Forestry in the United Kingdom.

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W. SCHLICH, Ph.D.,
C.I.E., F.R.S., F.L.S.

FORESTRY

IN THE

UNITED KINGDOM.

BY

W. SCHLICH, PH.D.,

C.I.E., F.R.S., F.L.S.

AUTHOR OF "A MANUAL OF FORESTRY."

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INTRODUCTION.

Experience in India convinced me that, if systematic, economic forestry were to become an enduring thing in India and in the colonies, it would be necessary to make it so in the mother country. When forestry in Britain has once become an essential part of the industry based upon the soil, those who go out to govern the British possessions beyond the seas will be duly impressed by its importance. They will bring to their spheres of action a sympathetic understanding of the business, which will go a long way to prevent any oscillating policy, that otherwise might threaten to interfere with the progress of forest management. Continuity of action will then become the order of the day, without which no industry can flourish, whatever its name or nature may be; and least of all forestry, the produce of which frequently requires a century and more to mature.

Thus it was in the interests of India that I first took up the subject of British forestry, and it has occupied me ever since I returned from India in 1885. I travelled over the greater part of England, Scotland and Ireland, and soon became aware of the great importance to this country of extended afforestation and improved management of the existing woods. Already in January, 1886, I submitted to the Earl of Carnarvon, then Viceroy of Ireland, at his Lordship's invitation, a pamphlet entitled "Afforestation in Great Britain and Ireland." Before that pamphlet had left the press, a change of Government took place, and my pamphlet was, I presume, shelved. However, I went on, and at various periods I published not only a Manual of Forestry, but various articles and other papers. Of the latter I desire to draw

particular attention to two: (1) "The Timber Supply of the British Empire," read at the Imperial Institute in March, 1897; and (2) "The Outlook of the World's Timber Supply," read before the Society of Arts in March, 1901. During the last seven years I had the pleasure of advising several landed proprietors regarding the management of their woods, for whom I drew up management schemes, or working plans as foresters call them. In 1903 I prepared a working plan for the Alice Holt woods, belonging to the Crown. These labours brought me more and more into contact with British forestry.

On the 17th November, 1903, I gave a lecture on "Forestry" at the Royal Agricultural College, Cirencester, as Honorary Professor of Forestry at that Institution. On the 25th February, 1904, I delivered another lecture at Carpenters' Hall, in the City of London, on "The Forestry Problem in the United Kingdom." As various friends have taken an interest in the matter, and asked for additional copies of my last lecture, after the original stock had been exhausted, I decided to publish the present essay.

I propose to examine the question, whether extended and improved forestry is of such importance to this country generally, as to justify any special measures to be taken towards furthering it, and if so, what these measures should be. Hence, I have brought together the remarks made in my last two lectures, extracts from my other publications, and additional matter, so as to represent a somewhat enlarged statement of the problem; I have added notes on the afforestation of mountain and heath land, a special section on the financial aspect of the business, and notes on the management of some types of existing woodlands. The latter were published by me some years ago in the "Gardeners' Chronicle." I have now somewhat altered them, so as to bring them up to date.

It will be understood, that I cannot give here a complete treatise on the management of woodlands in the United Kingdom. I have only picked out some of the essential points: for

a complete statement of the principles of sylviculture and forest management I must refer the reader to my Manual of Forestry.

The subject may be divided into the following three chapters:—

1. The importance of the forestry problem to the nation.
2. The measures which should be taken in this country to insure the benefits offered by forestry.
3. Notes on the afforestation of surplus land and the treatment of some types of British woodlands.

I have added ten pictures, illustrating the natural regeneration of beech, the production of high-class oak timber, and the proper density of spruce woods.

CHAPTER I.

THE IMPORTANCE OF FORESTRY.

Forests are, in the economy of man and of Nature, of direct and indirect value; the former through their products, and the latter through the influence which they exercise upon climate, the regulation of moisture, the stability of the soil, the healthiness and, last but not least, the artistic beauty of a country. I shall commence by offering a few remarks upon the more important indirect effects.

1. The Æsthetic Effect of Forests.

This is an aspect which plays a great part in the case of most of the woodlands at present existing in this country. Just compare the difference of feeling created, even in the mind of the most realistic person, on passing through a bare country side, without a tree for miles around, and on wandering through a country where fields and meadows alternate with inviting woodlands, especially on a warm summer day. It is no wonder, therefore, that we find in most parts of this country fine parks and artistically placed woodlands, which render Britain so beautiful and attractive. It is a subject which has been repeatedly dealt with, and upon which a good deal more can be said. On the present occasion only the influence which forests have upon the physical and moral development of the people shall be mentioned. By developing a taste for the beauty of landscape, forests greatly contribute towards the peace and contentment of mind of the dwellers in the country, and help to counteract the unwholesome fever of emigration to the big towns.

2. Effect of Forests upon Climate.

I shall draw attention only to a few points. It is well known how beneficially woodlands act in giving protection against strong winds. Indeed, many woods were created so that they might act as shelter belts for the benefit of fields and pastures, as well as to man and beast. An incidental further benefit of such woods consists in the fact that they act as breeding and resting places for useful birds, the great insect destroyers in agricultural districts. I need hardly point out that woods serve as excellent game coverts, and it is chiefly for this purpose that a great portion of the existing woodlands are maintained in this country. As regards the effect of forests on rainfall we need not trouble ourselves. In the first place that supposed effect is as yet very doubtful, and, secondly, we have in this country, I think, quite enough rain, and frequently a good deal to spare.

3. Effect of Forests upon the Stability of the Soil.

Forests assist in preventing erosion, landslips, the silting up of rivers and low lands, and they arrest shifting sands. The rain water, which falls on bare hill sides, rushes down, denuding the soil and carrying it into the water channels, which generally deposit it on lower ground, and often on fertile fields and meadows. This effect has not yet done irretrievable damage in Britain, but the commencement of such detrimental action can easily be seen. Anyone who has travelled to Scotland must have seen dozens of places in Northumberland where the water has cut into the hill sides and produced indentations, which certainly will go on increasing, if nothing is done to arrest such action. The same may be seen, and in a more aggravated form, on proceeding from Chester to Holyhead. Unless such mischief is stopped in time it may afterwards necessitate the construction of costly works, such as embankments, dams, and weirs.

What this means will easily be seen by those who pay a visit to the French Alps.

Again, there are unmistakable signs, in many parts of the country, that peat bogs are increasing, owing to the unprotected state of extensive waste lands. Indeed, in many quarters the opinion is held that the extensive peat bogs of Ireland came into existence since the original forests were destroyed. At any rate, there can be no doubt that, year by year, the bogginess of the open lands in the New Forest is increasing.

These few instances will show that the indirect effects of woodlands are of considerable importance. Those who desire to follow up the subject further, will find a considerable amount of information in Vol. I. of my "Manual of Forestry."

4. The Produce of Forests.

While the indirect effects of forests are sometimes difficult to estimate, it is comparatively easy to assess the direct effects, that is to say, the benefits which a nation derives from them through the produce which they yield. Here, again, we have to do with a great variety of things, such as timber, firewood, fruits, leaves, flowers, bark, turpentine, fibres, grass, moss, peat, game, and many other things. Some of these articles are of importance in agriculture and estate management generally, but on the present occasion I must restrict my remarks to the most important items, namely, game and timber.

a. Forests and Game.

Unfortunately, the old taste for the chase has now changed into the love of killing as many head of game as possible within the shortest possible space of time. This holds good especially with regard to red deer, grouse, pheasants, and rabbits. Let us begin with red deer. These are chiefly found in Scotland, where enormous areas are set aside for the purpose of rearing them. Such areas contain either no woods at all, or remnants of former forests. The object

is to procure as many stags as possible, so as to raise the shooting rent to a maximum. But the animals shot on these deer ranges are nothing like the fine beasts found in woodland areas. I remember visiting a few years ago the shooting box at Kranichstein, near Darmstadt, belonging to the Grand Duke of Hesse-Darmstadt, a nephew of our most gracious King. Kranichstein has served as a grand-ducal shooting box for many generations, and it contains a most interesting collection of stags' heads. There are rooms filled with heads of deer shot in the forests surrounding the box, and there is one room filled with heads of deer shot mostly by the Grand Duke's father during his frequent visits to Scotland. It is a most interesting sight to see the difference between the magnificent heads of deer which lived and developed in real forests, and the inferior antlers of the deer shot in Scotland. To my mind, the pleasure of stalking a king of the forest and carrying home a fine trophy is far superior to bringing home three or four heads, such as are now obtained in Scotland. If a larger proportion of the Scotch forests were once more brought under wood, we should, no doubt, improve the breed, and at the same time increase the revenue from the lands in question by the sale of timber.

The grouse, on the other hand, requires open lands, but there is room enough in Scotland, with its 9 million acres of waste land, for the rearing of grouse, even if a fair proportion of the land were afforested.

As to pheasants, it is easy to show that they can be reared, in great numbers, without interfering with the economic management of the coverts. This subject will be dealt with in Chapter III.

Rabbits, however, are a plague, which more and more endangers a rational utilisation of the soil. If a minute investigation were made into the damage done by rabbits, not only in forests but also on agricultural lands, people would be astonished at the amount. In my opinion, if the killing of large numbers of rabbits is desired by "chasseurs,"

well and good; let them establish rabbit warrens, and please themselves to their hearts' content, but let us make an effort to free, at any rate, agricultural lands from this plague, which now seriously reduces agricultural crops and demands an enormous outlay on wire-netting fences.

No doubt shooting rents give a convenient income to the proprietor. If, however, the areas are compared with the income, it will be found that the rent is not nearly so large as is sometimes assumed. I have, for years past, taken advantage of every opportunity to inquire into the matter, and I am satisfied that, all round, shooting rents fall short of a shilling an acre. There are occasional areas which give half-a-crown and even more, but there are also immense areas which give only a few pence per acre. On the other hand, much of the land, if put under forest, can be made to give a considerably higher revenue, even after allowing compound interest on all outgoings.

b. Forests and the Supply of Timber.

The home production of timber probably does not exceed 2 million tons. Over and above that, we import rather more than 10 million tons, so that only 16 per cent. of all the necessary timber are produced in the country. The increase in the annual imports between the years 1864 and 1899 amounted to $6\frac{3}{5}$ million tons, equal to an average annual increase of 190,000 tons a year. The average annual increase during the last five years amounted to 332,000 tons.

Of this timber, 87 per cent. are pine and fir.

3 ,, ,, ,, oak.

10 ,, ,, ,, teak, mahogany, and other furniture woods.

Hence, 90 per cent., or 9 million tons, are material which can be produced in this country by the afforestation of 6 or 7 million acres of land.

The timber imported in 1899 came from the following countries:

From Canada	=	1,897,000 tons.
,, Other British possessions .	=	318,000 ,,
Total from British possessions	=	2,215,000 ,,
From Russia	=	2,242,000 ,,
,, Sweden	=	2,396,000 ,,
,, Norway	=	863,000 ,,
,, France	=	825,000 ,,
,, Germany	=	403,000 ,,
,, The United States . .	=	992,000 ,,
,, Other foreign countries .	=	168,000 ,,
Total from foreign countries .	=	7,889,000 ,,
Grand total of imports . .	=	10,104,000 ,,

For these imports we paid:

To British possessions . . .	£6,687,000
,, Foreign countries	£18,990,000
Total .	£25,677,000

Some 19 million pounds went to foreign countries, except in so far as British ships brought the timber across the sea.

The 90 per cent. of timber, which could be grown in this country, represent a value of £20,623,000. But this is not all. Consider what industries, using wood as their raw material, might not spring up, if the timber were produced at home. In 1902 we imported 525,000 tons of wood pulp, for which we paid £2,398,215. Surely, if we can grow anything, we can grow timber fit for wood pulp! Then, remember the toys and games, of which we imported in 1902 to the value of £1,240,840. Again, there are imports of

	£.
Wood pulp boards . . . . value	256,903
Matches . . . . . ,,	419,099
Brooms and brushes . . . ,,	317,665
Baskets and basket ware . . ,,	262,116
Other sorts of wood, including wood ware, etc. . . . . ,,	1,320,520

If all these items are added up, we find that we now pay for imports of timber and the above-mentioned articles the sum of 27 million pounds, all of which could be produced in this country. Imagine for a moment what an amount of labour it would require to produce these articles at home, and all the time we do not know what to do with our "Unemployed." Is it not time to wake up and do something?

We have, for instruction and as an example, only to glance at the beech woods in the Chiltern Hills, whose existence caused the development of an extensive chair industry. Tens of thousands of workmen are employed in that industry, which would never have seen the light of day without those forests. The industry has now developed to such an extent that it consumes the beech and other timber from the surrounding counties, as well as large quantities imported from abroad. There can be no doubt that similar industries will spring up in other parts of the country, if we create the necessary woodlands, and thus produce the raw material.

c. Uncertainty of Future Supplies of Timber.

If we sit still and do nothing, can we rely for any length of time on getting the necessary timber, in fact, as long as we can pay for it? My reply is, "By no means."

To begin with, we are not the only importing country in Europe. As a matter of fact most European countries import, and only a few export timber. This fact is illustrated in the statement on the opposite page.

It will be observed that the following countries import timber (net): Great Britain and Ireland, Germany, France, Belgium, Denmark, Italy, Spain, Holland, Switzerland, Portugal, Bulgaria, Greece, and Servia. The exporting countries are: Roumania, Norway, Austria-Hungary, Sweden, and Russia. If we draw the balance for the whole of Europe, we find an annual deficiency of 2,620,000 tons. For a good many years past, Europe has not been able to supply, from within its own

limits, the timber required by the several nations. I may add, that the deficiency is increasing. The total annual increase in net imports of all European countries of late years amounted to 600,000 tons. If the same rate of increase

NET IMPORTS AND EXPORTS OF EUROPEAN COUNTRIES.

(*Average Data, calculated from the Returns of Five Years.*)

Country.	Imports. Tons.	Exports. Tons.
Great Britain and Ireland ...	9,290,000	
Germany	4,600,000	
France	1,230,000	
Belgium	1,020,000	
Denmark	470,000	
Italy	420,000	
Spain	210,000	
Holland	180,000	
Switzerland	170,000	
Portugal	60,000	
Bulgaria	50,000	
Greece	35,000	
Servia	15,000	
Roumania		60,000
Norway		1,040,000
Austria-Hungary		3,670,000
Sweden		4,460,000
Russia, with Finland ...		5,900,000
Total	17,750,000	15,130,000
Net imports into Europe ...	2,620,000	

lasts for another 10 years, and there is every sign of it, an additional 6 million tons a year will be required.

But it will be said, why not work the forests in the exporting countries more heavily? In reply, it must be pointed out

that *Norway* is already working her forests with a heavy deficit, by cutting more than grows annually, and this has been known for some time past. *Sweden* was hitherto considered solvent in this respect, but official information lately supplied by our representative at Stockholm, and published in a Parliamentary paper, shows that, according to the statements of the Swedish officials, the forests of that country are now being worked with an annual deficit of 106 million cubic feet. Here, then, is another of our most important sources of supply also beginning to fail us. Of the *Austria-Hungarian* exports only small quantities come to this country, because half of them go to Germany and the rest to various other countries. The exports from *Roumania* are small and do not affect the question under consideration. There remains, then, *Russia with Finland*. That country has enormous areas of forest, but it has far greater areas without it. Moreover, a large proportion of the so-called forest area does not produce timber fit for export. Russia's population and industries are rapidly increasing. Different views are taken of her capability to maintain her export of timber. My personal opinion, having weighed the evidence on both sides, is that Russia is a doubtful factor. At any rate, the authorities have already taken measures to restrict the working of the forests, for fear that, some time hence, the available out-turn of the forests might fall short of the requirements of home consumption.

It has, more than once, been said that the forests of Siberia are of sufficient extent to make good any deficiency which may occur. How erroneous such views are will be seen from the following extract from a recent report of the Russian Finance Minister. He says:—"In dealing with the settlement of immigrants in Siberia, it will be necessary to give special attention to the forests, the actual condition of which threatens Siberia with great perils in the future. Almost everywhere the forests have either been totally destroyed, or devastated by the local people, so that they have almost lost their value. Absence of supervision, and the rise in the price of

forest produce, following the construction of the railway and the development of steam navigation, are causes of the exhaustion of Siberia's forest richness. The principal causes of destruction are, however, forest fires. Year by year enormous extents of the finest pine forests are ruined by fire. In the arrondissement of Altaï one can see every year tens of thousands of acres of forest burnt, and these fires uncover the sand, which has already commenced to become moving sand. In consequence of this enormous destruction of forests, the climate of Siberia is actually deteriorating, and this is probably the cause of the famine which reigns since two years in the Altaï. For these reasons it is absolutely necessary to introduce at once a proper forest organisation into Siberia."

After such testimony by the Russian Finance Minister, Siberia may just as well be struck off the list of countries upon which those relied, who have as yet doubts regarding the coming shortness of timber supplies. Let us hope that matters are less serious in other parts of the Russian Empire.

On the whole, there can be no doubt that the pressure in Europe is increasing and is likely to continue doing so in the future. This is indicated by the course which the average price of timber has followed. From about 1870 to 1888 the price of timber fell, chiefly owing to the great development of the means of transport by sea; from 1888 to 1894 prices were steady, but in the latter year a gradual rise set in, which in 1899 amounted to 18 per cent. The South African War brought some disturbance, but in 1902 a further advance occurred, so that the total rise during the 8 years, 1894 to 1902, comes to 20 per cent. There can be no doubt that we shall never again see the low prices of 10 to 15 years ago, because the more accessible forests in European exporting countries have been heavily worked, if not exhausted, so that the timber for export has, year by year, to be carried over longer distances before it reaches the sea.

But what about the non-European countries? The following table will illustrate the position of affairs:—

NET IMPORTS AND EXPORTS OF NON-EUROPEAN COUNTRIES.

Country.	Net Imports. Tons.	Net Exports. Tons.
South America...	330,000	
Egypt	200,000	
Australasia	160,000	
Cape of Good Hope	150,000	
Natal	50,000	
China	50,000	
Mauritius	20,000	
Ceylon	10,000	
Japan	5,000	
West India, Mexico, Honduras, etc.		13,000
West Coast of Africa		28,000
India		55,000
United States of America ...		1,020,000
Dominion of Canada and Newfoundland		2,144,000
Total	975,000	3,260,000
Net export of non-European countries		2,285,000

The total net exports very nearly balance the net imports of European countries; the small difference could not be traced. It will be observed that the only exporting countries of importance are the United States of America and Canada.

Australasia has as yet large stores of timber, which consist, however, chiefly of hardwoods. A certain quantity of it is exported, but she imports so much pine and fir that a balance is shown against her.

The *United States* are working with a heavy deficit as compared with production, so that they have, in steadily increasing quantities, to draw on Canada. The gravity of

the position has been recognised, and great efforts are being made to guard against a future timber famine in that country. Instruction in forestry is being given at three universities and some forty other educational establishments; State forests are being created at a rapid rate, and even private forest lands are brought under systematic forest management. The United States have now at Washington a well organised "Bureau of Forestry" presided over by Mr. Gifford Pinchot, a wealthy American, who studied forestry chiefly in Germany, but also in France and Switzerland. He is assisted by seven gentlemen at headquarters, and some thirty field assistants. This staff is busy in gradually introducing systematic management into the State reserves and into private forests. Can we not learn something from this?

Canada has as yet great stores in her 266 million acres of real timber lands, especially of coniferous timber. If the authorities in these self-governing colonies could be induced to introduce systematic management into the more important forests, that country might for ever supply the rest of the world with the necessary coniferous timber. Some mild efforts have been made by the Governments, and even forestry societies started, but the interests of the lumber trade are very great and powerful, and in the meantime the destruction of the forests by reckless cutting and fires goes on. Let us hope that a thorough change may soon be effected.

5. Conclusions.

On the whole, then, the following conclusions seem justified:—

1. We require enormous and ever-increasing quantities of timber.
2. Prices are likely to be higher in the future than they were in the past.
3. Supplies from outside rest on a very unsafe basis.
4. An increase of the woodlands in this country, if brought

about by the afforestation of surplus land, will keep a large amount of money in the country, and lead to an increased demand for labour in the establishment and management of such woodlands, and it is likely to cause the development of additional industries which use wood as their raw material.

CHAPTER II.

MEASURES TO BE TAKEN IN THE UNITED KINGDOM.

1. Land available for Afforestation.

THE land in the United Kingdom, excluding water, is at present used as follows:

UTILISATION OF THE LAND IN THE UNITED KINGDOM.

Countries.	Area of Dry Land.	Area under Crops and Grass.	Area of Woodlands.	Mountain and Heath Land.	Other Lands.
	acres.	acres.	acres.	acres.	acres.
England. .	32,380,991	24,679,965	1,665,741	2,324,624	3,710,660
Wales . .	4,748,468	2,810,824	181,610	1,270,470	485,564
Scotland. .	19,068,958	4,897,169	878,765	9,289,378	4,003,646
Isle of Man, Jersey. .	185,453	124,650	869	29,729	30,205
Ireland . .	19,322,798	15,230,591	303,023	2,226,867	1,562,317
Total. .	75,706,668	47,743,200	3,030,008	15,141,068	9,792,392
Percentage	100	63	4	20	13

It will be observed that 63 per cent. are used for crops and grass, 4 per cent. are woodlands, 20 per cent. mountain and heath land, and 13 per cent. other lands. The latter include, in the case of Ireland, 1,124,111 acres of turf bog and 428,662 acres of marsh.

The area of woodlands, 4 per cent. of the total area, is smaller than that of any other European country except Portugal. Again, only some 67,000 acres, equal to 2¼ per cent. of the British woodlands, belong to the State, or rather the Crown, a percentage which is smaller than in the case of any other European State. In France the percentage is 12, in

Norway 12, in Austria-Hungary 12, in Sweden 27, in Germany 33, and in Russia 61. The area under forest per head of population is—

In the United Kingdom . . .	0·1 acres.
In France	0·6 ,,
In Germany	0·7 ,,
In Austria-Hungary	1·1 ,,
In Russia	5·9 ,,
In Norway	8·4 ,,
In Sweden	8·9 ,,

Considering all these matters, I believe I am justified in saying that an effort must be made to increase the area under timber in this country. Even apart from the $9\frac{3}{4}$ million acres of so-called other lands, about which it is difficult to obtain detailed information, we have over 15 million acres of mountain and heath land to select from. A large proportion of these lands are used for light grazing and as shooting grounds, but I am satisfied that their average rental value is not more than a shilling an acre. Even the best of them rarely give more than half-a-crown, while there are millions of acres in Scotland and Ireland which give only a few pence a year per acre, or nothing at all. I hope to show further on that a large proportion of these lands could be made more remunerative than they are at present, even allowing compound interest, at a reasonable rate, on all outlay.

2. Climate and Soil.

It is sometimes said that it is all very well to urge extended forestry in the United Kingdom, but that home-grown timber is of a quality inferior to that of the timber now imported from abroad. This is to a very large extent a fallacy. The late Forestry Committee had abundant evidence that we can, and do, produce timber of a quality at least equal to that imported in the case of oak, ash, and larch. As regards Scotch pine and

spruce, frequently an inferior quality has been produced, because the trees were given too much growing space, and in consequence laid on too broad annual rings. Proper sylviculture can remedy this.

On the other hand, the imported timber of nearly all species comes to us in pieces which are straighter and more free of knots than the ordinary home-grown timber. This is, again, due to faulty sylviculture in our own woodlands. Too heavy thinnings and too much growing space to the individual tree while young account for this. If we treat our forests in a more rational manner, we shall produce just as fine timber as that now imported.

As regards the climate, there is practically nothing better to be desired as far as the production of timber is concerned, however unpleasant it may be in other respects. We have, generally speaking, mild winters and cool summers. Of rain we have plenty, often too much, while snow and ice are not nearly so frequent as in other northern European countries. Unfortunately, of gales and strong winds we have more than a fair share, but, with proper management, their injurious effect upon forest growth can be considerably reduced. Let foresters commence cutting in the east and gradually proceed to the west, and the damage by gales will be only a fraction of what it is, if the reverse direction is followed. On the whole, our climate, at any rate up to the centre of Scotland, though it may not be equal to that of a great portion of France, compares favourably with that of Northern Germany, Norway, Sweden, and Northern Russia, whence we import some six million tons of timber a year.

In coming now to the question of *soil*, I may say we have it of good, bad, and indifferent quality, just as in the above mentioned countries. There is, however, one great drawback in the case of afforesting land which has been lying waste for long periods of time, as it has suffered in yield capacity, owing to continued exposure and the dissipation of all organic matter. In such cases there will be some

difficulty in the beginning, and a start must be made with species which are little exacting. When a suitable forest crop has once more been established on the areas, the producing power of the land will increase in the same degree as organic matter accumulates in the soil, and then more exacting species can be introduced as a second crop. The loss of increment in the beginning is a penalty which we shall have to pay for neglect in the past.

What we require are improved sylvicultural methods, and the late Forestry Committee pleaded, in the first instance, for improved instruction in forestry. I am happy to say that this recommendation has already borne fruit. A special forestry branch has just been added to the Royal Agricultural College at Cirencester; a similar branch is about to be added to the Kent and Sussex Agricultural College at Wye; both institutions are for the instruction of landed proprietors or their sons, or young men preparing for the position of estate managers. A forest school for woodmen has just been started by the Commissioners of Woods in the Forest of Dean. This step is likely to be of great importance. It provides for the training of a class of men, who are wanted, not only for the Crown Woods, but also by private proprietors who own a limited area of woodlands. The instructor in charge, Mr. C. O. Hanson, one of my own pupils, has made a fair start under the supervision of the Deputy Surveyor, Forest of Dean, and it is to be hoped that the school will prosper. The students, who are of the woodman class, have theoretical instruction on two days a week, and they work in the forest the remaining four days.

Instruction in forestry has for a series of years been given at the University of Edinburgh, and there is every prospect of its being considerably enlarged. Further measures in the same direction will, no doubt, follow, especially if the State authorities see their way towards helping a little more than has been done in the past. I shall presently again refer to this subject.

3. Proprietorship of the Land.

There exists one great difficulty, inasmuch as the bulk of the mountain and heath land is private property. In some cases the proprietors are not inclined to plant, and in others they are hard up, and cannot afford to meet the initial expense of planting, or forego the present small income from the land until the plantations commence to yield a return. The question thus arises, what can be done to overcome the difficulty. There are various ways of meeting the case:

1. The State may encourage afforestation by private proprietors, by providing the means of education in rational, economic forestry, and by making advances at a low rate of interest to proprietors who are short of cash.
2. The State may acquire surplus lands and afforest them.
3. Municipalities may acquire surplus lands and convert them into communal or corporation forests.

a. Private Proprietors.

All three agencies ought to be put into motion, but as matters stand we must look chiefly to the first one. As far as education in forestry goes, the State gives already small subsidies to certain establishments; but these might with advantage be increased, so that landed proprietors, their sons, and land agents may have an opportunity of becoming acquainted with the principles of economic forestry at the establishments where they go for their education—that is to say, at the principal universities and agricultural colleges. In addition, elementary schools for working foresters should be established in various parts of the country. The total expenditure under this head need not frighten the tax-payer.

It seems of the utmost importance that arrangements should be made to give advances to landed proprietors, who are willing to plant but unable to meet the initial expenses, at the rate of interest at which Government can borrow plus

a suitable addition by way of a sinking fund. Such advances should cover the actual outlay for planting, and the plantation would remain mortgaged to Government until the advance has been paid back. Let us take an example: A proprietor wishes to plant 1,000 acres at a cost of, say, £5 an acre. This would involve an outlay of £5,000, a sum which he may be unwilling, or unable to raise except at a high rate of interest. Under the plan suggested above, he would have to pay about £150 to £175 a year, which he may be able to afford. After some twenty years (and frequently sooner) the thinnings would commence, when he would be relieved of the payment to the State, and from that time forward the plantation would give him an increasing income. The State has just agreed to pay a large sum of money for the benefit of the Irish cultivators. Would it be too much to ask such a small consideration as that just indicated for another set of loyal subjects?

Then, there is the manner in which rates and taxes are assessed upon woodlands. The late Forestry Committee was of opinion that it could be improved and made more just, but it is a difficult subject, and I must refer those who are interested in the matter to the report of the committee.

Another serious matter is the question of the rates charged by railway companies for the carriage of British timber. These rates are higher than those charged on foreign timber. The Forestry Committee also dealt with this subject, and it is to be hoped that the complaints of timber merchants may be taken up at an early date. There is, however, one point to which attention must be drawn. It was given in evidence before the committee that in most cases the foreign timber was easier to handle and packed better in the trucks, so that the railway companies were bound to charge something for British timber over and above the amount charged for foreign timber. This drawback will disappear when we begin growing cleaner timber.

Finally, it should be mentioned that some county councils

have attempted to make timber merchants pay for damage done to roads on account of specially heavy traffic. Such an attempt is absolutely unfair, and, it is to be hoped, unlawful. Planted land pays rates and taxes for a long series of years during which it causes no traffic. If the proprietor, or timber merchant, which comes to the same thing, is called upon to pay extra for traffic when the crop becomes mature, he is made to pay rates twice over. The matter must be fought out, either in the law courts, or in Parliament.

b. The State as Proprietor.

It has often been urged that the State should acquire large areas of surplus lands and put them under forest. Indeed, an enthusiastic gentleman actually proposed that Parliament should vote one million pounds a year for the next hundred years, so as to purchase and afforest seven million acres of land. I do not go as far as that, but I think that the State could do something in that direction. From time to time suitable tracts of land come into the market, and there is, in my opinion, no reason why the State should not acquire such land. On the whole, however, cases of that kind are comparatively rare in England, but probably more numerous in Scotland. In Ireland the State could do something substantial in connection with the carrying into effect the latest Irish Land Act. Many of the estates, especially in the congested districts, contain large areas of waste land which are not required by the new proprietors. Such areas might be acquired by the State and converted into State forests. The price of such land would probably be less than £1 an acre. No doubt, such a procedure would be beset by difficulties, especially in the beginning. It has been said that the adjoining farmers would destroy the plantations, but the difficulty can be overcome by making it the interest of the surrounding population to preserve the woods. The forests will provide additional work, and by and by tend to create

various local industries, all of which will, I feel sure, make the people the friends of the forests, and not their enemies.

c. Municipalities as Proprietors.

What I am now about to place before the reader will, no doubt, remind him of the controversy regarding municipal trading. Whatever the ultimate result of that controversy may be, I hope that an exception may be made in the case of municipal forests. I need scarcely remind you that the City of London already possesses such a forest, the Epping Forest, so that the ice is really broken. That forest is, no doubt, managed with a view to its serving as a recreation ground for the inhabitants of London, and not for economic reasons. I do not know how the finances of the forest stand, but from what I have seen during various visits to the forest, I am certain that it could continue to serve its present purpose, and yet yield a revenue, provided excessive sentimentality were somewhat curbed.

There is, however, another matter which, year by year, is becoming of greater importance to all our large towns, and that is the question of the "Unemployed." It is well known how serious the matter becomes every winter, how special efforts are made to deal with it, and yet how much remains to be done. I maintain that afforestation offers one of the means of solving the question. The bulk of forest work can be done at those times of the year when the question of the unemployed is most pressing, that is, in winter. Now I ask, why should the great City of London, yea one or other of the City Companies, not buy a few tracts of mountain land, where forest work could be given to the unemployed during winter? It is true that extensive tracts of surplus land cannot be found in the immediate vicinity of London, but railway communication is so complete that a moderate distance does not make much difference. I have gone over the agricultural returns and picked out the following information as bearing specially on the question under consideration, and showing that there is

plenty of land to choose from for all the large towns in England and Wales:—

Mountain and Heath Lands in England and Wales.

		Acres.	Acres.
In the county of Surrey	=	13,136	
,, ,, ,, Kent	=	6,636	= 36,502
,, ,, ,, Sussex	=	16,730	
,, ,, ,, Suffolk	=	30,732	
,, ,, ,, Norfolk	=	44,101	= 74,833
,, ,, ,, Yorkshire			= 546,388
,, ,, ,, Northumberland	=	471,303	
,, ,, ,, Cumberland	=	262,859	
,, ,, ,, Durham	=	53,874	= 996,868
,, ,, ,, Westmorland	=	208,832	
,, ,, ,, Devonshire	=	160,188	
,, ,, ,, Cornwall	=	56,715	
,, ,, ,, Somerset	=	51,031	= 295,260
,, ,, ,, Dorset	=	27,326	
In other English counties			= 374,773
Total in England			= 2,324,624
In Wales			= 1,270,470

I do not ask London, or any of the other large towns, to launch out upon a big scheme at once, but I fail to see why an experiment should not be made on a moderate scale. Let us take Surrey, Kent, and Sussex. Out of the 36,502 acres of mountain and heath land a few thousand acres might be acquired. On this area I should start planting on a small scale under an efficient superintendent, so as to train a small establishment to the work. The men so trained would subsequently act as foremen. When pressure comes in winter-time in London, the unemployed would be sent to the estate and

employed in preparing the land for planting, by draining, fencing, and digging planting holes, on such a scale that sufficient work is provided for the men, until hard times pass, and they can return to their ordinary occupation, a certain number perhaps being retained to do the actual planting. Towards spring the staff of workmen would be reduced to its permanent strength, which would be busy with nursery work during spring, summer and autumn.

A certain outlay for housing would, of course, have to be incurred, but the work done on these plantations would lead to some tangible results, and not to waste, as is so often the case with relief works.

If the experiment turns out a success, and with proper arrangements it should do so, further land might be acquired in the above-mentioned three counties, or in Suffolk and Norfolk, or even further north.

In many cases, operations of this class may be combined with the utilisation of catchment areas for waterworks. The Corporation of Liverpool has extensive gathering grounds at Vyrnwy in North Wales, where plantations have already been commenced. Here a fine example of utilising mountain lands can, and it is hoped will, be given, which I trust will be imitated by other corporations. In spite of much discussion as to the advisability of afforesting gathering grounds, there can be no doubt that it is the best means of keeping the water pure and of regulating its flow, a fact which will be affirmed by those who have enquired into the magnificent works carried out by the town of Verviers in Belgium. Its gathering ground on the banks of the river Gileppe is entirely under forest, and with the most satisfactory results.

If London and other large cities embarked on an enterprise like that sketched by me, a considerable area might gradually be brought under forest; it would help to overcome the difficulty of the unemployed, and add considerably to the quantity of timber produced in the country. Moreover, it

would lessen the emigration from the country into the large cities. This emigration has gradually developed, until it has become a calamity ; it can only be cured gradually by providing more work in the country.

4. The Labour Question Generally.

And this brings me to the labour question generally. If afforestation were undertaken on a large scale, there is no reason why five or six million acres should not gradually be brought under wood, thus producing the bulk of the ordinary timber required by the country. Every acre afforested would require an expenditure on labour of, say, £2 for planting. After the forests have been established, every acre would require about five days labour a year, or a total of thirty million days for the work in the forests. Then there is the large business of transport and working up the timber, as well as the various industries which would spring up. On the whole, I estimate that not less than a population of two and a half million people would find additional work in the country, counting five members for each family.

There is yet another point of great importance. I have already indicated that most forest work can be done in winter, when agricultural work is slack ; hence, the two kinds of work can be made to fit in with each other, and thus make available more labour for agriculture during summer. This would be an inestimable benefit for agriculture, which is at present so short of labourers.

Nor must we overlook the beneficial effect which work in the open country would have upon the physical condition of the people. We have heard a good deal of late about physical deterioration. Surely, a measure which enables a larger proportion of the nation to live under the healthy conditions of a country life must be welcomed by, and commend itself to, all who would wish to improve the physical condition of the people.

5. Conclusion.

It is not a fanciful problem which I have endeavoured to indicate, but a scheme which is realisable if we really put our shoulders to the wheel. Let us hope that the matter will not be pushed aside with a light heart by those who can help to realise it.

For a period of eighteen years I have urged the subject upon public attention, and a slight movement to take it up is now on foot. May that movement increase in vigour, so that at last something substantial is done, which, I have no doubt, will prove a lasting benefit to the United Kingdom and its people.

A few weeks ago the subject was before the House of Commons in connection with the question of the Unemployed. Only a few days ago it came before the House of Lords, when the Earl of Onslow spoke in a very sympathetic manner. He announced "that the Treasury had promised assistance in the foundation of at least two forest schools in England, one for the instruction of young men who were likely to become land-owners or land agents, and the other for woodmen. The former he should prefer to see attached to one of the great Universities. There was a strong feeling in the country that we should not be behind foreign nations in our knowledge of woodcraft, and that our resources ought to be made more use of. This method of utilising the soil his Department was most anxious to encourage, and by the training of young men of both classes in the science of forestry they believed that by making a small beginning now, they might be enabled to lead up in the course of years to great results. The time might come, therefore, when this country would be able far more than at present or in the past to rely upon its own resources for the production of forest timber."

These are comforting words to me, after having struggled for many years against adverse conditions.

CHAPTER III.

THE AFFORESTATION OF SURPLUS LAND, AND NOTES ON THE TREATMENT OF SOME TYPES OF BRITISH WOODLANDS.

The treatment of forests depends on the objects which it is proposed to realise. It rests with the proprietor, in so far as his choice is not limited by the laws of the country, to determine in each case what these objects shall be, and then it becomes the duty of the forester to see that they are realised to the fullest extent and in the most economic manner. This fundamental principle should never be lost sight of. In these islands nearly the whole of the existing woodlands belong to private proprietors. They desire, in the majority of cases, to have the woods so managed that they lend themselves either to landscape beauty, or the rearing of game, or the production of a particular kind of produce required in the management of estates. In such cases economic working is beset by considerable difficulties. And yet, even under such conditions, the objects of the proprietors may be realised, and the woods be made to yield, if not a full, at any rate a fair return, while the proprietor must put down any deficiency in the income against his pleasure, or against shooting rents, or the benefits derived by the rest of the estate.

Where the manager is not hampered in this way, and where economic forestry is aimed at, as it would generally be in the case of extended afforestation of mountain, heath and other waste lands, the question of finance would be of the first importance. The forester must decide what and how to plant, and how to treat his woods, so as to realise the highest possible net returns. The answers to these and other questions practically require a treatise on sylviculture and forest

management, for which I must refer the reader to my "Manual of Forestry," especially Volumes II. and III. On this occasion I can offer only short remarks on the afforestation of mountain, heath and other waste lands, and on a few selected types of woods as they now exist in the country.

1. Soil and the Selection of Species.

Many varieties and qualities of soil are found on the mountain and heath lands; hence the selection of the proper species to plant, in the first instance, is of the highest importance. No general rule can be laid down, and the selection must be made on the spot in each case. There is, however, a fundamental rule which runs thus: "*Never attempt to plant a species which is not thoroughly suited to the locality, in other words, which is not likely to thrive in it.*"

Every disregard of this rule is likely to lead to financial loss. It is quite astonishing how often the rule is sinned against. Sometimes the planter has not a sufficient understanding of what species is most likely to thrive best in a given case. This shortcoming must be met by proper instruction. In other cases the planter has developed a fancy for a certain species, and proceeds to plant it under all conditions. This is a most disastrous failing, which the forester must combat with all his might. The subject of selection must be approached with an open mind, and all personal fancies must absolutely be put on one side.

Different species make different demands on the locality, not only as regards the chemical, but also, and chiefly so, the physical conditions of the soil. Hence, foresters divide the species according to their demands on the fertility of the soil. Some species, such as sycamore, ash, oak and elm, to do really well, require a fertile soil; others, such as chestnut, beech and silver fir, are somewhat less exacting; next come Norway maple, lime, alder, larch and spruce; less exacting again are willow, poplars, birch, Weymouth, Scotch and Austrian pine. As a general proposition it may be said, that

heavy soils are better adapted for broad-leaved species, and lighter soils for conifers. There are, however, exceptions; spruce, for instance, does well on heavy soils. A medium class of soils, called loam, practically suits all species; in the same degree as the soil becomes heavier, broad-leaved species should prevail, and *vice versâ*. The final selection of the right species is a difficult task, and the subject must be studied in detail.

Amongst the mountain and heath land of this country areas are, no doubt, found, which can at once be planted with the more exacting species, but as the greater part of it has deteriorated in consequence of long exposure, it will, in the majority of cases, be advisable to let the first crop be a non-exacting conifer, such as Scotch, Weymouth and Corsican pine, and, in suitable localities, larch. These species will gradually improve the land, so that they can be followed by more exacting species.

2. Pure Woods or Mixed Woods?*

The question whether to grow woods consisting of one species only, or woods containing two or more species intermixed, presents itself to every proprietor and forester in this country. Taste, as well as considerations based on economic grounds, differ much on this subject, and it seems worth while enquiring in which cases and under what conditions the one or other class of wood is indicated.

As to the question of taste, it is impossible to evolve any rule. Some proprietors prefer pure, others mixed woods. If we ask Nature, the answer no doubt will be, that in by far the majority of cases mixed woods are the rule, though the species may be arranged in groups of greater or smaller extent, according to the character of the locality, and the requirements of the several species. Many people think, that the old woods here and there found in this country are natural woods, but

* See pages 68 to 88 of "Schlich's Manual of Forestry," Vol. II., third edition.

there can be no doubt that many of them are nothing of the kind. Indeed, there is, perhaps, not a single wood in England which does not owe its present condition to interference by the act of man, not even the so-called natural woods in the New Forest and in Epping Forest, about which so much has been written. As they appear to us now, they are the result, if not of actual sowing or planting, of the cutting-out of certain species which Nature had introduced, of coppicing, pollarding, and other violent interference, not to omit the effects of cattle-grazing and fire.

Proceeding now to the economic aspect of the matter under consideration, the case may shortly be stated thus:—The object in view should be to manage woodlands so as to secure, *permanently*, the best possible results, whether measured by quantity and quality of produce, or by net cash receipts, or the interest which the invested capital yields. Stress is laid on the word "permanently." No doubt a proprietor can, for a certain period of time, realise large returns from his woods; but in doing so he may seriously injure the future yield-capacity of the land. Returns are legitimate only if by their realisation the property is not reduced in value, as measured by its yield-capacity. On thoroughly fertile soil, and under a favourable climate, the danger is, perhaps, not great; but where such conditions do not exist, and this occurs in the majority of cases, at any rate so far as the soil is concerned, woodlands should be stocked with such species, and treated in such a manner that the yield-capacity of the locality is not reduced. On the contrary, it should in many cases be improved. And thus we arrive at the question whether pure or mixed woods are indicated, and in the latter case, how they should be arranged.

The beneficial effects of a full crop of trees upon the soil are brought about chiefly by the following two agencies:—

(1.) The trees form a dense leaf-canopy, which protects the soil against the effects of the sun and air currents.

(2.) The fallen leaves, and certain plants which grow in the shade of trees, such as mosses, form a layer of humus, which covers the mineral soil, and produces a suitable proportion of organic matter.

These two agencies secure to the soil fertility, and above all, a permanent supply of moisture, without which no crop of trees can thoroughly flourish. Whenever the above two conditions are fully secured, the yield-capacity of the soil is maintained, and in many cases improved. Hence, the answer to the question before us runs thus:—

"*Only trees which have a fairly full foliage, and preserve a good leaf-canopy to an advanced age, are fit to be raised in pure woods. Species which do not possess these qualities should be mixed with trees of the former kind.*"

Accordingly, foresters arrange the trees grown for economic purposes into two classes. To the first class of trees fit to be grown in pure woods belong the beech, hornbeam, silver fir, spruce, and in a less degree sycamore, Weymouth pine, and Douglas fir. To the second class of trees belong larch, birch, poplar, ash, oak, and sweet chestnut. Half-way between the two classes stand Scotch, Austrian, and Corsican pine, inasmuch as they benefit the soil up to a certain age, say to forty or fifty years, after which they begin to thin out and join the second class. As a rule, the trees of the first class are shade-bearing, whereas those of the second are light-demanding, in addition to being thin-crowned. It so happens, however, that the second class comprises the most valuable timber trees, more particularly oak, ash, and larch; hence, mixed woods in which these species form a prominent feature, are indicated in Britain, in preference to pure woods.

The next question is, how should such mixtures be arranged? Unfortunately no rational answer has been given to it by many British foresters during the last two generations. Instead of following the good old plan and the ordinary laws of nature, as exhibited by older woodlands, modern foresters conceived the idea of cramming together on the same area about as

many species as they could think of. Light-demanding and shade-bearing, quick-growing and slow-growing, spreading and conically-shaped, tender and hardy, conifers and hardwood, have been mixed together anyhow, without any reference to the habits and requirements of the several species in mixture. The natural consequence has been, that the more aggressive species, especially conifers, such as larch, Scotch pine, and spruce, took the lead, and, being frequently unchecked by the hand of the forester, ousted the better kinds of hardwood, and more particularly the oak. Only too many plantations of this kind can be seen in the south of England, as well as in the Midland counties, where the trees, which were originally meant to serve as nurses for valuable hardwoods, have actually killed the latter, or crippled them to such an extent that they have become useless. "The nurse has devoured the baby." It is indeed time that we return to more simple methods, that is to say, to mix only species which are in every way suited to each other, and to mix and treat them so that each has a chance of fulfilling the object for which it is reared.

If one species is merely to serve as a nurse for the other, the former must be cut out just at the moment when the welfare of the permanent species demands it. This rule is simple enough; but there is another point to which special attention must be drawn—namely, the permanent species must be sufficiently numerous to form a full crop when the nurses have been removed. Many instances can be seen where the former only represents from 10 to 15 per cent. of the total number of plants, whereas the nurses amount to 85 or 90 per cent. What is the result? When the nurses are cut out, there remains a thin, straggling crop of hardwoods, not sufficient to make a wood by themselves, and they are generally cut away with the nurses, to make room for a new crop. Such a procedure is without sense, and involves useless expenditure. In these mixtures, the principal species should represent not less than half the crop from the commencement.

The arrangement of more permanent mixtures requires still more care, since it depends on the relative height growth, the light requirement, and shape of the species in mixtures. Hence, it is of the utmost importance to restrict mixtures to as few species as possible. Pure woods are easier to manage than mixed woods; mixtures of two easier than mixtures of three or more. It is far better to mix two species on half the area, and two others on the second half, than to mix four species over the whole area.

In summing up, we arrive at the following simple rules:—

(1.) Only species which are capable of preserving the yield-capacity of the locality may be raised in pure woods.

(2.) In the case of mixed woods, at any rate one of the species in mixture must be soil-improving, and it should be more numerous than the others.

(3.) As a rule, not more than two, and certainly not more than three, species should be mixed on the same area, unless each species is placed into separate groups, representing a series of small pure woods.

(4.) Shade-bearing species may be mixed with each other, provided their rate of height growth is the same, or the slower-growing can be effectually protected against the other, either by giving it a start, or cutting away the threatening individuals of the faster growing species.

(5.) Shade-bearing and light-demanding species may be mixed, if the latter are faster growing, or given a start.

(6.) Light-demanding species should not be mixed with each other, except under exceptional conditions, such as the following:—

(*a*) In very fertile localities.

(*b*) In very inferior localities where nothing else will grow.

(*c*) If the mixture is a temporary one, as in the case of nurses grown to protect a tender species during early youth; or if the wood is treated under a very short rotation, as, for instance, where only pit timber is grown.

(7.) Whether the mixture should be arranged by single trees,

in alternate lines, or whether each species is to form separate groups, depends on circumstances, especially the relative height growth, and the shapes of the species in mixture. Where these differ, groups are indicated, a system which has of late years much grown in favour with foresters. At any rate, the species should be placed into alternate lines, so that one can be protected against the other.

3. The Density of Forest Crops.*

In the previous section special attention has been drawn to the necessity of growing a forest crop so that the fertility of the soil is preserved, if not increased, and that the most valuable class of timber is produced. The question may therefore be asked, "What is the proper density of a forest crop?" or to put it differently, "What is the most suitable growing space to be given to each tree?"

The theory of the case is simple enough, and it runs as follows:—"*The density of a forest crop should be such that the objects which the proprietor has in view are most fully realised.*" Hence, if the object is to produce landscape beauty, it is in some cases desirable to give to each individual tree sufficient space to grow and spread in a natural way, while in others a group of massed trees may be desirable; no special law can be laid down in this case.

When trees are grown for economic purposes, matters are different. Here a balance must be struck between the preservation of the fertility of the soil and the production of high-class timber. For the former purpose it is best to keep the crop as dense as possible from start to finish; but such a procedure may seriously interfere with the second object, and it may involve heavy additional expenditure at starting.

In the case of natural regeneration, successfully carried through, as many as 50,000 or 100,000 seedlings may be found on an acre, and these are, after a comparatively short space of

* See "Manual of Forestry," Vol. II., third edition, pages 119, 174, and 289.

time, reduced to a limited number, the strongest taking the lead, and suppressing the others. In this case, ordinarily no extra expenditure is incurred, and the bountiful regeneration provided by Nature causes the surviving plants to be pushed up by their less-favoured companions, which are destined to die an early death. Similar effects may be produced by sowing large quantities of seed to the acre, but this causes additional expenditure. The latter is further increased if dense planting is attempted; and it is a question for serious consideration, up to what extent dense planting is financially justified.

The question can be answered only through statistical data based upon numerous measurements and countings. Such data are not available in this country; hence we must have recourse to those collected in Germany and France, especially in the former country. Investigations have been going on now for a considerable number of years, so that we have data based upon many thousands of measurements. I have compared them with measurements made by me in this country, and I am of opinion, that, on *average* land, the following are the most suitable numbers of trees at various ages, *whenever the production of clean timber is aimed at.*

NUMBER OF TREES, PER ACRE.

Age of Wood.	Spruce.	Beech.	Oak.	Scotch Pine.
40	1,100	950	850	750
50	700	600	550	500
60	500	420	370	400
70	400	320	270	300
80	300	250	220	250
90	260	200	180	200
100	220	180	140	170
110	200	170	120	150
120	190	160	100	140

The numbers in the above table refer only to soil of average quality. On first class soil the numbers are smaller, and on inferior soil, larger. Figures for larch are not available at present, as, owing to the larch disease, that species is

in Germany now-a-days grown only in mixture with other species, especially beech. In the meantime, the figures given for Scotch pine apply, approximately, also to larch.

The matter, then, stands thus: We require at the age of 40 years the above-mentioned numbers of clean stems, and the question is, how many plants should be put in, to produce them, and at the same time shelter the ground sufficiently. Here several matters must be considered. *Spruce*, though at first somewhat slow, does not develop very strong side branches, while the early thinnings are practically of no value, except where Christmas trees are saleable; hence 2,700 plants (4 ft. × 4 ft.) are sufficient to produce 1,100 clean stems at the age of 40, provided the thinnings are done sparingly up to that age. The same holds good for *Douglas fir* and even *ash*. Closer planting increases the cost considerably, and does not lead to appreciably better results. For *larch* a planting distance of 4 ft. × 4 ft. is quite sufficient, and the thinnings can be fairly heavy, even below the age of 40 years, because that tree wants a good deal of growing space, without developing strong side branches. *Beech* requires somewhat more pushing, and 4,000 plants to the acre are indicated, when that tree is not regenerated naturally or by sowing the beech nuts in situ. *Oak* and *Scotch Pine* have a tendency to develop strong side branches; hence they must be kept dense during youth; not less than 4,000 plants to the acre are required, and thinnings must be very sparingly carried out up to the age of 35 or 40 years. In order to reduce the expenditure, the best plan is to sow the seed of both species in situ, or, if this is not possible, to plant one or two years old seedlings. In the case of oak, there should be 8,000 one year old seedlings to the acre, and they can be planted with a planting peg or the vertical notching spade. (See figures 65, 70 and 71, at pages 215 and 217 of Volume II. of my Manual, third edition.) I am of opinion that most, if not all, of the old oaks (say more than a hundred years old) in this country have been raised either from naturally fallen acorns, or from acorns sown in

situ. This is, without doubt, the best way of starting oak woods, but where the acorns are likely to suffer severely from mice, the next best thing is to plant one year old seedlings. Such plants invariably develop better leaders than plants put out when three or more years old. *Corsican* and *Austrian pines* may be treated as Scotch pine. Of *Weymouth pine* not more than 2,700 to 3,000 plants need be put to the acre.

The above remarks refer to the rearing of fine timber trees. Where only poles or pit timber are grown, the thinnings before the age of 40 are somewhat heavier, so as to produce a certain diameter at an earlier age than is the case when working for timber trees with clean boles.

4. Yield and Financial Results.

In attempting to answer the question, what will be the yield and financial results produced by afforesting mountain and heath lands in this country, we meet with great difficulties. The most natural way would be to inquire what the results of forestry on similar lands have been in the past. That attempt would lead to disappointment, because, in the first place, it is almost impossible at present to obtain in this country data which would conclusively show what yield to expect, and, secondly, the few data available as to receipts and expenses are almost invariably rendered useless by the fact that many items are included under expenses which have little or nothing to do with forestry by itself. Again, I have no hesitation in saying, that the returns hitherto yielded by British woodlands might in many, if not in most, cases be doubled by following the rules of rational sylviculture and by systematic management. An example will best illustrate this:

There is probably no country in the world which has such complete records of the past management of woods as the

kingdom of Saxony. That country possesses 428,000 acres of State forests, which occupy good, bad, and indifferent land, less of the first and more of the others. The forests are chiefly found in the hills, where they go up to 3,000 feet above sea level. The systematic management of the forests was commenced rather more than 100 years ago, and authentic records are available from the year 1817 up to the present. They show that the outturn in 1817 was 61 cubic feet of wood (timber and firewood) per acre, and 92 cubic feet in 1893, representing an increase of 50 per cent. The average stock per acre standing in the forests rose from 2,173 cubic feet in 1844 to 2,658 cubic feet in 1893, or an increase of 22 per cent. This shows that the forests were worked in a conservative manner. The net returns, after paying for all possible items of expenditure, were as follows:

		s.	
During the period	1817—26 =	4	per acre and year.
,, ,, ,,	1827—36 =	4·2	,, ,, ,, ,,
,, ,, ,,	1837—46 =	4·7	,, ,, ,, ,,
,, ,, ,,	1847—56 =	6·3	,, ,, ,, ,,
,, ,, ,,	1857—63 =	10·0	,, ,, ,, ,,
,, ,, ,,	1864—73 =	14·8	,, ,, ,, ,,
,, ,, ,,	1874—83 =	17·5	,, ,, ,, ,,
,, ,, ,,	1884—93 =	18·5	,, ,, ,, ,,
In the year . .	1900 =	22·5	,, ,, ,, ,,

This represents an increase of 463 per cent. in the net receipts per acre. No doubt the price of wood also rose, from 2·1 pence in 1817 to 4·5 pence in 1900, equal to an increase of 114 per cent., or about one-fourth of the increase of the net receipts, which is thus due chiefly to improved management. These are data referring to the whole of the Saxon State forests, and not to any case specially picked out. There are forests in the Saxon hills which give double the above-mentioned net revenue, growing on land which is not worth

five shillings for agricultural purposes. The bulk of the Saxon State forests are stocked with spruce, a species at present so much despised in this country. Surely similar results would be obtained in this country if we managed our woodlands as carefully as is the case in Saxony!

After this digression we must return to the subject under consideration. I have before me tables showing the yield of forests in Germany, based upon thousands of measurements, and referring to various species, such as beech, Scotch pine, spruce, and silver fir; also provisional tables for oak, larch, and other trees. I have also on numerous occasions measured British woods, and compared the results with those given in the tables. In this manner I have estimated the yield which may be expected from British woodlands if treated systematically and according to correct sylvicultural methods. That yield depends, of course, on the particular class of timber which it is proposed to grow and on the method of treatment, but it would lead too far to give here all possible cases. Hence, I have selected the simple method of high forest as applied to larch, ash, Scotch pine, spruce, beech, and oak, and determined the returns which they are likely to give if planted on *average* forest land.

I have assumed that timber of some size is wanted, and that the woods are finally cut over:

In the case of	larch	at the age of		70	years.
,,	ash	,,	,,	70	,,
,,	Scotch pine	,,		80	,,
,,	spruce	,,		90	,,
,,	beech	,,		120	,,
,,	oak	,,		130	,,

These rotations are about the most profitable in the case of high forest. As firewood is at present of little value, I have left it altogether out of the account.

The following returns may safely be counted on:

Returns of one Acre of Larch Wood.

Thinning at the age of			Shillings Net in forest.
20 years =	20 cubic feet quarter girth measurement at	6*d.* =	10
Ditto, 30 ,, =	130 ditto	7*d.* =	76
Ditto, 40 ,, =	330 ditto	8*d.* =	220
Ditto, 50 ,, =	360 ditto	9*d.* =	270
Ditto, 60 ,, =	360 ditto	10*d.* =	300
Final yield, 70 ,, =	3,900 ditto	1*s.* =	3,900

Returns of one Acre of Ash Wood.

Thinning at the age of				Shillings.
30 years =	60 cubic feet at	10*d.* =		50
Ditto, 40 ,, =	150 ,, ,,	1*s.* 0*d.* =		150
Ditto, 50 ,, =	220 ,, ,,	1*s.* 2*d.* =		257
Ditto, 60 ,, =	270 ,, ,,	1*s.* 4*d.* =		360
Final yield, 70 ,, =	2,100 ,, ,,	1*s.* 6*d.* =		3,150

Returns of one Acre of Scotch Pine Wood.

Thinning at the age of				Shillings.
30 years =	40 cubic feet at	3*d.* =		10
Ditto, 40 ,, =	150 ,, ,,	4*d.* =		50
Ditto, 50 ,, =	330 ,, ,,	5*d.* =		137
Ditto, 60 ,, =	380 ,, ,,	6*d.* =		190
Ditto, 70 ,, =	400 ,, ,,	7*d.* =		233
Final yield, 80 ,, =	4,300 ,, ,,	8*d.* =		2,866

Returns of one Acre of Spruce Wood.

Thinning at the age of				Shillings.
40 years =	40 cubic feet at	3*d.* =		10
Ditto, 50 ,, =	160 ,, ,,	4*d.* =		53
Ditto, 60 ,, =	300 ,, ,,	5*d.* =		125
Ditto, 70 ,, =	400 ,, ,,	6*d.* =		200
Ditto, 80 ,, =	400 ,, ,,	7*d.* =		233
Final yield, 90 ,, =	6,300 ,, ,,	8*d.* =		4,200

Returns of one Acre of Beech Wood.

Thinning at the age of							Shillings.
	40 years	=	50 cubic feet at		6*d.*	=	25
Ditto,	50 ,,	=	100 ,,	,,	7*d.*	=	58
Ditto,	60 ,,	=	280 ,,	,,	8*d.*	=	187
Ditto,	70 ,,	=	350 ,,	,,	9*d.*	=	262
Ditto,	80 ,,	=	400 ,,	,,	10*d.*	=	333
Ditto,	90 ,,	=	460 ,,	,,	11*d.*	=	422
Ditto,	100 ,,	=	560 ,,	,,	1*s.*	=	560
Ditto,	110 ,,	=	600 ,,	,,	1*s.*	=	600
Ditto,	120 ,,	=	4,000 ,,	,,	1*s.*	=	4,000

Returns of one Acre of Oak Wood.

Thinning at the age of							Shillings.
	40 years	=	60 cubic feet at		9*d.*	=	45
Ditto,	50 ,,	=	150 ,,	,,	10*d.*	=	125
Ditto,	60 ,,	=	200 ,,	,,	11*d.*	=	192
Ditto,	70 ,,	=	230 ,,	,,	1*s.* 0*d.*	=	230
Ditto,	80 ,,	=	240 ,,	,,	1*s.* 1*d.*	=	260
Ditto,	90 ,,	=	250 ,,	,,	1*s.* 2*d.*	=	292
Ditto,	100 ,,	=	260 ,,	,,	1*s.* 3*d.*	=	325
Ditto,	110 ,,	=	270 ,,	,,	1*s.* 4*d.*	=	360
Ditto,	120 ,,	=	270 ,,	,,	1*s.* 5*d.*	=	381
Final yield,	130 ,,	=	4,070 ,,	,,	1*s.* 6*d.*	=	6,105

These data must be considered as very moderate in amount. More especially the early thinnings are likely to yield more than I have estimated. However, my object was to keep on the safe side, and to introduce into the amount the *minima* of returns which may be expected from average land.

I must next deal with the expenses. They are the cost of planting, looking after the plantations, rates and taxes, etc. These items must be estimated on the supposition that a considerable area is planted, say 1,000 acres. I have raised my own plants during the last sixteen years, planted during the same period some 2,000 acres under varying conditions, and

found that the planting of mountain and heath land, including the cost of the plants, can, on an average, be done at the following rates:

	£	s.	d.
Planting an acre with spruce for .	3	10	0
,, ,, ,, ,, Scotch pine ,, .	4	0	0
,, ,, ,, ,, larch . ,, .	4	10	0
,, ,, ,, ,, beech . ,, .	5	0	0
,, ,, ,, ,, ash . ,, .	6	0	0
,, ,, ,, ,, oak . ,, .	6	0	0

The cost of looking after the plantations, including rates and taxes, may be put down at 4*s.* an acre per year all round, up to the time when the crop is cut over. Rates and taxes on mountain and heath land, such as is here under consideration, cannot be high, since its letting value is small. I have shown above that the average return from such land cannot be placed at more than 1*s.* an acre all round. Not all the 15 million acres of such land are suitable for successful afforestation; but I may safely say that the suitable part of the land cannot be placed at a higher rental than half-a-crown an acre. At 32 years' purchase such land would fetch £4 an acre. If regular fencing is wanted extra expenditure would be necessary, but on the other hand the plantations would yield an annual shooting rent, and I have placed one against the other by leaving both out of the amount.

And here I may draw attention to the fact that in operations on a fairly large scale fencing is not nearly so expensive as is sometimes supposed. Assuming that

	£	s.	d.	
To fence 1 acre costs . . .	9	0	0	
,, 4 acres in one block costs .	4	10	0	an acre.
,, 16 ,, ,, ,, .	2	5	0	,,
,, 64 ,, ,, ,, .	1	2	6	,,
,, 256 ,, ,, ,, .	0	11	3	,,

and so on.

To fence small areas here and there, where a considerable extent of land in large blocks is available, means to waste a great deal of money.

Basing the calculation on the data given above, it will be found that a proprietor will get *compound interest* on his outlay at the following rates:—

Value of Land.	Per cent. in case the land is planted with—					
	Larch.	Ash.	Scotch Pine.	Spruce.	Beech.	Oak.
£						
1	5·2	4·6	3·9	3·7	3·3	3·3
2	5·1	4·5	3·8	3·6	3·2	3·2
4	4·8	4·2	3·5	3·4	3·0	3·0
6	4·5	4·0	3·3	3·2	2·9	2·9
8	4·3	3·8	3·2	3·1	2·8	2·8
10	4·1	3·6	3·0	3·0	2·6	2·6
15	3·7	3·3	2·8	2·7	2·4	2·4
20	3·4	3·0	2·6	2·5	2·2	2·2
25	3·2	2·8	2·4	2·3	2·0	2·0
30	3·0	2·6	2·1	2·1	1·8	1·8
35	2·8	2·4				
40	2·6	2·2				
45	2·5	2·1				
50	2·4	1·9				

It has been said in public, "that no British landowner will invest money in forestry unless he is assured 4 per cent. on his money." But, I ask, is this reasonable? What other investment of equal security gives 4 per cent. in these days? Does agriculture proper give 4 per cent.? Why should forestry be expected to give a higher per cent. than agriculture? Take for a moment the case of British consols; they give, nominally, $2\frac{1}{2}$ per cent., but look at the ups and downs which they undergo! A few years ago they stood at 112, a few days ago they were quoted at $85\frac{1}{2}$, a

fall of £26 10*s.* on every hundred, *representing more than ten years' interest.* Imagine what they would fall to, if we were to be involved in another big war, say in connection with the trouble in the Far East! Such fluctuations do not occur in systematic forestry. Once that industry has been established in an orderly manner, it yields a steady income year after year, and the capital is safe from anything like the fluctuations to which consols are subject. In my opinion, forestry conducted on proper lines offers an investment at least as safe as consols, and it seems to me unreasonable to expect more than 2½ per cent. from it. There are millions of acres in these islands fit for planting, which are valued at such a low rate that they can be made, if put under forest, to yield steadily a good deal more than 2½ per cent. At the same time I must lay stress on the fact that all forest operations must be conducted in a truly economic manner. Extravagance has no place in forestry, or in agriculture either.

The above table shows that under the given conditions it pays, as compared with consols, to grow:—

Larch, if soil of average yield capacity does not cost more than	. . .	£45
Ash,	ditto, . . .	32
Scotch pine,	ditto, . . .	22
Spruce,	ditto, . . .	20
Beech,	ditto, . . .	12
Oak,	ditto, . . .	12

For ordinary mountain and heath land, valued at £4 an acre, the money invested in forestry would yield compound interest in the case of:—

Larch	= 4·8 per cent.
Ash	= 4·2 ,, ,,
Scotch pine	= 3·5 ,, ,,
Spruce	= 3·4 ,, ,,
Beech and oak	= 3·0 ,, ,,

It will be observed, that it pays to grow on such land larch, ash (if the soil is otherwise suitable), Scotch pine and even spruce. As regards beech and oak the margin is small; hence I shall give some further information regarding oak. Supposing we grow oak on land of the first yield capacity: in that case the following returns may be expected:—

Thinning at the age of					Shillings.
30 years	=	70 cubic feet	at	8*d.* =	47
Ditto, 40 ,,	=	200 ,, ,,		9*d.* =	150
Ditto, 50 ,,	=	250 ,, ,,		10*d.* =	208
Ditto, 60 ,,	=	300 ,, ,,		11*d.* =	275
Ditto, 70 ,,	=	320 ,, ,,		1*s.* 0*d.* =	320
Ditto, 80 ,,	=	330 ,, ,,		1*s.* 1*d.* =	357
Ditto, 90 ,,	=	330 ,, ,,		1*s.* 2*d.* =	385
Ditto, 100 ,,	=	330 ,, ,,		1*s.* 3*d.* =	412
Ditto, 110 ,,	=	330 ,, ,,		1*s.* 4*d.* =	440
Ditto, 120 ,,	=	330 ,, ,,		1*s.* 5*d.* =	467
Final yield=130 ,,	=	6,400 ,, ,,		1*s.* 6*d.* =	9,600

If we make the calculations as before we obtain the following results:—

Value of Land. £	Per cent.
5	3·5
10	3·2
15	2·9
20	2·7
25	2·6
30	2·5

This shows that it pays to grow oak on really good land valued up to £30 an acre (on average land up to £12). In other words, land of good quality which lets for more than 15*s.* net an acre if used for agriculture, will lead to loss if put under oak.

Before I leave this subject, it will be as well if I show the financial results in case not large timber but only poles are

wanted, for instance, for fencing or pit props. In these cases the treatment differs considerably. Let us suppose we grow larch, or Scotch pine, or spruce under a rotation of forty years. In that case we should probably make two thinnings, say at the age of fifteen and twenty-five years in the case of larch, and at twenty and thirty years in the case of Scotch pine and spruce. These thinnings would be heavier than when large clean timber is to be produced.

Supposing we have planted larch on fairly good land and remove the original 2,700 plants as follows:—

Number of poles removed at the age of 15 years	= 1,400
,, ,, ,, ,, ,, 25 ,,	= 600
,, ,, ,, ,, ,, 40 ,,	= 700
Total . . .	. 2,700

Then we can count on the following receipts:—

	£	s.	d.
Thinning in the year 15 say . .	10	0	0
,, ,, ,, 25 ,, . .	30	0	0
Final cutting in the year 40 ,, . .	70	0	0

The per cent. on the investment comes out as follows, if the other data remain as before:—

	Per cent.
Cost price of land = £5, interest . .	= 9
,, ,, = 10 ,, . .	= 7
,, ,, = 15 ,, . .	= 5·6
,, ,, = 20 ,, . .	= 4·8
,, ,, = 25 ,, . .	= 4·3
,, ,, = 30 ,, . .	= 3·9
,, ,, = 35 ,, . .	3·6
,, ,, = 40 ,, . .	= 3·4
,, ,, = 45 ,, . .	= 3·1
,, ,, = 50 ,, . .	= 2·9

Supposing now that the cultivation of larch is undesirable on account of the larch disease, and that Scotch pine and spruce are planted for pit timber. Assuming further that we get altogether 3,000 cubic feet of timber at the end of forty years, valued at 6*d.* a cubic foot, and that the thinnings are left out of account, we obtain the following results:—

			Per cent.
Cost price of land	= £1, interest	. .	= 5·7
,, ,,	= 2 ,,	. .	= 5·3
,, ,,	= 4 ,,	. .	= 4·9
,, ,,	= 6 ,,	. .	= 4·5
,, ,,	= 8 ,,	. .	= 4·2
,, ,,	= 10 ,,	. .	= 3·9
,, ,,	= 15 ,,	. .	= 3·4
,, ,,	= 20 ,,	. .	= 3·0
,, ,,	= 25 ,,	. .	= 2·7
,, ,,	= 30 ,,	. .	= 2·5

Even in that case the operation pays well, as such land is not likely to cost more than £10 an acre, and probably not more than £4 to £6.

I could give many other examples, but those already given will show that, on financial ground, the afforestation of mountain and heath land rests on a safe basis.

As I received several enquiries regarding the manner of making calculations like those given above, I shall here add, as an example, the details for larch under a rotation of 70 years.

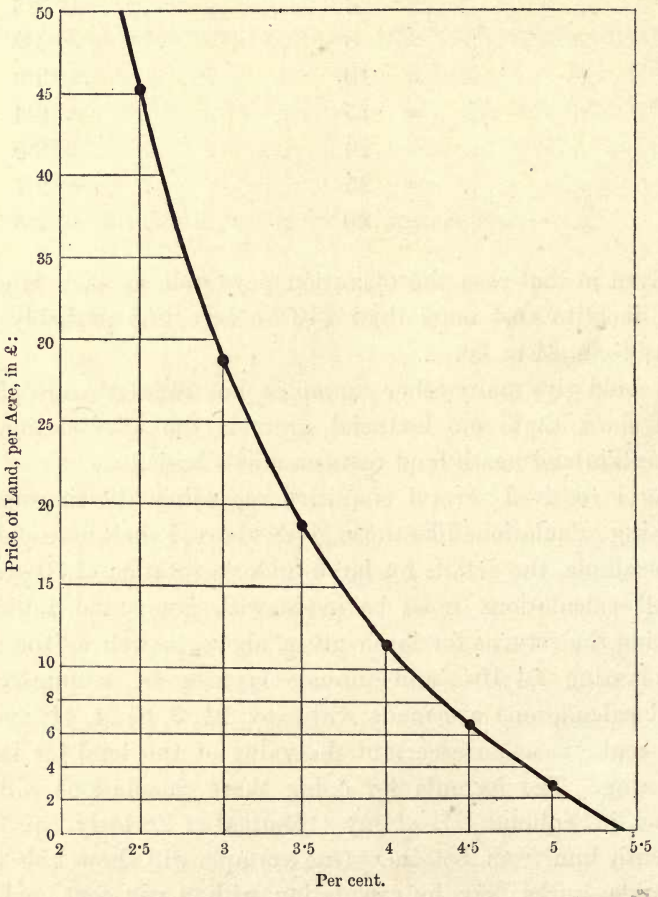
All calculations must be made with compound interest. Taking the returns for larch given above, as well as the cost of planting £4 10*s.*, and annual expenses 4*s.*, a number of trial calculations are made with, say, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, and 5 per cent., so as to ascertain the value of the land for larch planting. The formula for doing these calculations will be found in Volume III. of my "Manual of Forestry," p. 126, seventh line from bottom. One example will show how this formula works, say by calculating with 3 per cent., which

means that all money is taken out of an investment which gives 3 per cent. :—

$$\text{Value of soil} = \frac{\begin{array}{c}3900 + 10 \times (1{\cdot}03)^{50} + 76 \times (1{\cdot}03)^{40} \\ + 220 \times (1{\cdot}03)^{30} + 270 \times (1{\cdot}03)^{20} + \\ 300 \times (1{\cdot}03)^{10} - 90 \times (1{\cdot}03)^{70}\end{array}}{(1{\cdot}03)^{70} - 1} - \frac{4}{{\cdot}03}$$

If this calculation is carried out, we obtain

Value of soil = 576*s*. = £28 16*s*.



If the calculations with the other per cents. are carried out, we obtain the following :—

	£	s.	d.
Value of soil calculated with $2\frac{1}{2}$ per cent. =	45	10	0
,, ,, ,, ,, 3 ,, =	28	16	0
,, ,, ,, ,, $3\frac{1}{2}$,, =	18	4	0
,, ,, ,, ,, 4 ,, =	11	1	0
,, ,, ,, ,, $4\frac{1}{2}$,, =	6	3	0
,, ,, ,, ,, 5 ,, =	2	15	0

These values are now plotted with the per cents. as abscissæ and the soil values as ordinates, and a curve drawn through them, when the diagram on page 50 is obtained.

From this diagram the per cents. yielded under different soil values were read off and entered in the above table for larch. The per cents. for other species were ascertained in the same way.

5. The Treatment of Game Preserves.

In the previous pages I have dealt chiefly with the afforestation of additional areas, and, I trust, shown that a fair interest on the invested capital may safely be expected. I cannot close this essay without offering a few remarks on the subject of improving the returns from some of the existing woodlands. As already stated, the management of these woods is subject to special demands on the part of the proprietor, which frequently reduce the income ; nevertheless, I believe that the latter can be considerably increased, if the management is more systematised in the manner now to be indicated.

British woods consisting of broad-leaved species are used as game preserves, especially for the rearing of pheasants, and the latter object is, in the majority of cases, paramount. On most estates the gamekeeper's duties are entirely separate from those of the woodman, and in only too many cases the two men prosecute different objects.

If antagonism has hitherto existed between the two officials of an estate, it is, at any rate in many cases, just as much the

fault of the forester as of the gamekeeper, because the former has not succeeded in managing the woods in such a manner that they lend themselves to the preservation of game, and yet yield an adequate revenue from timber and firewood. As matters are in Britain, it is no use crying out against game, because proprietors, rare cases excepted, will not adopt an economic management of their woods, if game is interfered with to any considerable extent. It is the business of the forester to manage the woodlands in such manner that they meet the objects which the proprietor has in view to the fullest extent, and in the most economic manner. The preservation of game being in most cases an important object, the forester must set to work and meet it, without reducing the yield of the woods more than is absolutely unavoidable. There is no reason whatever why both objects should not be obtained, without perpetual warfare between the gamekeeper and the forester. Indeed, there are good reasons why the two offices should be in one hand, since it rests at all times with the proprietor to decide whether the one or other object shall take precedence. What the exact method of treatment should be, cannot be laid down in a general way; it depends on local conditions, the kind of game to be preserved, and on the extent to which one object is to be sacrificed to the other. Hence, only concrete examples can illustrate how such cases should be dealt with. On this occasion I propose to deal with the sylvicultural treatment of pheasant preserves.

Pheasants can be reared in woods managed under any sylvicultural system, but it is generally recognised that those systems are best adapted which provide an underwood worked as coppice, and an overwood worked as high forest. The question then is, how should such woods be managed, so that they favour a plentiful and healthy stock of pheasants, and yet yield a commensurate income by the sale of timber and other wood. Both objects can be obtained by treating such woods under the system known as "coppice with standards," according to an orderly and systematically-arranged plan of

operations, or, as foresters call it, working plan. The necessary conditions may shortly be indicated as follows :—

(1.) A full and dense underwood is essential, at any rate over the greater part of the area. This can only be maintained by cutting it over periodically, and protecting the new shoots for some years against ground game. If the underwood is allowed to grow too old, it becomes thin below, and no longer fulfils its purpose as regards the game. Again, if not protected against ground game, the new shoots are cut back, or seriously injured, and they become weak and are deficient in giving shelter. Again, if the stools are too old, they will not send forth vigorous fresh shoots when cut over.

(2.) The overwood must be sufficiently thin to admit the required amount of light to the underwood, without which the latter cannot thrive. To meet this requirement, it is necessary that the overwood should consist of thin-crowned species, such as ash, oak, larch, birch, poplar, and perhaps pines, and the underwood of species which are either shade-bearers, or which at any rate can stand a moderate amount of shade. Of broad-leaved shade-bearers, which alone can come under consideration in the case of coppice, beech stands first, and hornbeam next. These species, however, are not very remunerative, and in the majority of cases, others, which are more so, must be chosen. Among these, ash stands first, and hazel perhaps next. Ash demands a fair amount of light, but it is well known that it will thrive, provided the overwood is constituted as indicated above. Alder is useful in wet places, and chestnut on sandy soils. Other species may be added to the underwood to meet special requirements.

(3.) The third essential condition is that game preserves should be disturbed as little as possible. If forest operations are conducted in them, it must be done at a certain season of the year, say before March, and if possible at a few years interval.

The question then arises, how can all these requirements be made to fit in? This it is proposed to show on an example.

Let it be assumed that a proprietor has an area of 200 acres in one block, or in a number of blocks, say four of fifty acres each, or one of 100 acres and two of fifty acres each, or any other combination, the soil and situation being suitable for the growth of oak, ash, and larch.

Determination of the Rotation of the Underwood.—The first point to decide is what age the underwood is to reach. The answer depends, of course, on local conditions. In some cases the underwood is cut at the age of 10 years, in others at 12, 15, 20, or more years. In the High Meadow woods it has been decided to cut it at 35 years. This is a somewhat high age, but it has been adopted chiefly because at that age the underwood yields material fit for pit-timber. Short rotations of the underwood have the important disadvantage that the overwood will develop strong branches low down, and yield stems clear of branches only to a moderate height, but the advantage that stools will send up vigorous coppice shoots. Long rotations of the underwood have the advantage that the overwood or standards will have boles clear of branches to a considerable height, and thus yield timber of high value, but the disadvantage that a certain portion of the stools will send up either feeble shoots or none at all. A middle course is probably best. If the underwood consists chiefly of ash, with an admixture of hazel, the rotation of it might be fixed, on fairly good land, at 20 to 25 years, according to local conditions. In this way the standards of oak and ash can be kept clear of branches to a height of about 30 feet. Let us say, for the sake of illustration, that 20 years has been chosen.

Division of Area into Annual Coupes.—The second step is to arrange the woods into twenty coupes, or cutting areas, of approximately equal extent, and to deal with one coupe in each year. In our example that coupe would be equal to $200 \div 20 = 10$ acres. If more convenient, the area may be divided into forty coupes of five acres each, of which two are dealt with in each year. If the total area of woods is very large, there would be two, three, or more series, each containing twenty

coupes. The important point is the distribution of the coupes in each series of twenty, which requires to be explained. Let us assume a simple case, say there are four blocks of 50 acres each, so that there would be five coupes in each block. At the outset, the stocking in already existing woods, in all probability, would be more or less irregular, but it should be laid down as a rule that cuttings in each block should be made only once in every four years. In this way each block will enjoy absolute rest for three years, and at the end of the first twenty years the ages of the underwood should be as follows :—

Block I.

Coupe 1 should have underwood = 20 years old.
,, 5 ,, ,, ,, = 16 ,, ,,
,, 9 ,, ,, ,, = 12 ,, ,,
,, 13 ,, ,, ,, = 8 ,, ,,
,, 17 ,, ,, ,, = 4 ,, ,,

Block II.

Coupe 2 should have underwood = 19 years old.
,, 6 ,, ,, ,, = 15 ,, ,,
,, 10 ,, ,, ,, = 11 ,, ,,
,, 14 ,, ,, ,, = 7 ,, ,,
,, 18 ,, ,, ,, = 3 ,, ,,

Block III.

Coupe 3 should have underwood = 18 years old.
,, 7 ,, ,, ,, = 14 ,, ,,
,, 11 ,, ,, ,, = 10 ,, ,,
,, 15 ,, ,, ,, = 6 ,, ,,
,, 19 ,, ,, ,, = 2 ,, ,,

Block IV.

Coupe 4 should have underwood = 17 years old.
,, 8 ,, ,, ,, = 13 ,, ,,
,, 12 ,, ,, ,, = 9 ,, ,,
,, 16 ,, ,, ,, = 5 ,, ,,
,, 20 ,, ,, ,, = 1 ,, ,,

The following diagram will further illustrate this :—

NUMBER OF COUPE, OR YEAR WHEN IT WILL BE CUT IN EACH ROTATION OF 20 YEARS.

No.	17	13	9	5	1		18	14	10	6	2
WEST.	Block I.					Ride.	Block II.				EAST.
Age.	4	8	12	16	20		3	7	11	15	19

No.	19	15	11	7	3		20	16	12	8	4
WEST.	Block III.					Ride.	Block IV.				EAST
Age.	2	6	10	14	18		1	5	9	13	17

Age of Wood at the Commencement of each Rotation.

In this way each block of the wood will contain young, middle-aged and old coppice, and have three years' complete rest. Whenever it is practicable, the coupes should be so arranged that the cuttings proceed against the prevailing wind direction, leaving a shelter-belt on the east and north edges of the wood against cold winds.

Number and Distribution of Standards.—The third question to be decided is the number and distribution of the standards. The number depends, of course, on the quality of the locality, the species, and the size of timber which it is proposed to grow. Under any circumstances, the ages of the standards must be multiples of the rotation of the underwood whenever cutting comes round ; that is to say, in our example, coupe No. 1 would contain standards aged 20, 40, 60, 80, 100 . . . years old, of which the youngest form part of the underwood, until cutting has actually taken place.

The number of standards in the several age-classes must form a falling series, in other words there must be more standards in the 20 years old class than in the 40 years class,

and so on to the oldest class, which would contain only a few trees per acre. It is, of course, out of the question to work up exactly to the theoretically determined number in each class. Hence, such figures can only serve as a general guide. *By way of illustration*, the following example will show the numbers before and after cutting, and the difference, representing the number of trees removed at each cutting, assuming that the oldest trees shall reach the age of 100 years.

NUMBER OF STANDARDS IMMEDIATELY BEFORE CUTTING.

Age of Trees.	Oak	Ash, Larch, &c.	Total.
New standards, still forming part of the underwood, say	25	25	50
Standards 40 years old	25	25	50
„ 60 years old	15	15	30
„ 80 years old	5	10	15
„ 100 years old	5	...	5
Total	75	75	150

NUMBER OF STANDARDS IMMEDIATELY AFTER CUTTING.

Age of Trees.	Oak.	Ash, Larch, &c.	Total.
Standards just selected from underwood, 20 years old	25	25	50
Standards 40 years old	15	15	30
„ 60 years old	5	10	15
„ 80 years old	5	...	5
Total	50	50	100

STANDARDS CUT.

Age of Trees.	Oak.	Ash, Larch, &c.	Total.
Standards 40 years old	10	10	20
„ 60 years old	10	5	15
„ 80 years old	...	10	10
„ 100 years old	5	...	5
Total	25	25	50

In this example it has been assumed that ash, larch, &c., disappear at the age of 80 years, oak only being allowed to reach a higher age. Any other suitable combination may, of course, be adopted; for instance, some of the 80-year-old oaks may be cut out, or specially fine oaks may be allowed to grow beyond the age of 100 years. In such cases, the other figures must be modified accordingly. It is, under any circumstances, necessary to begin with a large number of young standards per acre, to guard against accidents, and because not all will develop into fine timber trees. In selecting the 20-year-old standards, or tellers, the finest specimens are chosen, and these reduced step by step, allowing only the most promising trees to reach maturity. In this way timber of various dimensions is obtained at every cutting. It goes without saying, that in addition to oak, ash, and larch, any other suitable species may be introduced, as, for instance, spruce, a few specimens of which are very desirable in pheasant preserves. The distribution of the standards over the area should be so that each coupe contains about the same number, with the proper proportion in the age classes. In some cases the standards are arranged by single trees, each separated from its neighbour; in others they stand in small groups.

The system of placing the standards into moderate sized groups can be specially recommended, because :

(1) far more valuable timber trees are produced, as the standards push each other up; and,

(2) woods so arranged are just what pheasants like; a dense underwood, over which groups of trees (standards) are scattered. In this case the age classes of the standards are placed into separate groups. The area occupied by the underwood on the one hand, and the standards (or patches of high forest) on the other depends on circumstances, and more particularly on the objects which the proprietor has in view.

Procedure to be followed at each Cutting.—When the underwood has reached the desired age, in our case 20 years, the

first business to be attended to is the selection of the new standards, in our example twenty-five oaks and twenty-five ash and larch, or any other species which may be desired. It is essential to select in the first instance more than this number, as some may be injured by the subsequent fall of the standards. Then the rest of the underwood is cut. The next step is to cut the standards which are to come down. As soon as the material has been removed, the area must be examined for seedling plants of the desired species. If a sufficient number is found no planting will be required; but if this is not the case, all vacant spaces must be filled up with healthy, vigorous plants, or new groups of standards started. It is impossible to say how many plants may be required, but in the majority of cases, 400 per acre will suffice, even if no natural seedlings at all are found. Of these, about 100 should be oak, and 300 chiefly ash, with a moderate number of larch and other desirable kinds. These will grow for 20 years, when the fifty best will be left as new standards, and the others, oak, ash, and other hardwoods, are cut over to produce new stools for coppice in the place of those which have died, or are too old to produce vigorous shoots. The final step is to go over the coupes cut 4, 8, 12, and 16 years ago, to free the plants from threatening stool-shoots, and perhaps thin out the shoots where there are too many on one stool.

In order to give sufficient time for all these operations, it should be arranged that the wood, or block (in our example one out of four), where forest work is to be done in any one year, should be shot over early in the season, so that the work may be commenced not later than December 1st, and be completed by March. In this way the forest operations will not interfere with the shooting, so that both objects can be fully realised.

Financial Results.—It is impossible to say what the receipts at each cutting would be during the first and perhaps second rotation of 20 years, as they depend on the stock of timber existing on the area at starting. When, however, the system

as sketched above has been introduced, the following estimate of receipts and expenses per acre, on land suitable for this method of treatment, will not be far out, calculating with prices as they now exist in the Midland counties, and taking the cuttings as indicated above:

RECEIPTS.

		£	s.	d.
25 oaks yielding, say, 500 cubic feet of timber, at 1*s.* 6*d.* each . .	=	37	10	0
25 ash, larch, and other trees, say, 500 cubic feet of timber, at 1*s.* 3*d.*	=	31	5	0
Underwood, prepared for sale, say .		10	0	0
Total per acre . .	=	78	15	0
Total for 10 acres . . .	=	787	10	0

EXPENSES.

These can only be indicated in a very approximate manner, somewhat as follows:

		£	s.	d.
Felling and preparing timber and underwood for sale, &c. . .	=	170	0	0
Price of 4,000 plants, with planting, at 50*s.* per 1,000 . . .	=	10	0	0
Going over the four older coupes, say, 10*s.* an acre, 40 acres .	=	20	0	0
Taxes, tithes, rates, say 3*s.* an acre, on 200 acres	=	30	0	0
Fencing with wire netting and one or two top wires, average annual expenditure, say . . .	=	40	0	0
Part salary of forester, say 4*s.* an acre	=	40	0	0
Total annual expenses .	=	310	0	0
Annual net receipts . . .	=	477	10	0
Or per acre	=	2	7	9

I am satisfied that such an average annual income can be derived from fairly good soil, fit to produce oak, ash, and larch, such as is devoted to pheasant coverts in the Midland counties. First-class soil will, doubtless, give higher returns, without in any way interfering with the rearing of pheasants.

6. Conversion of Coppice Woods into High Forests.

There was a time, when coppice woods yielded such high returns, that this method of treatment was doubtless the most profitable which could be adopted. Now, however, matters have changed. Oak bark has fallen in value to such an extent, that the surplus of the sale value over the cost of peeling and preparing the bark has become very small. Not long ago the author had to do with an extensive area of oak coppice woods in the south of England, which had given of late years, after deducting the cost of cutting, peeling, etc., an income of about four shillings an acre annually. Taking into consideration the cost of administration, rates, taxes, etc., these lands give practically no income at all. Nor is oak bark likely to rise again in price. There is not only an ever increasing import of foreign tanning materials, but it is almost certain that before long tanning will be done chiefly with artificially prepared agents. Hence, one group of coppice woods is financially lost. Matters are even worse as regards other coppice woods. Where ash can be grown, fair financial results may still be obtained, and in certain localities hazel and chestnut sell as yet; but taking coppice woods as a whole, their value has fallen so much that in many cases the produce is actually unsaleable; hence the time has arrived to consider their position in rural economy. In some cases, as in game preserves, coppice in combination with standards may still be indicated, but in all other cases, coppice woods should be converted into high forests, whenever the proprietor looks forward to the realisation of reasonable returns from his woodlands.

When conversion has been decided on, the simplest plan is to carry it through step by step as the coppice in each section

of the wood reaches the most profitable age. As soon as the coppice has been cut, it should be interplanted with suitable timber trees, the plants being placed between the stools. They will grow up with the fresh stool-shoots, the latter providing shelter to the soil, and driving the seedling plants up. As the shoots are likely to grow at first quicker than the seedling plants, the area must be gone over repeatedly, and the plants freed from interfering stool-shoots. During these operations only so much of the shoots should be cut away as is absolutely necessary for the benefit of the plants, the rest being left to protect the soil. Subsequently, one of two plans may be followed: if the height-growth of the seedling plants is sufficiently rapid to outstrip the coppice shoots after some time, the two may be allowed to grow on together. If, on the other hand, the coppice outstrips the seedling trees for a lengthened period of time, then it may be cut over once more, and the subsequent shoots will assume the shape of an underwood.

The question, what trees to plant, is of the first importance. The selection depends, as in all such cases, on the special conditions of each locality; but the following remarks may prove useful. In the majority of cases, fast-growing species are indicated, such as larch, ash, Douglas fir, and various pines, say Scotch, Corsican, and Weymouth. The first three should be planted only on fairly good soil, and in otherwise suitable localities. Larch, particularly, should not be planted if the disease is prevalent in the locality, and under any circumstances only on cool aspects. Ash requires a sufficient quantity of moisture in the soil, while Douglas fir is partial to sheltered positions. In warm localities and on indifferent soils the three pines are indicated. As regards oak, sycamore, and similar timber trees, they can be recommended only in the case of really fertile lands, and then the stool-shoots must be periodically reduced in size and height, until the seedling plants, especially the oak, can hold their own against the coppice.

When interplanting coppice woods, it is essential that the plants should be given the best possible chance of holding their own against the stool shoots, hence vigorous plants with a well-developed natural root system should be chosen, and they should be placed into pits. None of that barbarous system called notching, under which the roots are all pushed to one side.

A few words about silver fir and spruce. In many cases these species may be planted into coppice woods. They stand much shade, especially the silver fir, and when they have once commenced to go ahead, they will speedily overtop the coppice shoots. The author has, since 1894, planted spruce into coppice, on an area of 1,700 acres, so far with complete success. He has found the cost of going over the areas, to help the spruce against the coppice shoots, very small, and in plantations, seven years old, the spruce does not require any further help. The value of spruce timber in Britain is at present small, but if the trees are grown in fully stocked woods, they will produce timber of a higher quality, because the annual rings will be narrower, and the stems free of branches to a good height. As to quantity, spruce is a good producer; on soil of fair quality 100 cubic feet, according to quarter-girth measurement, per acre and year may safely be relied on. The author has a spruce wood forty years old, situated on a rather steep south-eastern slope, the underlying rock being clay-slate, at an elevation of 1,100 feet above the sea, which has produced 127 cubic feet, quarter-girth measurement, per acre and year. Such woods will pay a fair rate of interest on the capital invested in them, apart from any rise in the price of timber in the future.

7. The Production of High-Class Oak, Ash, and Larch Timber.

Firewood being of small value in Britain, timber trees should be reared in such a manner that they yield the highest possible percentage of high-class timber, and a correspondingly

small quantity of wood which is only fit for fuel. In this respect the above-mentioned three species differ very considerably. Larch produces naturally a high percentage of timber; oak, on the other hand, will spread out horizontally, if not prevented from doing so, producing a short stem and large head, and yield only a poor percentage of timber, accompanied by a high proportion of firewood. Ash stands between larch and oak in this respect; and yet the rearing of these three species has much in common. All are light-demanding, especially the larch; all are thin-crowned, and none of them improves the yield capacity of the locality if raised in pure woods. The best way of rearing them is to mix them into a shade-bearing, full-crowned species. Of these, beech is the best. In mixture with beech, the above-mentioned three timber trees find all the advantages of a permanent and complete shading of the ground, a heavy fall of leaves, followed by a thick layer of humus, and freshness of the soil throughout summer. The competing beech forces the other species to push upwards, kills off their lower branches, and causes them to produce long, straight, clean boles of high value. Woods of this kind require, however, the careful attention of the forester, especially in the case of the oak.

Oak and beech stand sufficiently near each other as regards their demands on the locality. No doubt oak prefers a somewhat moister soil than beech, but the latter accommodates itself to the former; as a matter of fact they are growing and thriving together over extensive areas. The principal difficulty to contend with is their relative height-growth. In some localities the oak keeps pace with the beech, but in the majority of cases the latter is faster growing after the first few years, and, if unchecked, kills out the oak. In the former case, the oak can be mixed singly into beech woods, care being taken in the thinnings to help the oak whenever necessary. In the second and much more frequent case, the oak must either be given a considerable start of the beech or placed into groups, or both.

For the purpose of giving the oak a start, it may be grown pure in the first instance. It will fairly shelter the ground until it begins to thin out, which generally occurs according to local conditions between the age of thirty to sixty years. Up to that age the wood should be kept dense, so that tall, clean stems may be produced. About the age of forty somewhat heavier thinnings should commence, giving to the more promising oaks gradually more growing space. Then a specially heavy thinning is made, and the area under-planted or sown with beech. The young beech are very grateful for the shelter of the oaks during several years. Then more thinnings may take place, leaving the most promising oaks in such numbers that the beech below them has sufficient light to come up. Both crops are then allowed to run through a full rotation, favouring at all future thinnings the development of the oak. In this way a crop of mature oak and beech is obtained, the age of the former being some fifty years more than that of the beech. This method of growing mixed oak and beech is shown in the illustrations Nos. 5 to 8 of the Appendix.

The second method of rearing oak with beech is to place the former into groups, surrounded by a sea of beech. For the oak, the most favourable spots should be selected, where the soil is deep, and the aspect favourable, especially south-east or south. These spots should be sown with acorns, or densely planted with young oak plants one year old about 8,000 to the acre. As soon as they are well established, the remaining parts of the wood should be stocked with young beech, either naturally or artificially, according to circumstances. The size of the oak groups varies much. If they are too small, the beech does much damage along the edges; if too large, the advantages of the admixture of beech are considerably reduced. Hence the area of the oak groups should lie between one-quarter and one acre. In the natural course of events the beech will commence to intrude itself into the oak groups as soon as they begin to thin out above, thus

establishing an underwood of beech in them. In this way, again, fine oak can be produced, and the increment per acre can be kept at the highest possible rate.

Instead of beech, the silver fir has been used for underplanting oak woods, a method which has given very good results. In somewhat moist places, hornbeam has taken the place of the beech. Spruce has also been used, but it is not so good as the others, as the oak is liable to become stag-headed; the mixture is admissible under favourable conditions, or where the spruce is to be cut out at a comparatively early age. Oak has also been underplanted with Weymouth pine, and with fairly good results.

The rearing of *ash and beech* in mixture can be done as in the case of oak and beech. The ash is either grown pure and subsequently, at the age of twenty to thirty years, underplanted with beech; or the two are started at the same time. In the subsequent thinnings, the ash is duly protected against any attacks on the part of the beech. Frequently ash and oak are planted together, mixed, and subsequently underplanted with beech or silver fir.

The rearing of *larch in beech* is of special importance, now that the larch disease has spread over the length and breadth of Britain. Whatever the cause of the disease may be, suffice it to say that its rapid spreading is due to the indiscriminate planting of pure larch, especially in localities which are not thoroughly suited to the species. It is now recognised in Britain that larch should only be planted in favourable localities; that is to say, in a fairly rich soil, and on cool aspects. Even then the formation of pure larch woods is dangerous, because, if the disease breaks out, it will rapidly spread over the whole wood. Hence, larch should be mixed in moderate quantity with another species, which, as it were, separates the individual larch trees. None is better than beech. Here the larch has its best chance. The procedure is to plant a limited number of vigorous larch plants into beech, and let them grow up together, protecting the former

sufficiently during the thinnings, as it requires to have its head freely exposed to sun and air.

Another method is to grow larch pure, to thin it out heavily between the ages of fifteen and twenty-five years, and to under-plant it with beech. Of the larch only the best stems are left to grow into timber trees.

Unfortunately very extensive areas of young pure larch woods are found in Britain. Only the other day, the forester of a large landed proprietor in the Midlands appealed to me for advice, what to do with some 2,000 acres of young larch, frightfully diseased. Cases like this are very sad, and I believe the only chance of saving some of the trees as yet unattacked is to cut out as quickly as possible all diseased larches, and to under-plant with beech, thus preserving healthy conditions for the further development of the remaining trees. Instead of beech, such woods may be under-planted with silver fir, whenever the latter is likely to give better financial result. Douglas fir may also be tried, and ought to do well, since the remaining larches will give it just that shelter which the leading shoots of the Douglas fir so much require. Even Weymouth pine may be used for this purpose. The author has under-planted Scotch pine with that tree, and the results are everything that can be desired. If the Weymouth pine does well under Scotch pine, it will do still better under larch, as that tree gives a lighter cover than the Scotch pine.

8. The Forest of Dean: An Object Lesson.

In the previous section on "The Production of High-class Oak, Ash, and Larch Timber," special attention has been drawn to the importance of raising these light-demanding and thin-crowned timber-trees in mixture with a full-crowned, shade-bearing species, such as beech or silver fir. This method of rearing our valuable trees has for its principal object to secure a continued fertility of the soil. As some

readers may raise the cry of "theoretical speculation"—a cry so frequently heard when people do not understand a subject, or do not care to face the inconvenience of a new departure—it will be useful to fortify what has been said by producing an example in point. It is, alas! a negative example, but it will serve its purpose. The example is the "Forest of Dean."

Any person with a pair of eyes, who visited the Dean eight or ten years ago, and made his way across the several woods, found on by far the greater part of the area a thin crop of oaks from eighty to ninety years old, of poor height growth, with rounded or flat tops, and the branches coming down low, so that only clear boles of small length were formed. Looking down on the ground, our observer would see the soil covered with a matting of grass and weeds, overrun with brambles, etc. Presently the wanderer would probably come across a solitary old oak or two of magnificent dimensions, towering high over the eighty to ninety years old crop; the idea would at once cross his mind that the flat-topped younger generation could never grow to the height of the few remaining old trees, and he would be sure to ask, "What has brought about this change?" The answer is, "The nineteenth-century foresters in charge of the Dean have ruined the former fertility of the soil by trying to grow oak pure beyond youth, by excessive thinning, and by unrestricted grazing."

An enquiry into the past history of the forest has revealed the fact that, up to the end of the eighteenth century, the Dean carried a mixed crop of oak and beech in the proportion of one oak to about two beeches; under these conditions the fine oaks of enormous size were produced which made the forest renowned, and provided large quantities of first-class timber for the "walls of oak" of Old England.

This fine crop of timber was cut early in the nineteenth century, with the exception of about 500 acres, which were cut in 1852—1853, yielding an average of 154 cubic feet of timber per tree, according to quarter-girth measurement.

The cleared areas were replanted, so that most of these woods are now about ninety years old, and the rest forty to fifty years. As far as is known, oak was planted with nurses, the latter having been cut out subsequently. And then the disastrous treatment commenced. When the woods had reached the age of thirty or forty years, they were considered safe against cattle, and the greater part of the enclosures were thrown open, especially to extensive sheep grazing. About the same time it was considered the correct thing to thin heavily, and this was done during a number of years, until the trees were practically isolated. What the result of these operations is, has already been indicated. The soil, exposed to the unrestricted action of sun and air currents, became in most parts practically unproductive, the result being a very inferior crop of unpromising oaks, short in height, and branched low down. How different might have been the results, if, instead of throwing open the enclosures and making senseless thinnings, the oak had been underplanted with beech at the age of thirty to fifty years, thus keeping the soil under constant protection, and causing a gradual accumulation of fertile leaf-mould on the soil.

It is due to Mr. Stafford Howard, Commissioner of Woods, and Mr. P. Baylis, Deputy Surveyor, Forest of Dean, to say that they recognised the unsatisfactory state of things, and set to work some ten years ago to mend matters. There were, however, great difficulties in the way. In the first place the areas, so ruthlessly thrown open, had to be re-enclosed, and this can only be done gradually; however, good progress has already been made, as several thousand acres have been fenced, and others will follow, until the whole area of 11,000 acres allowed by law has once more been brought under proper control. In the second place, the authorities had to consider what to do with the existing woods. In consultation with the late Mr. Hill, of the Indian Forest Department, they decided to underplant with beech the limited area of woods under fifty years old, where the mischief could still be remedied, as quickly as the

occurrence of beechmast years permits. The older oak woods, about ninety years old, demand a somewhat different treatment, and this was commenced by Mr. Baylis about ten years ago. In these woods, only oaks of some promise are left, all others being cut out; then all blanks are filled up, chiefly with larch, oak, and other trees, such as sycamore and ash, and in suitable places spruce and Douglas fir. As soon as these young plantations have made a fair start, beech will be brought in over the whole area, so as to return to a state of affairs similar to that which existed a hundred years ago.

Some wiseacres have of late been writing about "The New Forestry." Alas! it seems to me what is really wanted is to return to "The Old Forestry," and to eliminate as quickly as possible the errors introduced into British forestry by the nineteenth century forest experts. These gentlemen were in too much of a hurry. "Quick returns regardless of consequences" was their maxim, and now they have almost ruined national property of an enormous value, inasmuch as they have considerably reduced the fertility, or yield capacity, of the soil. It may indeed be said that the competency of a forester can be judged by examining the soil in his forests: if there is a good layer of leaf-mould on the ground, the management is sure to have been good; if not, undoubted mistakes have been made, which should be eliminated as quickly as possible.

No doubt, some readers will say, This is all very well, but what are we to do with so much beech, which fetches only a small price per cubic foot? The answer may be given by another question:—What is done with beech in Buckinghamshire and adjoining counties? Why, it is made into chairs and other articles of furniture, and it fetches at least a shilling a foot all round. In other words, provide the raw material, and industries to utilise it will soon spring up. They follow the raw material. Beechwood is coming into use more and more every year, for casks for dry goods, railway sleepers, pattens, heels for ladies' boots, and what not. Besides, the

beech need not occupy more than half the crop, or it may be kept almost altogether below the oak.

Let us hope that the twentieth century foresters will profit by the lesson, and revert to methods of treatment which will secure the continued yield capacity of the soil, and thus lead to returns far higher than those which have been obtained of late from extensive woodlands in these islands.

APPENDIX.

TEN PICTURES ILLUSTRATING THE NATURAL REGENERATION OF BEECH, THE PRODUCTION OF HIGH-CLASS OAK TIMBER, AND THE PROPER DENSITY OF SPRUCE WOODS.

No. 1.—*Beech Wood* in Buckinghamshire.

No. 4.—Old Style *Oak Wood* (Spessart), Exposed to Unrestricted Cattle Grazing.

No. 5.—*Oak* Regeneration 3 Years Old, Started by Sowing Acorns under a Thin Shelter-wood.

No. 8.—*Oak Wood*, 110 Years Old, with Beech Underwood, 53 Years Old (Spessart).

Number of oaks per acre = 240.

Total production of oak timber, quarter girth measurement = 5,670 cubic feet.

Production per acre and year = 52 cubic feet, valued at £4, apart from the beech.

Soil a sandy loam of only middling quality, overlying old red sandstone. Oaks clear of branches for 50 feet.

No. 9.—*Spruce Wood* (Nassau), 60 Years Old.

Total production of timber, quarter girth measurement = 9,310 cubic feet.
Production per acre and year = 155 cubic feet, valued at £3 17*s.* 6*d.*