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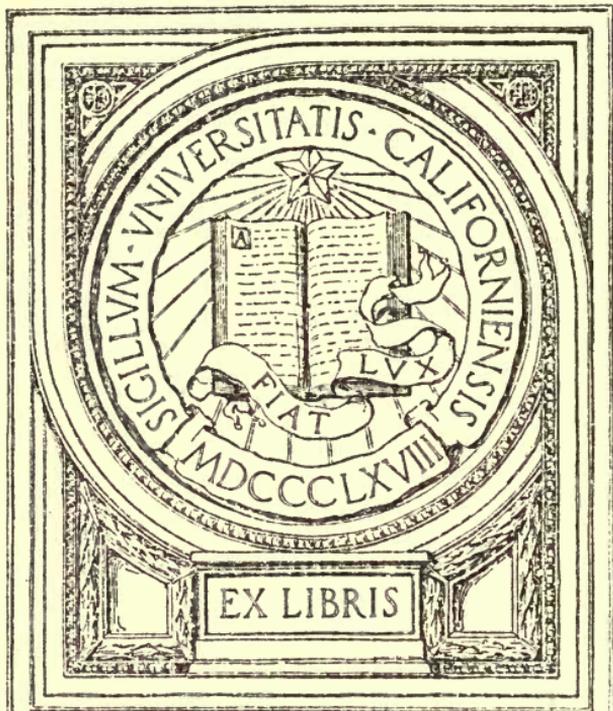
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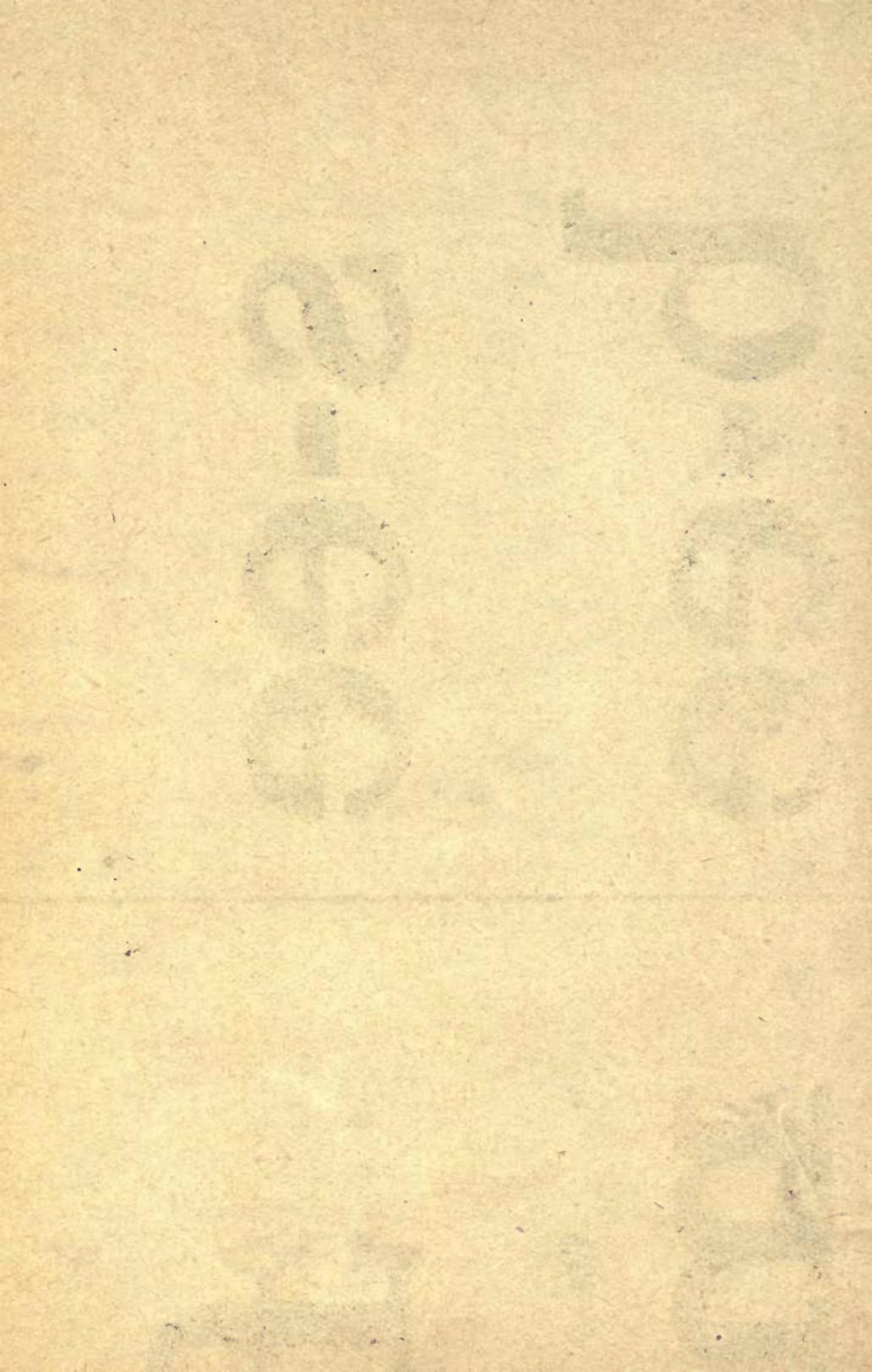
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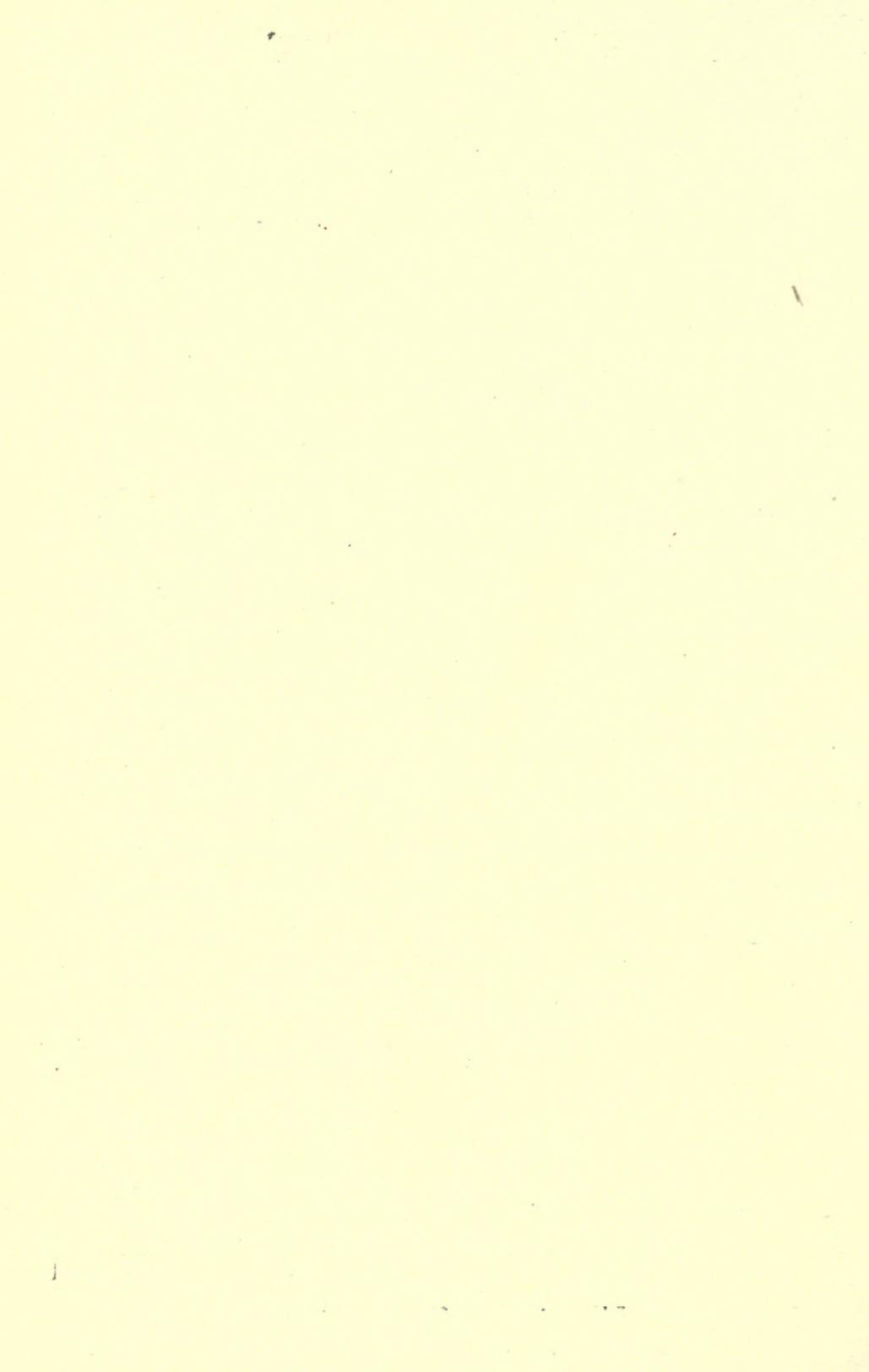
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PREFACE.

IN submitting this little volume to the public, and more especially to those interested in afforestation, I would wish to make it clear that although I am a Crown officer, this publication is of a purely private nature. Any remarks or opinions expressed in it are in no way official or inspired.

Chapters I., II., and III. were written for publication in the *Glasgow Herald* during the winter of 1916-17, and are now reproduced in slightly revised form by the kind permission of the proprietors of that journal.

I wish also to thank Mr Geo. H. Crosfield and Mr W. Power for the kindly aid they have rendered me in reading my proofs.





AFFORESTATION.

CHAPTER I.

NATIONAL FORESTRY.

IT is quite three years since we had very forcibly brought home to us some of the consequences of our national neglect of forestry. The fact that we had for many years been paying away to foreign countries immense sums which ought to have been circulating in our now depopulated areas is only one of these consequences. More immediately serious was the awkward situation in regard to our timber-supplies—a situation which aggravated high prices, hampered our war industries, and put an extra strain on shipping. If we have not learned our lesson now, we are not likely to learn it at all.

Much has been done in the past with a view to awakening the nation and the Government to the urgent claims of forestry; yet little impression seems to have been made. Commissions have been appointed, and have issued reports in favour of a national scheme; committees have deliberated, and also reported favourably; a Scottish Board of Agriculture has been established, with the development of forestry in Scotland as one of its special official objects; the Development Commissioners have been acting for several years, with the advancement of forestry in the kingdom (among other things) as a specified purpose. And what are the practical results? Until very recently, when a certain amount of preparatory work and planting has been done, the actual afforestation has been negligible.

Had less money been spent on preliminaries and reports, and a larger sum spent on planting, there would have been something to show for the expenditure, some valuable experience would have been gained, and we should have had a certain number of acres under a crop of trees in various stages of development.

The chief aim in the past has been to enlighten the Government, so that they might be persuaded of the necessity for action. Deputations have been met by Ministers, and resolutions innumerable have been forwarded to them with the object of convincing them that there is no valid or sufficient excuse for their inaction. But what is quite evident is that, whatever action may be taken by the Government on the lines of a national afforestation scheme, such action, to become effective, must receive the impetus of popular conviction, clamantly and persistently expressed; and no effort, political or otherwise, should be spared in keeping the question in the forefront of national policy. The writer's contention is that effective action should not, and need not, be delayed until the end of the war, but should, and can, begin right now. The initial stages would not make any appreciable demands on labour. On the other hand, they must be got over before forestry can absorb any appreciable amount of labour. This is a point to be noted in connection with demobilisation. Forestry schemes ought not to be set in motion in a month or even in a year. First of all, the pros and cons for establishing forests in certain districts must be carefully weighed. The selected districts must then be surveyed, and a general scheme of operations for several years drawn out and delineated on a plan. The section to be dealt with immediately has then to be surveyed in detail, subdivided into compartments of convenient size; lines of roads and access paths defined, and carefully set out on the plan; and the different qualities of soil and subsoil have to be investigated. Not till then

is the area ready for actual labour. The time required for this initial work depends upon the nature and extent of the ground which is being treated.

Even then it is not ready for the planter. Much more preparation—which, however, entails a certain amount of labour—has to be done. The area must be enclosed with suitable fences and drained where necessary; ground game must be exterminated, and bracken-cutting attended to at the proper season; and any other preparatory work must be carried out, according to the conditions, before planting operations can commence. While this preliminary work is in progress, the raising of plants for the ground under survey will have been attended to in the nursery—work which can be carried out to a great extent by women. But the surveying and planning is the real preliminary work, and it is that which should have immediate attention. What is required is to have a number of suitable areas earmarked, surveyed, mapped out, and so prepared that when the time comes that labour is available there will be no unnecessary delay in getting the planting set agoing on systematic principles. Provided sufficient labour is available to perform the draining and fencing and other heavy work, women may (in most localities) be suitably employed on actual planting operations and other light work.*

Owing to the present denudation of existing woodlands, there will be a great amount of planting required to restock the cleared ground. It ought, therefore, to be the primary aim of the Government to ensure that all such areas are properly treated and not allowed to run to waste. This, however, will be a simple process compared with the treatment of new ground, because cleared woodland is

* This has been amply demonstrated during the last two winters. See *Transactions of the Royal Scottish Arboricultural Society*, vol. xxxii., Part I., page 81. Seven months' experience of women-workers by the writer confirms this claim.

already in a suitable condition for planting and requires little preparatory work, whereas the new ground that will be available has lain in a more or less derelict state for a century or longer, and will require a thorough survey, and careful—in many cases laborious—treatment.

Some advocates of forestry are of opinion that little or nothing can be done or even attempted until a staff of skilled foresters has been trained. The writer cannot agree with them, although he has no desire to underrate the thoroughly skilled forester—rather the reverse. The disagreement is in regard to the method of training. The one method is to train men *for* the work, the other to train them *at* it. The latter, which is claimed to be the better, necessitates afforestation work being in progress, so that the skilled foresters may be efficiently trained. The natural inference is that unless planting is begun with the best available men, it is not possible to train men for larger operations in the afforesting of new or 'waste' land. A good sound scientific groundwork in the principles of silviculture is an essential part of the training, but unless that is backed up by practical knowledge gained from experience, it is of comparatively little value for this special work.

What is wanted to begin with, however, is an effective co-ordination of forestry administration. At present there are interested in the advancement of forestry the Development Commissioners, the Board of Agriculture, the Scottish Board of Agriculture, and the Office of Woods (which has interests in England, Scotland, Wales, and the Isle of Man), besides half-a-dozen or more corporations. It is questionable if any one of these bodies can embark on a scheme of any consequence without first obtaining Treasury sanction. Until one authority with ample powers and funds has been appointed for the United Kingdom, there is little prospect of forestry being put on a sound footing and promoted in a manner proportionate to our need.

CHAPTER II.

OUR LOST FORESTS.

SCOTLAND was originally the site of several very extensive forests, and undoubtedly there were many others of smaller area, all branching out towards the seaboard along the glens and river-courses. The principal tree of the Lowland forests was oak, with groves or odd trees of elm, ash, and aspen in suitable situations; a fair amount of birch on banks and higher ground; and alder, with saugh or willow bushes, on marshy land beside lochs or rivers. An undergrowth of gean, bird-cherry, rowan, hazel, holly, yew, sloes, thorns, and briers was more or less prevalent throughout the forests, with patches of broom and whins in openings and on hard knolls. The remnants of this bygone forest are still in evidence in Cadzow Park, near Hamilton. Patches of this type of forest, if it had existed, would also be found all over the mainland, but in the Highlands and southern uplands the extensive primeval forests were composed chiefly of Scots pine, and reached in some localities to an altitude of over one thousand five hundred feet. Along with the pine much alder would be found in moist places, and birch and rowan in openings, the birch encroaching on the pine at every opportunity. Among the birch there would be an undergrowth somewhat similar to that found in the Lowland forests, but rather less varied in composition; while among the pines there would be a more or less abundant crop of juniper-bushes. A few remaining fragments of these great pine forests are still to be seen in the Spey Valley, on Deeside, at Achnacarry, and at the head of Glen Orchy, where the West Highland Railway passes through it. It is more than probable that the pine forests never reached the western seaboard of the Highlands except at the heads

of the longer inlets. Along that broken coast the natural tree-growth would be chiefly birch, alder, and hazel, with patches of oak, ash, and rowan in situations suitable for their growth, and the farther west they reached the more would both the height of the trees and the altitude at which they would grow decrease, until on the exposed coasts and promontories they would be dwarfed to mere bushes, not extending beyond an altitude of one hundred feet, or be unable to flourish at all.

The clearances of these natural forests were no doubt begun in prehistoric times, but probably the first great clearances were made by the Romans in their attempt to conquer the country. In 207 A.D. the Emperor Severus employed legions of auxiliary troops in clearing the impenetrable forests which harboured the natives, and in the process is stated to have lost fifty thousand men. At a later period the Danes cut and burned large tracts. John, Duke of Lancaster, is said to have had twenty-four thousand axemen employed at clearances. King Robert the Bruce is credited with having destroyed certain forests in the neighbourhood of Inveraray. General Monk ordered clearances to be made 'that so they (the forests) may not be longer a harbour or shelter for loose, idle, and desperate fellows.' In the early days of the industrial era, before it was known that iron could be smelted with coal, much needless destruction was wrought by the custom of bringing the ore to forest regions for smelting, destroying the wood for miles around, and then moving on to another district where wood was to be obtained. Traces of this devastation may be seen at many places in the Highlands of Scotland and in the Lake District of England. The wind also would undoubtedly aid in the general destruction. The final result is to be seen in the present treeless wastes that meet the eye everywhere we turn.

The late Dr Smith, of Inveraray, has left it on record that, in the beginning of the nineteenth century, a splendid

crop of young seedlings sprang up almost yearly in the pine forest at the head of Glen Orchy. But, instead of these being protected, the inhabitants herded their cattle among them, with the result that they were regularly destroyed. Then the great increase of sheep through the Highlands and the practice of allowing them free access to the remaining natural woods still further prevented Nature's remedial measures from having effect; and the inordinate increase of rabbits during the latter part of the past century made natural regeneration an absolute impossibility. Natural decay unquestionably had a part in this process, but only to a limited degree. When the ordinary laws of Nature were thrown out of gear, and her recuperative efforts rendered useless, natural decay was bound to set in.

Doubtless our abundant supply of coal for fuel, and the easy importation of high-class timber, have adversely affected the protection of our forests; but our national lack of appreciation of forests and trees is probably due, in large measure, to our insular position. The sea to a very great extent shapes the thoughts, the ideas, and the characters of the inhabitants of our islands. With peoples brought up in Continental countries, to whom the sea is a name, an unknown feature, and a place the imagination looks upon with more or less dread, the forests as a formative influence correspond very closely to what the sea is with us. Forest life and scenery have inspired most of the poetry, legend, and music of east and central Europe. This is particularly the case in Germany. The inhabitants of that country are traditionally the poorest sailors and the best foresters in Europe. Their Governments have encouraged the forest tendency. But they have also, for their own ends, overcome, so to speak, the national inertia in maritime matters, and have within living memory built up a naval and mercantile fleet of no mean dimensions. How was this accomplished? The

Government made up their mind that it was to be done ; they educated the people up to the idea of doing it, and so they got it done. What is there, then, to hinder us in this country from accomplishing something of the same nature, but in the opposite direction? Are we prepared to admit that the Germans can accomplish more than we can? Possessing the finest timber-raising climate in Europe, are we to accept as an eternally fixed necessity our present position of having the smallest forest area in Europe, and no forest system at all?

CHAPTER III.

OUR DEPENDENCE ON FORESTS.

THERE is scarcely a sphere or occupation in life in which wood does not play an important part. Look round the house and think what it would be if all that is derived from the forest were removed—practically devoid of furniture, floorless, and roofless. The worker in metals without the use of wood would be as helpless as the carpenter whose whole work is with timber; the miner, tradespeople, the lawyer, clerk, and warehouseman would be in a similar position. Without wood, tramway-cars and railway-carriages would be intolerably uncomfortable, books and newspapers would be high-priced luxuries, and games like cricket, golf, and hockey would have to be given up. Then there are the military needs: timber for soldiers' huts, for the trenches, for temporary railways, for dug-outs, for rifle-stocks; charcoal for trench fires; and distilled products of wood for munitions.

Our dependence on forests is no less evident when we consider their effect on the atmosphere. Every child knows that the atmosphere we breathe is composed mainly

of a mixture of the gases oxygen and nitrogen. The former is that on which all animals, including man, and indeed all living organisms, are dependent for breathing; so far as that function is concerned, the latter is useful only as a diluent. Of the other components in the atmosphere, one of the chief is carbonic acid gas (CO_2). This gas is produced mainly by combustion and by the breathing of all living organisms. By both of these processes a large amount of oxygen is used, is combined with carbon, and returned to the atmosphere as CO_2 . If this process went on without another of a counteracting nature, the inevitable result would be that atmospheric oxygen would gradually diminish, with a corresponding increase of CO_2 , which ultimately would produce a condition in which life would be impossible. Indeed, some scientists have asserted that with our present extravagant method of the use of nature's products, we are actually hastening on to such a state. Others declare that science will intervene by inventing some means of liberating oxygen from oxides abundant in the earth, and thus maintain a sufficient supply for all purposes. But nature has a use for CO_2 in the atmosphere, and also a means of removing it, and if a proper balance can be maintained by natural means there will be no occasion for science to make up the deficiency of oxygen by artificial means. All green plants in the presence of sunlight use up CO_2 from the atmosphere. The green leaves of plants take in this gas, utilise the carbon, and return to the air part of the oxygen. Of all plants, trees provide the greatest leaf-surface on a given area of the earth. It follows that if a balance is to be maintained in the atmosphere, a proper proportion of every country should be devoted to forests. Further, trees can be successfully raised on land which will not produce other useful crops; and if such land is devoid of plants, excepting a scanty covering of heaths, useless grasses, and mosses with the most meagre leaf-surface,

there is a certain and very considerable loss in the natural process of maintaining the atmosphere in proper condition.

The climatic influence of a greatly increased area of woodlands is also well worthy of consideration. The benefits to be derived by agriculturists from the shelter of woods are by no means negligible. Sir Walter Scott, in a review of a book on forestry, remarked: 'Indeed, it has always seemed to us not the least important branch of this great national subject that the increase and the proper management of our forests cannot but be attended with the most beneficial effects on the population of the country. Where there lies stretched a wide tract of land, affording scanty food for unsheltered flocks, the country will soon, under a judicious system, show the scene most delightful to the eye. . . . In numerous places we are surprised to see the marks of the furrows upon plains, upon bleak hillsides, and in wild moorland. We are not to suppose that in the infancy of agriculture our ancestors were able to raise crops of corn where we only see heath and fern. But in the former times, and while the hills retained their natural clothing of wood, such spots were sheltered by the adjacent trees, and were thus rendered capable of producing crops. There can be no doubt that, the protection being restored, the power of production would again return.'

CHAPTER IV.

FORESTRY AND AGRICULTURE.

THERE seems to be a suspicion in some quarters that forestry operations are prejudicial to the interests of agriculture. A careful study of the needs of both industries will rid the mind of any such fallacy. Forestry and agriculture are allies, not enemies, and each stands to

gain much from the other. This has been sufficiently proved in certain of the more barren districts of Germany, where forestry has kept in a healthy state agricultural communities that otherwise would have dwindled away and disappeared. It must be borne in mind that all land suitable for cultivation, excepting such small areas as are required for nursery purposes, will be excluded from planting in any well-considered planting scheme. Such land will be used for agricultural purposes in the most economically advantageous manner for the benefit of the community, without in any way prejudicing the operations of either agriculture or forestry. A few suggestions are offered as to how this may best be done.

With regard to grazing-land, a good deal of it must necessarily be taken up by planting. It is questionable, however, whether the loss in grazing will be in direct ratio to the amount of land taken up. An undoubted benefit will be derived by agriculturists from the shelter provided by forests for stock on wind-swept hillsides and moors; and those who know the value of this will admit that it will very largely compensate for the reduction in grazing area.

In many districts of Scotland where an afforestation scheme may be profitably embarked upon, there will be found included in rough hill or moorland pastures not only a small percentage of more or less useful arable land in the valleys and on the lower slopes, but also large stretches of grazing-land which from altitude or other reasons will be quite unsuited to tree-growth. The problem is to utilise these areas to the best advantage. If judiciously dealt with, a great part of them should prove to be of no little agricultural and grazing value. These lands cannot be left out of consideration in drawing up a scheme of afforestation.

The question of utilising the more or less arable land of the valleys and lower slopes for crofters and small-holders

presents no difficulty. With regard to the large tracts of inferior land, there are alternative methods of reaping some benefit from them. The question of their utilisation for sport will be dealt with in a subsequent chapter. What we have to consider meantime is how they may best be treated as an agricultural subject in conjunction with forestry.

While small-holdings along with forestry may be established on a sound and lasting basis, scope will be found through these latter classes of lands to fit in with small-holdings a class of farms of considerable or even large area.

In face of recent legislation, it is somewhat difficult to state precisely what is a small-holding and what a farm. All holdings with rents of £50 or under may be included within the Small-Holders Act, yet it is possible to rent in the Scottish Highlands as much as two thousand acres at a rental of £50. It requires some straining of terms to class such an acreage as a small-holding. What we have first to do, then, is to arrive at an understanding of what—in connection with forestry—constitutes a small-holding. When this has been done, other agricultural holdings may be treated as farms.

Small-holdings may be divided into two classes. The first includes places where one to three cows and their young may be kept summer and winter, with sufficient arable land to raise crops for the holder, his family, and stock. The holder will cultivate his holding in spare evenings and afternoons, with a few whole working-days in spring and autumn. Subject to these conditions, he will have permanent employment at a steady wage from forestry work. This class of holding will serve the interests of forestry by providing a means of sustenance for the forest worker; it will fulfil the wants of the agriculturist by utilising advantageously any small patches of good land that occur in the area of planting operations.

Forest areas, however, may also include good land of sufficient extent to justify a second class of larger holdings, where more stock may be kept and more cropping done, but still not large enough to enable the holders to make a decent living or to occupy their time fully. The holders of these larger holdings will also be useful in the forestry operations, and thus augment their livings in their spare time. These larger holdings will, of course, not be so numerous as the former class.

Then there is the land already referred to as unsuitable for either afforestation or cultivation, but for which some profitable use must be found. As such land is not adaptable to small-holdings, it will be necessary, in preparing a planting plan, to sacrifice considerable stretches of good plantable land adjacent to farm-houses, and connecting with the higher and rougher ground which has been excluded from the proposed forest area. By this means the grazing value of large tracts will be maintained, and in course of time, through the shelter provided by the forest, the sacrifice of timber-producing land will be amply compensated for by the greatly enhanced value of the poor land.

Further, the grading of holdings and farms as outlined will provide facilities for aspiring agriculturists to rise by progressive stages from small-holders to renters of large farms; while those inclined to make a profession of forestry will have scope for their advancement as the work of afforestation increases.

The housing question will present a serious difficulty in many localities. Existing farm-houses will be available for the largest farms, but to take advantage of all available land much building will be necessary. In many rural districts the cost of erecting houses is extremely high; and it will be a serious handicap to any scheme of afforestation if it has to bear the whole cost of extra building. Since the joint operations of forestry and agriculture are

demonstrably for the general good of the nation, it would appear to be somewhat unfair to expect the timber-growing side of the project to bear the whole expense of housing. This is clearly a case in which a special annual grant should be made. As agriculture would benefit as well as forestry (for their interests, in Highland areas, would be quite inseparable), such a grant would be profitable economy. For it would mean that within the forest area housing for all classes of holders would be provided at about half the cost that a dual scheme would entail; and, as has been shown, it is only by the joint use of the ground by forestry and agriculture that great stretches of the Highlands (and of the southern uplands) can be made a real source of national strength.

CHAPTER V.

THE GAME QUESTION.

THE question of dealing with game may prove to be one of the most troublesome problems to be encountered in the advancement of forestry. The protection and encouragement of certain game birds and animals has developed a sport which now occupies a position altogether disproportionate to its utility. From the point of view of forestry it has become a positive evil. No good is to be gained by detailing the damage that has been done by game during the last half-century through the excessive importance that has been attached to it. Suffice it to say that game has been responsible for a great amount of unskilful (and therefore unremunerative) management of woods. In too many cases woods have been reared to produce good game-coverts rather than good timber. The interests of forestry do not demand the total abolition of sport or the wholesale

destruction of game; but the interests of sport and game, in so far as they clash with the national interests of forestry, must be relegated to their fit and proper place.

Different classes of game in the forest area will require different methods of treatment. Rabbits are the greatest enemy to plants, although they may not always be the most difficult pest to deal with. They must be exterminated wherever there are young plants, if the young plants are to have a reasonable chance of success. Nor would this be without advantage in other respects, because in many parts of the rough grazings throughout the country the best land is so overrun by rabbits that farm stock cannot live on it. If owners of lands adjoining newly formed plantations will keep a stock of rabbits, power must be obtained to compel them to confine the rabbits to their own land. It is unfair that a proprietor, whether a private individual or a public body, should clear ground of these pests for the cultivation of timber for the benefit of the country, and also be expected to fence out his neighbour's stock of rabbits.

Black-game may be placed as a good second to rabbits. The recommendation in the report on the proposed planting scheme for Glen Mor, 'that they must be reduced from their status of game to that of vermin,' will require to be legally enacted to enable forestry to be established satisfactorily. Black-game will be more difficult to deal with in some respects than rabbits. The latter may be fenced out; the former cannot. To save the plants in a comparatively small area it may be necessary not only to exterminate these birds in the neighbourhood of young plantations, but also to have them reduced to an absolute minimum over a very wide district.

Capercaillie, where numerous, may require similar treatment to black-game, but this bird has a less evil reputation for causing damage to young plants, and is neither so plentiful nor so widespread.

Hares, brown and blue, although less likely than rabbits to be a serious menace, may also be very injurious to young plants if not kept down to reasonable numbers. This can be more easily done than in the case of any of the previously named pests, and drastic treatment should be required only on rare occasions.

Grouse, stated by some to be addicted, like black-game, to picking the buds of young plants, although to a lesser degree, may safely be given reasonable scope as a game-bird for sport. They are comparatively harmless, because they frequent mainly land which to a large extent will be only partially useful for timber production, but which as grouse-moors may bring in substantial rents.*

Other game-birds, so far as experience shows, are not in themselves prejudicial to the interests of forestry.

Deer have been placed last on the list of the young plants' enemies, not because they are by any means the least harmful, but because they form a class by themselves, and are not usually classed as game. They may be more correctly designated beasts of the mountains in the case of red deer, and of low ground and plains in the case of roe deer. Fallow deer may be left out of consideration in Scotland. Roe deer may cause great damage to young plantations, and will necessarily have to be allowed only in very limited numbers, if at all, in the neighbourhood of the afforestation area during the initial stages. Red deer, being more numerous, are likely to demand stringent measures, and their proclivities for damaging agricultural crops will require consideration. Red deer, like grouse, may, however, prove to be a useful adjunct in many districts of the Highlands where the greater portion of the land which is their chief haunts will be outside the plant-

* This is submitted as an alternative use to which the poor upland excluded from the planting area may be put. The question of using such land for grazing has been treated in a previous chapter. Sport and grazing may also be combined.

ing area. The question will arise as to whether the cost of fencing them into their own preserves can be justified through the increased revenue to be derived from sporting rents.* Where they are not likely to be of some financial value, they must be ruthlessly dealt with in the neighbourhood of the afforestation area. Circumstances may also arise where a contemplated afforestation scheme may abut on a property on which deer are numerous. In such circumstances the only workable plan will be to require the owner of the deer to keep them on his own land, the cost of fencing to be borne jointly, or to have them treated in such a manner as will render them harmless to the adjoining plantations.

Finally, it will be necessary, in reference to all classes of game that are or may be injurious to young plantations, or that do, or may, hinder the successful prosecution of forestry, to establish forest laws to operate in the neighbourhood of forest areas, forbidding the keeping of an undue stock of certain species of game, the forest authority being empowered to give notice to the responsible party to reduce any particular class of game to requirements within a specified time. Such a law would have to be enforced by the entailment of severe penalties on those who failed to comply with its provisions.

CHAPTER VI.

SOME PRACTICAL SUGGESTIONS.

It is proposed in this chapter to consider briefly various problems which are bound to arise in connection with the inauguration of any scheme of afforestation—questions as to where planting operations should commence, of altitude, shelter, and aspect, and soil quality. The suggestions

* See note on previous page.

offered are based upon personal observations made during the writer's practical experience of these problems over a period of twenty years, and although they are submitted in separate form, it must be borne in mind that, except in the case of the first mentioned, these questions are interdependent, and must be considered as such to arrive at a decision in any particular case.

Firstly—Where should planting operations be commenced? A ready answer would be: Start wherever suitable ground is available. But several things besides the mere establishment of forest areas must be regarded, and the most important consideration is how the timber, when produced, can be taken to the market. Next in point of importance is the consideration of existing facilities for carrying out the initial work expeditiously and economically. Not the least of these is the presence on or near the area of a nucleus of labour available for the initial work. Next we come to the question—What road and railway or shipping facilities exist? And the existence of these, and the use that can be made of them, determine whether this or that place is the more suitable. Hence, to sum up, begin on the most suitable ground that is most convenient or accessible to the consumer, has at least a nucleus of labour available, and has a good system of roads for the carrying out of the planting. Inconvenient and inaccessible districts should be the last places to be planted, in the hope that by the time they are approached facilities may then be improved, and that when the timber has reached marketable age the markets may be more readily accessible, or may even have come nearer by reason of new industries having sprung up in the wake of the earlier created forests.

The altitude to which planting may safely be extended is a question to which no definite answer can be given. In a general way, other conditions being equal, the altitude will increase as we approach the equator or recede from

the seaboard. But latitude or distance from the sea does not wholly determine the altitude at which trees may be grown. For example, trees are grown successfully to greater altitudes in middle and eastern Inverness-shire than in the south-western counties of Scotland, showing that other influences must be taken into account. In the treatment of new ground it will be a wiser and more profitable policy to keep within the absolute limit of altitude than to exceed it, and in determining what this point is, aspect and shelter, and soil quality, frequently have a greater influence than latitude or distance from the sea.

The effect of aspect and shelter has an important bearing on the ultimate success of tree-growth. This is especially so in proximity to the seaboard. In all cases their effect is determined by the proximity or absence of land that is considerably higher than the planting limit. As a general rule, slopes facing south and west—that is, facing the prevailing winds—have a lower planting-line than those facing north—that is, on the sheltered side of the hills. But shelter is provided not only by higher ground to windward. Even on an exposed slope trees will grow better and straighter, and be less liable to be blown down, and the altitude for tree-growth will be increased, if in the immediate background of the slope there is ground of a considerable height above the limit of tree-growth. It has been observed that such high ground, provided it be in the immediate background, serves to lift the wind and break its force upon the trees. In all cases, and particularly in mountainous regions, the effect of shelter on the progress and stability of trees in general, and also on the quality of timber, must be carefully taken into account, because the shelter afforded by the high tops may not infrequently discount to a great extent the effect of latitude or proximity to the seaboard.

Soil quality is, under all conditions, of primary import-

ance. Indeed, in many parts of the West Highlands of Scotland it will be in practice the determining factor when selecting ground for planting. Many areas of comparatively low and sheltered ground will be encountered quite unfit for tree-growth on account of the inferior quality of soil even after expensive preparation; whereas stretches of higher and more exposed ground of superior soil quality in the same neighbourhood may safely be planted.

These conditions are due in the main to the absence or presence of peat. Where peat is absent, provided there be a reasonable depth of soil, altitude, shelter, and aspect are the determining factors of suitability for tree-growth of one kind or another according to the nature of the soil and of the situation. Much land, however, which will come under treatment will, in varying degree, be composed of peat, or be what is commonly called peaty soil. As regards pure peat, where it is less than eighteen inches in depth the ground will normally, with more or less treatment, be plantable. But the underlying soil or rock must be taken into consideration. Areas will be found where, with only a thin covering of peat, trees will not grow; but such exceptions are due in a greater degree to the nature of the soil beneath the peat than would on first sight be apparent. For the quality of the peat is greatly influenced by the degree of imperviousness to water of the soil on which it rests. Indeed, fairly steep slopes will frequently be encountered with only six to twelve inches of peat of very poor quality overlying boulder-clay or some such retentive soil; such slopes, although having no appearance of undue moisture, are quite unfit for tree-growth until thoroughly drained, and even then are frequently inferior to peat several feet deep. The same effect is not infrequently produced even with a non-retentive soil, where a soil-pan has formed under the peat. Until this pan is broken the area will be quite unplantable.

Again, in many places there will be found, overlying the solid rock, stretches of pure, or almost pure, peat. Generally these are of no value for planting; but in this case also the quality of the peat depends upon the nature of the rock. Where the rock is of a hard close-grained nature the peat is of the poorer quality, and the softer and more easily decomposed the rock is, the peat is correspondingly the better. On slopes where rocks of a softer nature are partly exposed, the peat becomes mixed with a certain amount of mineral substances from the rock, and such slopes are not infrequently quite good planting subjects. Indeed, it would appear that the value of the peat for planting purposes is governed in most cases by the nature of the underlying soil or rock more than by its actual depth.

On flat bogs where the soil or rock is out of reach, the draining necessary to render the land plantable can, as a rule, only be undertaken at a prohibitive cost; but even on deep peat there will be found some areas which are quite worth draining. These places can best be judged by the nature of the surface growth. Again, peat on a high flat, with slopes of good soil leading from it, frequently renders parts of these slopes more or less useless through the drainage from the higher bog running over or percolating through the soil, which will often be found to be quite acid. This effect can only be counteracted by good drainage along the margin of the peat, and by carrying down the water collected in well-defined channels. Experience has proved that the value of all soils, including peat-bogs, may be most readily and correctly estimated by a careful study of the natural herbage. In the succeeding pages some notes on that phase of the subject gained from observation will be offered.

CHAPTER VII.

NATURAL HERBAGE AS A GUIDE.

THE most useful and convenient guide for the classification of new areas is to be obtained by careful observation and discrimination of the nature and quality of the natural herbage. This may be more or less uniform, or it may be very varied in quality or species or in both, ranging from scrub-wood of various descriptions down to the poorest grasses, mosses, and kindred plants. In many districts which will come under consideration the variation may range between the two extremes, even within comparatively small areas; whereas in other places there may be large areas with comparatively little variety. Subjects of the former nature will obviously be more difficult to deal with, and even in a preliminary survey careful discrimination and examination of the whole area will be necessary to decide what is suitable land and what is unsuitable for forestry purposes. This phase of the subject has proved a most engrossing and interesting study, and at times is even a puzzling problem. It is hoped that the hints and opinions submitted, which are derived from careful observation during eight or nine years, may be of some guidance to those who may be engaged in the carrying out of afforestation schemes on new land, in enabling them more easily to discriminate between the different qualities of ground according, as it were, to their face value. It should be stated that the remarks are based chiefly on experience gained in the moist West of Scotland climate, although it is hoped they may be useful for guidance in any district. Certain modifications may be necessary in different districts, and more especially on different soils.

It is not possible in a short treatise to deal with all classes of herbage that may be encountered. But a

reference to those which experience has proved to be important, as good guides, may be of practical use.

There are several plants which can be classified as indicating a quality of soil entirely or partially inimical to tree-growth. Some of these may compose a pure crop covering small or large areas, or they may be found along with plants of similar nature or with those of better quality; while others are only encountered in patches scattered over ground chiefly occupied by different plants. Deer's-hair (*Scirpus caespitosus*) is found frequently almost pure over areas of all dimensions; and no such area should be planted. It is certainly more plentiful on higher altitudes which are outside the range of planting, but is also met with in abundance at all altitudes. Sphagnum also comes within this class, and is found not infrequently along with deer's-hair, producing a mixture which is invariably evidence of unplantable ground. But when plentiful, even by itself, it forms a peat of the very poorest quality. Cotton-grasses (*Eriophorum vaginatum* and *E. angustifolium*) in abundance indicate bad planting-ground. They are often found along with sphagnum, but not so frequently with deer's-hair, although often in close proximity. Bog asphodel (*Narthecium ossifragum*) is a plant of bad omen wherever found. Fortunately it seldom covers large areas, although frequently found scattered in small patches over ground with other plants and inferior grasses. Small sections of ground having a mixture of deer's-hair, asphodel, and grasses are not infrequently to be found scattered throughout areas of better soil quality. Heath and ling are frequently found in company with any or all of the before-mentioned plants. Although in themselves not of an ominous nature, their danger has to be considered relatively to the value of the company in which they are found. All land with a covering of heath or ling or both mixed with deer's-hair and asphodel is of the very poorest quality, and should be excluded from any planting area,

unless they are merely small areas in the midst of better land. These might in such cases be utilised in a limited way for experimental work in reclamation. Ground of this quality and that with a pure crop of *Scirpus* have already been mentioned as frequently being the means of reducing the value of good slopes through the acid water draining on to them, and encouraging a growth of *Scirpus* on what is to it unnatural soil.

What appears to be the poorest class of land worthy of direct treatment is that referred to previously as having a varying depth of peat up to eighteen inches—generally less—over boulder-clay, with a good slope—even steep in places—and showing little indication of excessive moisture. This ground may be recognised by the presence of a small percentage of deer's-hair and sphagnum and occasionally cotton-grasses along with dwarf blaeberry (*Vaccinium myrtillus*), the hair-grass (*Aira cæspitosa*), bent-grass (*Agrostis canina*), bushes of the dwarf willow (*Salix fusca*), yellowish-green moss (*Hypnum purum*, L.), and green moss (*Polytrichum commune*, L.) in tufts, and occasionally the grass purple molinia (*Molinia cærulea*), the two last-named only on the best parts. The quality of the soil is variable, but generally may be fairly accurately valued by the proportions of the above grasses to those of the previously discussed injurious plants. A rough estimate may be made by assessing the value of the ground as being in direct proportion to the prevalence of the grasses, and if these are less than three-fourths of the crop, the ground had better be set aside for experimental work. If there is little evidence of injurious plants among the grasses, the ground may be considered safely plantable after draining; but if the grasses are less plentiful, and replaced by blaeberry and heath, with much pale moss and more deer's-hair and sphagnum, the ground is not so good, and will require closer drainage. Should deer's-hair be in excess, with little grass excepting *Aira cæspitosa*, the ground had

better be classified as doubtful, and earmarked for experimental work. All ground of this nature requires to be well drained—closer or wider according to quality. It is recommended that a few inches of the boulder-clay should be removed from the bottom of the drains, which, except the leaders, should be cut across the hill with as low a gradient as possible. It is also a benefit to have the ground drained at least a year before planting commences. It has been observed that as a result of drainage the grasses increase and improve in vigour, whereas the injurious plants decrease and decline. From this it is inferred that all land bearing this nature of herbage may be sooner or later brought into a condition to carry a crop of timber, although in the poorest quality of ground it is probable that the first crop may be more preparatory than profitable. On land of this class small groups of *Carex binervis* and green moss are not uncommon, and their presence always indicates a patch of better ground.

Purple molinia, being a very widely distributed and important grass on moorland, deserves special mention. As already stated, it is found along with other grasses, but is frequently the principal or almost the only grass over large areas. It is a peat-lover, but is seldom found plentifully unless on peat of good or fair quality, and rarely on deep peat unless of good quality. Careful observation of its health and vigour gives a very good indication of the nature and drainage requirements of the land. On well-drained land or good moderately dry peat it is luxuriant, and in normal seasons comes to maturity in July or early August. If it is later in coming to full head, or, as is often the case, does so only sparingly, the ground will have to be improved by drainage, and the later and more sparingly it seeds, and the less luxuriant the growth, the more drainage will be required. It was quite remarkable that during the season in 1917 this grass was most vigorous, and seeded early and most profusely, all over the

usually wet moors and hills, a fact which can undoubtedly be attributed to the abnormally low rainfall from January to July of that year.

Several plants which flourish on peat or wet peat soils are very safe guides in making decisions as to what is worth draining. These are rushes, both single and tufted, the former being the more common, and bog-myrtle. Experience has proved that, almost without exception, where any one or all of these are abundant along with grasses or heath or both, the ground may be profitably planted after it is sufficiently drained. The single rush, however, is found at times in fair quantity on flat swampy ground of deep peat, which it may be very difficult to drain thoroughly, and which in most cases had better be left for experiment.

Certain plants which are always to be found on good planting-land may be enumerated, although they are really of more guidance, when considered along with the plants among which they are found, for deciding what class of tree is likely to prove most successful. They are: all good pasture grasses, bracken and ferns, and heath on dry land, provided it is well mixed with grasses. Ling also is an omen of fair soil, provided it be well mixed with grass on dry ground; but the ground generally is poorer, frequently very much so, and hard and shallow. Its value as a guide may be estimated more or less accurately by considering the nature, percentage, and vigour of the grasses found along with it; generally, the less grass the poorer the quality of the soil. Further, plants are proportionately longer in becoming established and slower in growth. This is still more marked if the ling is of stunted growth on bare, hard land.

The best planting-ground of all is that which has been cleared of a crop of scrub or coppice, oak, ash, birch, or hazel, or a mixture of two or more of them; although exceptions to this may be found where the crop has been

a very poor one on hard, stony, shallow land over rock. Where alder has been cleared on wet land or on edges of water, the soil quality is equally good; but the land usually requires drainage if it is to be stocked with conifers, and owing to the shallow spreading roots of alder, drain-cutting is both a tedious and an expensive operation.

CHAPTER VIII.

NOTES ON TREES.

IN the afforestation of waste-lands, unless under special circumstances, coniferous trees will almost invariably be the crop. It is proposed to offer some opinions and remarks on those trees that have come under the writer's close observation in that particular phase of forestry. The classification of soils by herbage has been dealt with in the previous chapter, and prominence will again be given to the natural herbage as a guide to which tree or trees will be most likely to give the best results on any given situation, judging it by the soil-covering.

Pines.—Though the first tree to be considered, the mountain pine is one not usually classed among timber trees, yet in the advancement of forestry it may prove to be very useful in the reclamation of inferior peats. It is reported that mountain pine (*Pinus montana*, var. *uncinata*) has been extensively used in Denmark for planting thinly on bog-land after draining, with the object of improving the quality of the peat, and that good results have been obtained in rendering this soil suitable for the growth of spruce, which was introduced when the condition of the peat had been rendered satisfactory. This pine has been tried on Inverliever in recent years with the same object in view. It has not yet been long enough established to give results, but it has been proved that it will grow on

drained ground which will not grow spruce or any other timber tree that has been tried on it. It has also been tried, with varying results, on moderately wet peat without drainage. It will be of inestimable value to forestry, for reclamation work, if this or some other tree can be proved so to improve the quality of the poorer classes of peat that spruces may be successfully cultivated on them.

Scots pine (*Pinus sylvestris*) is so well known and so accommodating that it is frequently planted in localities and situations quite unsuited to its proper development. It should not be extensively used in the West of Scotland. It is much better suited for the dryer climate of the east and inland parts of the country. In the west, however, there will be found places with a crop of short hair-grass and ling where it may be the most suitable tree to plant. It generally succeeds better among ling than any other timber tree; but it should not be planted on land that will grow spruce, larch, or silver fir satisfactorily.

Corsican pine (*Pinus Laricio*) is likely to give a better return than Scots pine, and seems to be better suited to the climate in the west. It has been tried in recent years on soils bearing a crop of short hair-grass and ling, but it is not yet advanced enough to enable one to offer an opinion as to its ultimate success. So far, it is successful, but is slow in becoming thoroughly established, some plants getting away, but the majority just keeping ahead of the herbage. It does well on a better soil which may be too poor for European larch, silver fir, or Douglas, or too dry for spruces.

Austrian pine (*Pinus Austriaca*) has only been used in a limited sense as a wind-break. It is a partial success on ground that is growing spruce well, ground bearing a natural crop of various grasses, which prefer a moderately high degree of soil moisture; but it has done better on dryer ground. All pines give best results with spring planting.

Spruces.—Common or Norway spruce (*Picea excelsa*) is decidedly suitable for the western climate. It succeeds well on a soil with a natural crop of pasture grasses thoroughly mixed with tall fescue (*Festuca elatior*), or a few rushes, or with any of the following plants: queen of the meadow (*Spiræa ulmaria*), lady's mantle (*Alchemilla vulgaris*), water avens (*Geum rivale*), and yellow iris (*Iris pseud-acorus*). It also grows well among soft grass (*Holcus lanatus* or *H. mollis*), and on ground that has been cleared of alder scrub, but in some cases only after draining. It flourishes where there is a good crop of bracken, and also among a thin bracken-crop with grasses or a little heath beneath, the results being better the heavier the bracken-crop. This ground, however, may likewise be used for other species. It also grows on soil of poorer quality, does moderately well among purple molinia, but is less vigorous among mat-grass (*Nardus stricta*), hair-grass (*Aira flexuosa*), and bent-grass (*Agrostis canina*), and still less so among the hair-grass, *Aira cæspitosa*. It is always better where there is a bottom of green moss than where the yellowish variety forms the bottom, and where there is a good mixture of single rushes among the grasses it is sure to succeed. A mixture of ling with any of these grasses greatly impairs the results. Spruce has no aversion to growing among bog-myrtle if the latter is not too dense and strong, although it is said by some that its life is short along with that plant. Almost all ground bearing bog-myrtle requires more or less draining to grow spruce, which in any case is slower in getting away and less vigorous than if grown among the better herbage.

Sitka spruce (*Picea Sitkaensis*) is also decidedly suitable for the moist West of Scotland climate. It may be planted on any situation that will do for common spruce. It has, however, a decided advantage over the common spruce where there is a rank growth on the ground, especially of rushes or iris; for it establishes itself more

quickly, and, being of more rapid growth, frees itself from danger in a shorter period. With Sitka spruce strong plants are decidedly preferable for planting out; two-year two-year plants of moderate growth give much better results than two-year one-year. The smaller sizes of the former should be planted among short herbage, and the stronger ones where the growth is more profuse. It also succeeds better among soft grass than common spruce or any other plant that has been tried. With these reservations there seems to be little to choose between common and Sitka spruce in their requirements. Neither of them does well among ling; in fact, unless there is a good proportion of grass among it, results are unsatisfactory. Neither do they succeed well on hard slopes or on sandy or gravelly banks. Where they have been tried on doubtful ground, with a varying proportion of plants inimical to them, results have been somewhat similar, the Sitka, if anything, showing greater vitality.

White American spruce (*Picea alba*) has recently been tried on a poor class of land with a growth of hair-grass, purple molinia, bent-grass, and a little deer's-hair. It has made a good start, equal to, if not better than, the other varieties of spruce. All varieties of spruce are most successful with late spring planting.

Silver Fir.—The common silver fir (*Abies pectinata*) gives promise of being a most valuable tree in suitable situations in the West of Scotland. It is exacting regarding soil quality, and should only be planted where the herbage indicates a high or at least moderate degree of fertility, and no evidence of excessive moisture—for example, tall fescua, rushes, spiræa, or iris. It succeeds well among bracken, but requires attention for several years if the bracken-crop is dense; where the latter is thin, with an undergrowth of good grasses, the firs require little or no attention. Frost-holes should not be planted, however good they may be. Soils where hair-grasses are

much in evidence are not very suitable—decidedly unsuitable if the grasses are thin and have a mat of the yellowish moss as a bottoming. Unlike the spruce, silver fir does not transplant so well in late as in early spring, and is better planted along with larch. It is also very susceptible to injury if there is delay in planting after lifting.

Nobilis (*Abies nobilis*), raised from seed collected locally, has been planted on Inverliever in groups for wind-breaks, and is very successful on soils similar to those suitable for common silver fir, and also on a good peaty soil.

Douglas fir (*Pseudo-tsuga Douglasii*) has come extensively under observation, and in general is doing well. In some cases where groups have been extended into rather unfavourable ground there is a marked falling off in the results. The conditions required for silver fir are generally applicable. But it is much better suited than silver fir to situations where there is a dense growth of bracken. Indeed, no tree is so well suited to these conditions, provided there be a fair degree of shelter. Generally, it should be planted in spring, after March.

Thuja.—*Thuja gigantea* gives a wider range in choice than Douglas fir in that it stands exposure much better, grows at a higher altitude, and stands a higher degree of soil-moisture; in a good soil, indeed, it is most successful with a degree of moisture quite unsuited to Douglas. It has been tried in a frost-hole among purple molinia and bog-myrtle, and is flourishing, with few deaths, at the end of three years.

Larch.—European larch (*Larix europaea*) does well in Argyllshire, and is remarkably free from canker. It stands exposure better than Douglas, but should not be planted on wind-swept ridges or promontories. Otherwise its requirements are similar to those of Douglas, and, as with silver fir, frost-holes should be avoided.

Japanese larch (*Larix leptolepis*) will succeed well on any soil that will grow the common larch, and succeeds even

with a poorer soil if need be. It is advisable to confine this variety to the poorer qualities of larch soils, where it is less rank in growth and gives evidence of producing a better quality of timber. Soils with a thin crop of bracken and poorer grasses, with a little heath or ling, suit it very well.

Both varieties love a high degree of atmospheric moisture, but must have good drainage in soil, and in the subsoil if the former is shallow. They should be planted in early spring. In large schemes of afforestation care should be taken that larch is not planted to such an extent that the supply of it will exceed the demand.

Beech.—The sylvicultural qualities of common beech (*Fagus sylvatica*) are too well known to require repetition. In all planting schemes it should be used as an auxiliary to the crop, if not as a timber-producer. Its soil requirements are very similar to those of larch and silver fir, but it is better fitted for exposed situations than the former, and on promontories makes a most useful wind-break along with the latter. It may be used with great advantage to the crop in filling up blanks in larch groups after these have had a good start. It may also be advantageously planted among spruces on good soils, and, with great benefit to the crop, on patches of better ground dotted throughout areas of poorer soil quality. The altitude to which it may be used in this respect will have to be decided independently for each locality. Beech may not succeed to the same height as spruce, but where it can be introduced its beneficial qualities demand that it should have due consideration.

The study of natural herbage as a guide in the discrimination of land which may be profitably planted from that which may not, and also as a guide to what class of tree should be planted, is a phase of the science of afforestation which is yet in its infancy. What has been said, the experience of the past ten years would appear to support; but one is daily ascertaining new facts and encountering

new conditions, and although it would perhaps be overbold to put forth any of the results of a study over so short a period as unchangeable facts, it is submitted that the deductions made have so far proved themselves correct in practical experience. We must proceed by easy stages of development, and the sooner a national scheme of afforestation is an actuality, the sooner shall we be able to co-ordinate the various branches of the science, which are still in their infancy, and to unite them firmly to a central trunk of practical forestry, planted firmly on our native soil.

NOTE

THROUGHOUT this book the scheme, or schemes, which the writer has mainly in mind are national—that is, carried out by the State on land purchased or rented for the purpose from the present owners. Obviously, however, these would have to be supplemented by schemes carried out by private owners on their estates; and for such private schemes a State loan or subsidy, secured under proper conditions and guarantees, would in many cases have to be given. Municipalities and County Councils and other public bodies, such as Wholesale Co-operative Societies, would also be entitled to subsidies if they required them. It is impossible to lay down rules as to the proportion of State-owned forests; but there are some grounds for believing that the ideal proportions would be:

Owned and worked by the State	. . .	25 %;
"	" other public bodies	40 %;
"	" private owners	. 35 %.

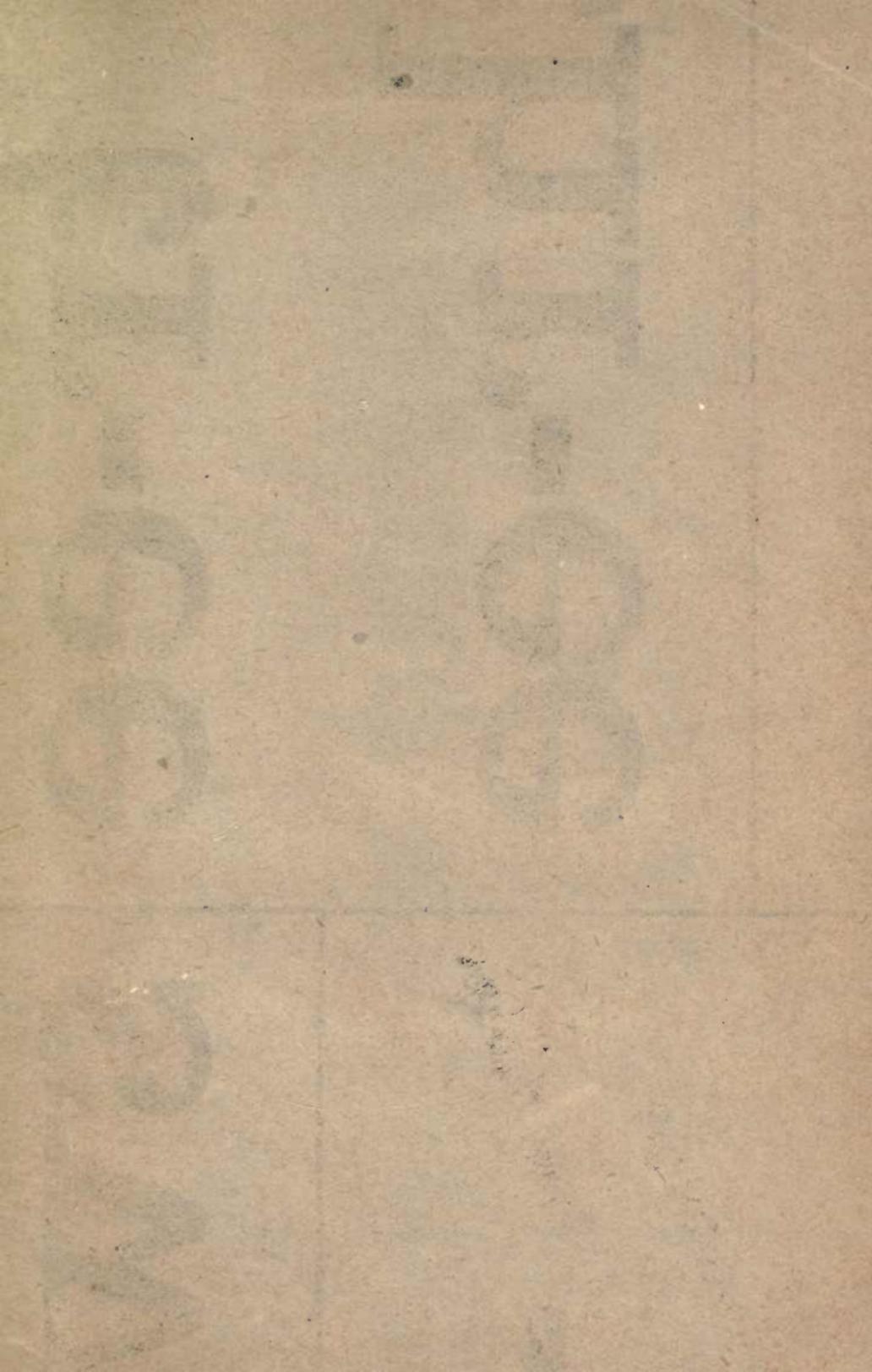
These proportions, however, would depend very largely on the future course of land legislation. In any case, of course, the rules followed in the State forests as to management would have to be made binding on all other owners of forests who had received loans or subsidies

APPENDIX.

SOME SIGNIFICANT FIGURES (PRE-WAR).

	United Kingdom.	Germany.
Annual value of timber and timber goods imported	£40,000,000	£15,000,000
Acres under forest	3,000,000	35,000,000
Publicly owned forests (in acres)	120,000	17,000,000
Persons employed in agriculture (the British figures include forestry; the Germans figures do not)	2,000,000 *	20,000,000
Persons employed in domestic service	2,000,000 *	?

* A comparison of these figures gives special food for thought, particularly when it is remembered that the vast majority of British domestic servants were in the south of England, and that, of the persons employed in agriculture, 800,000 were in Ireland; that is, England in 1913 had probably nearly half-a-million more domestic servants than agriculturists!



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