of waste land, therefore, the wise man will avoid, and the expert who recommends the planting of such will incur no small responsibility.

The white mossy surface should be taken as a true indication of sterility.

(2.) Healthy and vigorous heath, with bushes of gorse, bracken, and grass will be found indicative of a useful soil beneath, and may be planted with prospect of success.

(3.) Marsh and boglands abound in those waste areas, and are due to a low-lying position with pent-up waters or to a cold clay bottom. In the first the letting off of the water may lay dry an extensive area of useful land, but in the second, even with drainage, there must remain a great element of doubt.

(4.) Then there are areas of grassy hill land or downs, all of which may be planted with some degree of success, though on the immediate rocky outcrop, whether of chalk or other rock, success is doubtful. There are, however, in most of these pockets of useful clay, gravels, and sands which will yield a valuable crop of timber.

This analysis might be extended, but enough has been written to prove the point of selection and the necessity for studying it.

The soils in each of the above instances will be found crude and often quite unfitted for the reception of young trees, and to establish a plantation under such conditions will try the patience of any landowner; but perseverance will be more or less rewarded according to the wisdom of the selection and procedure.

A wise old Dorsetshire squire, who in his life probably planted successfully a greater area of poor land than any contemporary, has left maxims of value, which, though

quaint, are full of great practical wisdom, which many of us would be wise to take to heart. For example :—

“ Where wet white moss and stunted heath  
 Show a hard sandy crust beneath,  
 With holes you must not dig that spot,  
 But trench it deep and let it rot.  
 Remember that whate'er you do,  
 That crust must quite be broken through,  
 For it holds water like a plate,  
 And roots of trees can't penetrate.  
 Under this crust I've always found there lay  
 A stratum, fit for oak, of solid clay.”

Again :—

“ Where furze and fern will thrive and heath is long,  
 The land is good and all the trees grow strong.”

These are clearly lessons due to an observing eye, and if such be ever required it is this selection of soil for planting.

The glib statements of the uninitiated in regard to planting should be received *cum grano salis*.

If, then, we have shown the necessity of choice and selection in commercial planting we may pass on to those areas which have at one time been under cultivation, but which, due to decline in agricultural prosperity, have ceased to be remunerative. Many of these with a slight return to prosperity will again be cultivated ; but some are too poor to pay for tillage even should better prices of produce prevail. These it may be wise to plant. Here, again, a certain amount of selection will be needed, though such will apply more to the trees to be planted than to the fitness or unfitness of the soil for planting.

To establish a plantation on such sites is not an easy matter, for the soil is usually crude and often lacking in organic matter, and there is often no surface herbage to render the protection which young trees need and love.

Such land as this can usually be taken over by the land-

owner, even if let, with but a short notice; but on most estates there are areas immediately available for planting. The following are points worthy of consideration before commencing operations of magnitude:—

*Point I.*—Will the soil and site produce hereafter a crop of timber which will yield a sufficient sum to recoup the expenditure, including interest and compound interest, as well as a profit to the planter or his successors?

*Point II.*—Is the position one that will lend itself to a reasonable expenditure in the haulage of timber? For example, is it near a seaport where vessels can load direct, or near main roads which will carry a full load? Are there rivers near, which will allow of floating the logs when cut, or permit of approach of barges?

*Point III.*—Are there local industries which demand a certain class of timber, or poles, within easy reach? and if so, will the trees selected for planting be suitable? For example:—

Pit-props, in the coal districts; alder, beech, sycamore and the like in the cotton and linen districts.

It will be well to bear in mind that if one or more of these, or such like points, cannot be satisfactorily answered, planting will be a doubtful experiment, for there are many wooded districts now which are so remote from the centres of industry that no profit—sometimes even a loss—will attend their exploitation.

The only hope for such areas as this, whether at home or abroad, is a rise in value, or a cheapened railway or other service.

Another point of importance is that of the rating and taxation of woodland areas. All land, of whatever nature, is subject to both of these charges if it be beneficially occupied, and, unfortunately, the very fact of planting will render such land beneficially occupied, even if absolutely waste before.



These charges on land of such quality may be small, but nevertheless they are annual payments unaccompanied by any visible return at all, and cannot fail to act as a deterrent. The Rating Act of 1874 did much to discourage planting, and if it could be to this extent repealed, and land thus beneficially occupied be held free from all taxation until the first thinning be realised, it would be an encouragement. Surely this is worthy of consideration?

Tax existing woodlands by all means so long as land is taxed at all; but hold land yielding no tangible return free until such becomes appreciable. Some will say, trees are growing, wood is deposited each year, and therefore there is a profit, and a real benefit attaches to the occupation. This may be so, and of course is truly so, but it is unfelt, and the payment is out of pocket of the owner who will probably not ultimately reap.

Where inducement to plant is desirable to achieve success in reforestation, all reasonable obstacles should be removed; and the rule and basis of taxation not unduly strained.

In addition to selection of land from its intrinsic point of view, the rental value of such must be considered. The question therefore arises, when will land pay better to plant than to cultivate? It may be considered, too, from a capital-value standpoint. For example: If a syndicate or company be formed with the sole object of afforestation, at what price could they afford to buy the land? In other words, will it pay to plant land worth, say, ten or twenty pounds an acre? Our own opinion is that if the land can be let at ten shillings an acre planting becomes a doubtful improvement. Nevertheless there are many plantations which have resulted in a rent greater than this even on very poor land—land that will barely command a rent at all under present conditions of agriculture. There are many extensive agricultural areas within a few hours of London which may be bought

for five pounds to ten pounds an acre ; these are the lands to select for commercial planting, and, as will be seen by a later example, with ample prospect of success.

If land of this nature near industrial centres will not pay under tree culture, it is clear that tree planting of barren waste lands will not.

One more thought—continuity of ownership after planting is a most desirable condition. If the hand of the enthusiastic planter could be retained until the period of maturity is reached, what successes we should see ! This, however, is contrary to nature, and therefore newly planted areas often lapse into immature failure through neglect and greed.

#### METHOD OF PROCEDURE.

It may be well before dealing with the subject of procedure to remind the forester (be he who he will) that to reap a full success in planting he must secure and retain a full crop upon the ground. There will be one opportunity in the life of a plantation to secure this, and only one. Let this crucial point be missed and no full success can follow.

As we walk through the woodlands of England it is our one cry : Oh, for a full crop of such trees as these !

Again, let the planter at the first step—the initial step—rest assured that every care bestowed in preparation and planting will be repaid twenty years hence. Careless selection, careless planting, neglect of precautions will, on the other hand, result in disappointment.

#### *Preparation of the Ground.*

Having selected the site for planting, preparation will follow. As a rule very little is required, for trees will grow upon the surface turf, among grass, and light herbage, often better than on tilled land. There are cases, of course,

where to secure success land must be trenched, but when this is so the question of profit is a doubtful one. There are, however, instances when preparation will lie between trenching and simple slit planting; and it may be well to deal with a few typical cases.

(1.) *A Dry Heath with White Moss, and occasional Swamp or Bog.*

To plant such without preparation will result in failure, for as a rule the surface herbage is thick and dry, and even if buried, will not decay. The course to adopt, we have found, is to pare off the surface where the tree is to be planted and to plant by pit or notch in the soil beneath. The surrounding herbage will serve as a protection from driving and cold winds, and snow will press lightly upon the tender trees.

If there be an iron-stone pan, or conglomerate stratum within a foot or so of the surface it should be broken by the pickaxe before planting. This process is often of great value, and we know no better under given conditions.

Beyond this little is required except to cut a few surface drains in the wet places; and the subject of drainage will be considered as a preparation common to all conditions.

Where the herbage is heavy it must of course be cut; but there should be no surface burning, as such destroys the organic matter which trees need.

(2.) *Heath of better Quality with Bushes of Gorse, Grass, Fern, and other Herbage.*

The presence of such vigorous growth indicates a fairly useful soil beneath, and probably the surface soil is sufficiently deep to allow of direct planting by pit or notch. The probability is that on such land there will be but little water; and such as there may be will be readily removed by a few simple drains. If the soil be deep, say eight or nine inches,

probably pit planting will be preferable to slit planting; but when the soil is shallow and the subsoil cold, probably the notch or slit system will answer better. The latter possesses, too, the element of cheapness. Heavy bushes and long bracken fern must of course be cut entirely or sufficiently for planting. If long fern be not cut, and kept cut for a few years, it will fall with rain and snow and smother the young plants, and also cause damping off, which is a danger of some magnitude.

(3.) *Land on Hill Slopes and Mountain Ranges.*

The same rules will apply as to herbage; but slit planting on exposed sites is usually preferable to pit planting. The trees are small and less exposed to wind. Nevertheless, if the soil and subsoil be varied—there will seldom be uniformity over a large area—each system may be adopted according to local conditions. Among rocks, where the soil and moisture are just sufficient, trees will grow well, and often better than on level land; but the planting must be of a nature to suit the special conditions, and no uniform system should be adhered to. On the smooth surface of a hillside, due to slip or slide of decomposed rock, trees will grow if the soil be not too crude nor void of organic matter; but it will tend to success if the plain surface be terraced so as to receive the trees. If this be not done the slide is likely to continue, and smother the trees when small. There are, however, exceptions under which no planting can be recommended, and among these will be a slide of chalk. The surface, too, can never be planted with prospect of success—at least from a commercial point of view.

(4.) *Bog and Peatland.*

These soils when drained will grow very useful timber, and timber of fine quality. The preparation required will be

drainage, and this must necessarily be gradual, for the contraction of the soil is so great that a drain cut first will soon become ineffective, if not deepened.

(5.) *Derelict Agricultural Soils.*

Many of these are gradually returning to their primitive condition—using the term “primitive” in an agricultural sense; but many remain, and will remain, unremunerative under the plough. These it may be wise to plant, and the rent securable under afforestation will doubtless be higher than that under their derelict condition, even taking into consideration the sinking of capital to secure it.

Such lands will require, as a rule, no preparation whatever, beyond digging the holes, breaking the subsoil where obdurate, or removing such herbage as may have become rank.

*Drainage.*

The subject of drainage must be dealt with as it becomes necessary. It must be drastic and entire on wet lands, partial on lands only occasionally wet, and here and there where springs rise and the water squanders over the surface. In all cases the drains must be open, for pipe drainage will soon become inoperative through root-fibre; in fact, many drained lands for past agricultural purposes become water-logged after the lapse of years as the trees develop. All trees affect pipe drains; but surface-rooted trees, such as ash, beech, and elm, are perhaps the worst offenders. In the open drains through woodland areas this is of course of no importance. Drainage as a preparation for planting should be looked upon as essential only when moisture is in excess, for trees love moisture and will thrive even in excess better than agricultural crops.

The chief point in wet land, or land with a cold bottom,

stage or at maturity. To plant trees which will in due course prove useless is to be deprecated. For example: Lime, horse-chestnut, spruce fir, and the like will find few purchasers, even if the trees be sound and well grown, whereas larch, Scotch pine, oak, beech, ash, and the like will be saleable at all stages of growth and when matured.

The selection, bearing this principle in mind, must accord with the character of the soil, site, and degree of moisture. For example: On dry soils of good quality, clays, loams, and marls, trees of magnitude may be chosen, such as oak, beech, ash, elm, and in combination with them larch, fir, and Scotch pine. On drained but cold-bottomed lands, poplar, alder, sycamore; and, if not subject to periodical excess of moisture, ash, wych elm, and Scotch pine. On sand and gravel soils, sweet chestnut, sycamore, Corsican and Scotch pines. Then, on any reasonably dry land, of a calcareous nature, beech and larch; and so on.

#### *Pure or Mixed Planting.*

The question will next arise: Shall the trees be planted pure or mixed? We believe the best commercial returns will be secured by pure planting, because the growth is more uniform and control more effective. Therefore on subsoil suitable to larch, and where disease is not likely to be destructive, pure planting is to be highly commended; in fact, there are few more profitable forms of afforestation equal to this. The crop can be reaped at the pole stage, say in thirty or forty years, and the site replanted, or allowed to mature, say in forty to eighty years. Which will pay best must be a matter of opinion and calculation, and according to local conditions. For profit we are inclined to the former; but at the same time larch timber of full magnitude will sell at a high price per cubic foot. A full crop of matured larch reaches as nearly as can be the acme

of success. The soils which will carry this are numerous and widespread; but the most careful selection by the skilled forester is imperative. Next to this, on soils which will not carry larch, Scotch pine will probably yield the greatest profit. The price per cubic foot will be less than one half of larch; but a great number of cubic feet can be grown on an acre in from eighty to one hundred years.

With hardwoods, such as oak, beech, elm, and others, the returns will be longer delayed though the ultimate profit may be equal. It should be borne in mind that we are dealing with newly created areas and not with established or ancient woodland, and the lesson we think is one which will lean towards coniferous woods.

Where the soil will grow larch, but when, at the same time, there is probability of disease (due to low-lying land), a mixture with Scotch or Corsican pine will better secure success; but mixed hardwoods we do not recommend. There will be under such conditions lack of uniformity, unequal distribution as time progresses, a mixed character of timber unsuitable for trade purposes, and so on. Nevertheless, hardwood and conifers in combination will be found desirable and useful. The combination is one that tends to length and natural pruning, which results in sound timber free from knots and blemishes.

It is not necessary to deal further with this section of forestry, as it is one which, though of importance and full of interest, must be treated according to local conditions and opinions. The principle, however, is unassailable, that pure planting, or one class of hardwood with one class of conifer, will yield the most profitable return.

#### *Size and Form of Plantation, and Wind Belts.*

Form is usually of an arbitrary character; but when it is possible to choose, a convex form should present itself to the

prevailing wind. Further, a line or lines of pines, firs, or hardwood trees, which possess a natural tendency to lateral development, should be planted across the line of wind, and in very exposed sites these lines may be occasionally repeated. Every precaution should be exercised to prevent trees when young taking a leaning attitude. The size, too, of a plantation is often beyond control, and the site is generally of a limited description; but it should not be lost sight of that the greater the area the less will be the initial cost of planting, and the better will be the character and description of the timber grown. An immense mass of one kind of tree is always a thing of great beauty, and of supreme grandeur.

#### *The Planting.*

Having selected the site, prepared it, fenced it, selected the trees and the system of planting, the actual operation may be performed. It is, of course, believed by many that any one may plant a tree, which is true in a sense; but the point to be achieved is to so plant the trees that they may establish themselves early and grow vigorously. Careless planting and disregard to the condition of trees to be planted will lead to failure or to a partial success. Nature may assert herself in favour of the careless planter sometimes, but such reliance must not be strained. First select trees which have well-developed root-fibre, a ripened leading bud, and of a well-formed character, plant them with care, and, subject to season, they will grow and thrive; but take the trees as they come from the nursery, or as the nurseryman delivers them, without regard to wounds, ruptured root-fibre, and undeveloped leaders, and failure may result. In larch especially a wounded bark surface, due to careless lifting from the seed bed, may lead to disease which may spread throughout the plantation.

The holes should be all dug before planting, as this



prevents undue exposure of the young trees, to which is due the dry root-fibre and drooping habit. It would be more correct to say, dig the holes well in advance of the planters, as the area may be large. Let the holes be dug deeper than is required, and let the top turf or mould be thrown into the bottom, so making the hole about 6 inches deep at planting. Should the subsoil be hard, break it at the same time with fork or pick. Let the holes be 12 to 14 inches deep, 9 inches square at top, and filled in as suggested, and a man will dig about 100 to 120 a day, say at a cost of 2s. 3d. to 2s. 9d. a hundred. On hard and compact land a better plan may be to use the pickaxe to the full length of shaft and to notch in the plants. The picking can be done for 1s. 9d. to 2s. per 100. Prices, however, must be approximate, as they will be governed by the wages of the district.

On thin hillsides or soil with a light turf notch-planting may be adopted, as it is cheaper and often more effective.

A few hints on pit-planting may not be out of place.

Sink the tree to the nursery depth only, spread the root-fibre, fill in the soil completely before treading, and then tread the tree lightly all round, taking care not to bruise the bark with the foot. The practice, all too common, is to throw in a portion of the earth, tread it in with the heel, repeating this process until complete. This means ruptured fibre, misplaced and crowded roots, and damaged bark. The foreman should see every tree planted, and the men should be paid by the day. Trees 3 feet and upwards in height may be planted upright; small trees when notched may have a slight lean towards the prevailing wind.

With regard to the distance apart and form of planting, we prefer 4 feet, and triangular to any other. If 3 feet, the results will not be satisfactory, and the cost of both trees and labour unnecessarily heavy. If 5 feet apart, the lateral

development will be excessive, and apt to retard vertical growth. The equilateral distribution is preferable because the trees stand at equal distances in each direction, and undue crowding is avoided.

#### *A Home Nursery.*

If planting on an extensive scale be proposed, and especially if conducted annually, there should be a home nursery. This will place the trees safely upon a sound financial basis, and undue exposure of plants between lifting and final planting will be avoided. A nursery cannot be made at a moment's notice; so the landowner will be wise who chooses a site and prepares the soil without delay. The buying of seedling conifers, and passing the same through the nursery, is preferable to the collection and sowing of home-grown seed.

#### *Direct Sowing.*

There are occasions when direct sowing of seed is preferred to planting; but this can only be successfully done under conditions which lend themselves to such operation. It is better adapted to the regeneration of exhausted woodland than to the creation of new areas. The wise and regular deposit of acorns will often more rapidly result in the establishment of an oak plantation than when seedling trees are planted. The same applies to beech, for neither of these trees lends itself well to transplantation.

Direct sowing may be successfully carried out somewhat on the following plan; but local conditions should be studied and the sowing compared with other methods before adopting it.

Lightly fork the surface, sow liberally the seed of larch, Scotch pine, beech mast, ash keys, and other small seeds; and dibble in acorns at set distances. Cover in the whole,

and if not destroyed by mice, field voles, or other vermin, will doubtless be found effective.

*Care of Plantation after Planting.*

As a rule new plantations will take from two to five years to establish according to soil and seasons. It is sometimes most difficult to secure a complete success, and the greatest care of the forester is required. Young trees are subject to so many dangers—rabbits, hares, deer, drought, excessive moisture, frost, snow, cutting winds, and the like; so that patience and skill are essential elements of success.

Should the planting be completed by March, one man at least, and more if the area be large, should be left in charge. His duties will be to keep out ground game or to report to the keeper, to maintain the fence, tread in and resoil the trees where required, cut away gross or rank herbage, and other such like actions which will tend to life and growth of the trees.

This will often save trees from perishing in the dry season which may follow planting. The chief danger lies in a hot dry summer before the root-fibre becomes active.

The following autumn, say in October and November, dead trees should be pulled up and counted, and new ones planted in their place. The loss may be heavy or light according to season. It may be necessary to continue this in the following year, and with reasonable success the plantation may then be considered safe.

On moist soils, such as are found in the North of Ireland, West of England, and Wales, plantations become established much more rapidly than on the drier eastern coast.

Once established, little remains to be done beyond maintaining fences, banks, killing of ground game, and general oversight until the period of first thinning.

*Thinning of Plantations.*

This process may be justly called the crucial one, the one that wisely carried out will lead to success and profit, and unwisely carried out to failure, or to partial success only. The period of first thinning will depend upon the strength and development of the plantation, but perhaps twelve years may be taken as a likely one, when the remaining trees will be benefited by more light and air. The process is simple, but nevertheless must be carried out with discretion, and this, and every successive thinning, should be conducted by the forester himself.

The great and guiding principle to bear in mind is, that the best trees—those most likely to reach a useful maturity—should be left, and those which, by overcrowding these, interfere with their development, removed. In the first thinning it will be unnecessary to remove more than those which have died from drip and lack of light, or which show signs of disease, or are too near to better trees. Probably two to three hundred per acre will suffice. The question, too, will arise at the same time, especially in the case of a larch plantation, whether the remaining trees should be brushed, *i.e.*, have the lateral branches removed, or whether they should be left to fall off when their functions have been performed. We are inclined to discourage brushing, as it no doubt leads to disease through the bark being ruptured by the process. The wounds caused thereby form a fitting receptacle for the floating germs of the *Peziza Wilkommii*, and if these once become established the future of the plantation is doomed. Larch branches, in a close plantation, break off readily, so that some foresters prefer breaking them off with a blunt instrument. This may doubtless be done often with impunity, but we think it better to be on the safe side. The use of a sharp edge permits of no excuse whatever.

In the case of pines and hardwoods we prefer a reasonable use of the pruning chisel in the early stages of growth.

Between the twelfth and twentieth year little will remain to be done but a further light thinning on similar principles to the first—that is, the removal of the few trees which hinder the development of the main crop.

If at 4 feet, equilateral planting, we have an initial 3,000 trees to the acre, there may well be, when the period of twenty years is reached, 2,500 to the acre. The treatment of this close plantation after coming of age will be shown upon the accompanying table of approximate profits.

The value of the plantation (assuming it to be larch) when the period of twenty years is reached, may be estimated at 16s. a hundred, or, say, 2d. each, equal to £20 per acre. Of course, if the trees be Scotch pine or of mixed kinds the value may be less; but larch seems a better class of tree to take as an example when dealing with profits.

The value of a plantation is usually assessed strictly in accordance with its economic uses; but there are two indirect values which are often quite ignored. These are due to the æsthetic and sporting aspects, which together are of immense importance.

Probably these alone will justify the expenditure of capital in planting, and, if so, the whole matter of expediency is solved. Take a case to illustrate this point—let there be two estates, equal in every respect except that one is wooded and one is not. The demand for the wooded area will far exceed that of the other, and consequently the value will be greater without any regard whatever to the intrinsic value of the timber itself. We hold that every acre planted lends indirect value to the estate quite apart from any economic consideration.

A table to show what may result from wise and judicious planting during a period of eighty years—

The figures are based on the following points:—

- (1.) That the crop is of pure larch.
- (2.) That the soil is of a medium but useful character.
- (3.) That the trees, when planted, have been bought of a nursery-man, or planted by contract.

This is an important item, and leads to an increased cost.

- (4.) That the initial distance apart, and distribution, has been 4 feet, and equilateral.
- (5.) That the rent, rates, taxes together are estimated at ten shillings an acre.
- (6.) That the rate of wages has been normal.
- (7.) That the trees were planted in pits.
- (8.) That the whole had to be fenced against ground game.
- (9.) That no drainage was needed.

	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	
Cost of fencing ... ..	2	0	0										
„ plants ... ..	2	14	0										
„ digging holes and planting ... ..	3	0	0										
Rent, rates, and taxes for one year ... ..	0	10	0	8	4	0							
Compound interest on the £8. 4s. for 12 years at 4 per cent. ... ..							13	2	0				
First thinning, at 12 years, 200 trees at 1d. each ...	0	15	8										
Deduct cost of thinning, say	0	8	4	—			0	8	4	—	12	13	8
At 16 years of age, interest on £12. 13s. 8d. for 4 years at 4 per cent. ...							14	15	9				
Second thinning, 300 trees at 1½d. each ... ..	1	17	6										
Deduct cost of thinning, say	0	18	9	—	0	18	9				13	17	0
	<hr/>												

	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
At 25 years, interest on												
£13. 17s. at 4 per cent.				19	3	6						
Third thinning, 500 trees at												
4d. each... ..	8	6	8									
Deduct cost of thinning, say	3	2	6	5	4	2			13	19	4	
At 30 years of age, interest												
on £13. 19s. 4d. for 5												
years at 4 per cent. ...				17	0	7						
Fourth thinning, 400 trees												
at 6d. each ... ..	10	0	0									
Deduct cost of thinning, say	3	6	8	6	13	4			10	7	3	
At 40 years of age, interest												
on £10. 7s. 3d. for 10												
years at 4 per cent. ...				15	6	5			15	6	5	
Balance against plantation												
at 40 years of age.												
At 50 years of age, 500 trees												
at 3s. a tree ... ..							75	0	0			
Deduct cost of thinning, say							6	5	0	68	15	0
At 60 years of age, 500 trees												
at 4s. a tree ... ..							100	0	0			
Deduct cost of thinning, say							10	0	0	90	0	0
At 70 years of age, 300 trees												
at 6s. 6d. a tree ... ..							97	10	0			
Deduct cost of thinning, say							11	5	0	86	5	0
At maturity (or 80 years),												
allowing for deaths, say,												
100 trees, 200 trees at												
20s. a tree ... ..									200	0	0	
Value of produce of plantation, including the standing												
crop at 80 years of age ... ..									445	0	0	
Deduct loss at 40 years ... ..									15	6	5	
									£429	13	7	

The analysis of the foregoing table amounts simply to this: if the landowner were to invest the initial cost of planting at 4 per cent. and allow it to accumulate, he would at

the end of a certain period receive a capital sum provable by arithmetic without any exertion or enterprise. The question therefore is, Will planting of waste land yield a similar return with an additional profit?

At forty years of age the plantation has partly performed this, with a balance of £15. 6s. 5d. against the planting, and also the capital value of the crop standing upon the ground. After this somewhat lengthened period, the value of the crop quickly increases, until at eighty years there remains, after reaping a goodly harvest, a capital sum of £200. If £430 be divided by eighty we have £5. 7s. 6d. per acre per annum, out of which to pay rent, rates, taxes, maintenance, &c., truly a handsome return on the original capital expended. It may be said, Yes, but the planter will not reap it. This may be true, but his successor will, and as time proceeds, and planting becomes more general, each successive owner will enjoy the result of his predecessor's foresight.

In the example we have chosen as a type, there has been success, and a tree for which there is a universal demand has been planted; but even if Scotch pine be selected, there will still remain a handsome profit. If to all this, which is purely commercial, we add the indirect value alluded to in the text, and further, the benefit arising from reclamation of the waste land, the wisdom of planting on waste lands has been well proved. We may be too sanguine; but the past experience of thirty five years has proved that substantial profits will follow wise and judicious planting.

There is no reason whatever, beyond the initial difficulty of finding the money, why all the available waste and suitable land in Great Britain and Ireland should not be afforested. The benefit to the nation would be enormous, and the tide of emigration might be stayed.



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