

FORESTRY IN GREAT BRITAIN

A REVIEW OF PROGRESS TO 1964

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The forestry situation in Great Britain is remarkable for two factors. First, the net quantity of timber and timber products imported is the largest for any country in Europe, or indeed the whole world. Second, the proportion of land devoted to the raising of tree crops is little more than 7 per cent and so almost the lowest in Europe, and home-grown timber consequently forms only a small proportion, barely 10 per cent, of the total consumption of wood. The forest policy of Great Britain is directed to redressing this unfavourable situation by large scale replanting and afforestation.

The Natural Setting

Situation, Topography, Geology and Soils.

The mainland of Great Britain forms an island of very irregular outline extending for 700 miles (1,100 kilometres) from North to South, and being 300 miles from West to East at its widest point. It lies between 50° and 58° 20' North in latitude and 2° East and 6° West in longitude. Although only 20 miles (32 kilometres) from the coast of France at its nearest south-easterly point, it is separated from Scandinavia by distances as great as 400 miles (640 kilometres) further North. It may thus be regarded as an insular projection of the main European Continent far out into the Atlantic Ocean, and this circumstance gives it a maritime climate very different from that of other European countries in the same latitudes. The maritime influence of the warm Gulf Stream in the North Atlantic gives a generally mild winter climate, but the situation of Great Britain at the meeting point of continental and oceanic air masses results in very unstable weather conditions, characterised by sudden changes at any season of the year. Further, Britain's isolated and insular position renders it liable to high winds and gales.

Politically Great Britain is divided into three countries which will be used for convenience in the descriptions that follow. The ancient kingdom of Scotland extends to the North of a boundary running from the Solway Firth on the West to the River Tweed on the East, occupying about 30 per cent of the island. Wales, occupying about 10 per cent, lies to the West of England, between the River Dee and the River Severn, while England comprises the remaining Southern and Eastern areas, or some 60 per cent of the whole.

Most of England consists of plains or low hills seldom exceeding 1,000 feet (300 metres) in altitude, but in the North and also in the South-west, moorlands and mountains reaching 2,000 feet (600 metres) or even 3,000 feet (900 metres) are found. Both Wales and Scotland are mountainous, with many peaks reaching 3,000 feet (900 metres) and a maximum height of 4,400 feet (1,300 metres) on Ben Nevis in the West of Scotland. The hills and mountains occupy roughly half of the island, and all lie towards the North and West. Although the elevations are not high by European standards, they combine with the Northerly latitude and severe exposure to the Westerly gales to form

a major limiting factor to tree growth. The upper limit of economic afforestation is nowhere higher than 2,000 feet (600 metres) and locally in the West of Scotland it may be as low as 500 feet (150 metres). It follows from this that in Scotland, the North and West of England and Wales, forests are confined to the valleys amid the higher mountains, or to the lower hills; whereas in the South and East of England there is no altitudinal limit to tree growth.

The pattern of geological strata is very complex, since all geological periods are represented, though often by fairly narrow bands or small areas of each particular stratum. But broadly speaking it follows the main topography. The older and harder rocks, which are most resistant to erosion and yield the least fertile soils, lie towards the North and West, where they build up the mountain ranges. The South and East have younger and softer rocks, with on the whole gentler slopes and more fertile soils. Throughout the country, the general run of the strata is from South-west to North-east. Most of the rocks are siliceous in character, but there are several groups of calcareous rocks, lying mostly in the South-eastern or lowland portion of Great Britain. One is the chalk, which forms the famous white cliffs of Dover in the extreme South-east; bands of chalk forming low hills known as "downs" or "wolds" are found as far West as Devon and as far North as Yorkshire. The others consist of Carboniferous and Jurassic limestones, which outcrop as long narrow bands from the South coast across the Midlands to the North of England and locally in Scotland and Wales. In Scotland, North Wales, and South-West England, there are considerable areas of volcanic rocks, while metamorphic rocks prevail over most of the Scottish Highlands.

It is not possible to indicate any broad distribution of soils in Great Britain for they are spread in an intricate pattern that is not always closely related to the underlying rocks. One reason for this is the extensive glaciation that affected nearly all the country during the great Ice Ages. There is often a thick deposit of clay, morainic gravel, or even blown sand, covering the underlying rock; and it is this deposit, and not the main stratum, that forms the soil's parent material. Organic soils formed more recently from peat also cover great areas, and hide both the glacial drift and the main rock formation. These peaty soils are most frequent under the high rainfall of the North and West, and because of their low agricultural value are frequently available for afforestation. Podsolized soils, usually associated with a vegetation of heather, *Calluna vulgaris*, are common over glacial drifts in the East of Scotland and North-east England, and also locally over sandy strata farther South in England. Gley soils, associated with waterlogged sites, are found on glacial clays along the Borders between England and Scotland, and also on other clays in the English Midlands and elsewhere. Rendzina soils are common on the chalk and the limestones, while sand dunes or sandy deposits have been afforested at several points along the coast and locally inland. Brown earths are found under standing tree crops in many districts, but are seldom available for new planting. In general, the more favourable soils in Britain have been cleared for agriculture, and the forester is usually concerned with the less fertile or less tractable soil types, or with steep slopes.

Climate

Although the climate of Great Britain is often described as temperate, that conclusion rests on average values for temperature, rainfall and wind, which conceal wide extremes. The main climate features vary to a surprising extent and within short periods of time, in an unpredictable fashion, so it would be misleading to attempt any simple account. The British climate includes some characteristics which are favourable to tree growth, but others very adverse to the forester's work.

The extreme range of temperature is from 0°F to 100°F, (-18°C to 38°C) the means varying from 40°F (4.5°C) in January to 60°F (16°C) in July. Since the temperatures, even in winter, are generally above freezing point, it is possible to dig the ground and therefore to carry out nursery work and tree planting from autumn through winter to spring. But this favourable circumstance cannot be entirely relied on, for work is apt to be stopped by a spell of frosty weather that may last for several weeks. Brief and often local night frosts are apt to occur very late in the Spring, in May or even in June, and these do severe harm to young shoots of trees that may have proved quite hardy to winter cold. Severe winters occur with sufficient frequency to rule out several kinds of exotics from the warmer temperate zones, in particular the Australian *Eucalyptus* genus.

Rainfall shows great local variation; some districts on the East Coast receive only 20 inches (500 mm.) a year, whereas certain Western mountains get 200 inches (5,000 mm.). Average values are 30 inches (760 mm.) for the South-eastern lowlands and 50 to 60 inches (1,270 to 1,520 mm.) for the Northern and Western hills. It has been customary to regard these amounts as everywhere adequate for tree growth, but it has recently been appreciated (R. F. Wood, 1957) that during the main growing season, from April to September, the loss from evaporation exceeds the gain from rainfall over most of South and East England, though not elsewhere. This may explain why the rate of growth of spruces and other moisture-loving trees is higher in the North and West.

Although the rainfall is fairly evenly spread around the year, there is usually a pronounced dry spell during the spring months, between March and May. This renders nursery work more difficult and tree planting less certain, and it greatly increases the risk from forest fires. Occasional summer droughts can also be serious. Snow seldom lies for long in winter below 2,000 feet (600 metres) but heavy snowstorms are fairly frequent, particularly on the eastern side of the country. Damage to branches and foliage caused by clinging wet snow or hoar frost is occasionally severe.

Average wind speeds range from 10 miles (16 kilometres) per hour in the Midlands of England to 15 miles (24 kilometres) per hour on the West coast of Scotland. The prevailing winds are warm, moisture-laden, south-westerly ones, but cold, dry, north-easterly winds may blow for several weeks on end, particularly in spring. Gales with wind speeds up to 80 miles (130 kilometres) per hour occur quite frequently, and on extreme occasions speeds of 100 miles (160 kilometres) per hour have been recorded. During an average winter most parts of the country suffer two or three severe gales, usually from the South-west but occasionally from the North-west or North-east. The risk of damage to tree crops from windblow is therefore a constant concern of the forester, and is a subject of current research.

The native forest flora of Britain, having been derived originally from the neighbouring continent of Europe, appears well suited to the climate conditions of the South and East. But it is perhaps less well adapted to the Northern and Western highlands, from which indeed certain species, such as beech, black poplar, and field elm, are absent. The introduction of new timber-producing trees from abroad has involved their testing under our uncertain climate. Generally, it has been found that trees from regions with a clearly defined march of summer and winter temperature, such as Eastern North America, thrive poorly in Britain. But those from regions with a maritime climate, being accustomed to more fluctuating conditions, succeed; in particular, conifers from Western North America have done well.

Historical Review

Natural Forest Cover

Over the whole of Britain the processes of deforestation by grazing, burning, and clearances for agriculture, timber or firewood, have been carried to a point further than is found in most European countries. So little natural forest cover remains that it can contribute nothing substantial to the country's timber supplies. It is of little more than academic interest to botanists, ecologists, and of course, to foresters. But much research has been carried out on it, particularly through the medium of pollen grains and fragments of wood preserved in peat bogs. Dealing with the historical period only, from the beginning of the Christian era onwards, the following broad picture can be drawn.

The principal tree growing in the South and East of Britain was the pedunculate oak, *Quercus robur*, which formed extensive forests on the heavier soils; towards the North and West, and particularly in the Scottish Highlands and in Wales, its place was taken by the sessile oak, *Quercus petraea*, which is more at home on the lighter soils. Associated with these oaks, in different parts of the country, were various kinds of elms (*Ulmus* species), poplars (*Populus* species), limes (*Tilia* species), and birches (*Betula* species), and also ash (*Fraxinus excelsior*), beech (*Fagus sylvatica*), and hornbeam (*Carpinus betulus*). Hazel (*Corylus avellana*) was common as an undershrub. Some of these trees formed pure woods in certain situations, notably ash on limestone and beech on chalk. Alder (*Alnus glutinosa*) and several kinds of willows (*Salix* species) prevailed in moist places. This kind of woodland is regarded as an extension of the deciduous broadleaved forest of Europe.

Over the Scottish Highlands, and locally farther South, a different type of woodland was found. This is regarded as an outlier of the northern coniferous forest of Europe, but possessed only one important coniferous tree, the Scots pine, *Pinus sylvestris*. The spruce (*Picea abies*), the silver fir (*Abies alba*), and the larch (*Larix decidua*), common in continental Europe, are not native to Britain. With the evergreen pines was associated the deciduous birch. Small areas of this primeval natural forest survive in certain Scottish glens, where they are the subject of much interest and some research.

Planted Woods under Private Ownership

The early development of silviculture in Britain was based on the artificial establishment of coppices and plantations, rather than on the management of existing natural woods. In this respect it provides a contrast with European practice. The underlying reason was probably the more complete devastation of the original forest cover, particularly in the more closely settled areas. Evidence of early concern with the formation and protection of woodlands is found in an "Act for enclosing of Woods" in hunting grounds, passed by King Edward IV in 1482 and a further "Act for the preservation of Woods" passed by King Henry VIII in 1543. In Scotland, which was then a separate country, an Act was passed by King James IV in 1504 requiring every landowner to establish at least one acre of wood "where there are no great woods nor forests."

At first attention was directed to the management of coppices, mainly of hazel, but also of hornbeam, ash, sweet chestnut (*Castanea sativa*), birch and oak, with the object of securing small-sized material for hurdle-making, fencing, firewood, charcoal and bark for tanning leather. A rotational system of cutting was followed to ensure an annual supply. Later, as the original forest cover became further diminished, it became customary in the South of England to preserve large oaks, ashes, and sweet chestnuts, known as "standard" trees, to provide occasional large timbers for building houses, barns, or ships.

Originally, much of the open forest land used for hunting had been owned by the king, but a steady process of enclosure went on, accompanied by the disposal of the royal lands to the great landowners. It was these landowners, therefore, who undertook the planting and management of the new woods, until eventually nearly all the country's woodlands were under private ownership. During the seventeenth century, these landed proprietors began to take an interest in forming high forest plantations, and this work was greatly expanded during the prosperous eighteenth century, and has been continued ever since. The principal broadleaved trees grown as high forest were oak, ash, beech and sycamore (*Acer pseudoplatanus*), the latter having been introduced from Europe certainly as long ago as the fifteenth century. The planting of coniferous trees began with the native Scots pine, but during the eighteenth century the Norway spruce and the European larch were used on a growing scale. These seven trees comprised the bulk of the planting for timber, others being used only as auxiliaries or for ornament.

It is rather surprising to note that there was little regional variation in the selection of trees for planting, the same seven kinds being used to a greater or less degree in every county. This was only possible because many of these new woodlands were formed on fairly good sites that are not limiting for any of these species. It was customary for each landowner to select for planting some of the better ground close to his mansion house, where woods would provide shelter for his park and garden, and cover for his game birds, as well as a supply of timber for estate use or sale. Besides these "home woods" there are, on many estates, others more remotely situated and concerned mainly with commercial timber production, and these are usually on poorer ground, such as hillsides too steep for agriculture.

Towards the close of the nineteenth century, the private woodland owners began to use, on a small scale, four new conifers, namely Douglas fir (*Pseudotsuga taxifolia*=*P. menziesii*), Japanese larch (*Larix leptolepis*), Corsican pine (*Pinus nigra* var. *calabrica*), and Sitka spruce (*Picea sitchensis*), but as yet there are few mature woods of these kinds. It should be noted that out of the eleven trees commonly planted on private estates, seven have been introduced from abroad. Because so many privately owned woods were developed by separate individuals, each planting up some of his better and usually some of his poorer land to suit the economy of his agricultural estate or his personal taste, they tend to be individually small and scattered. Large woods are rare, and even where they occur are often divided between several landowners. An investigation by Dr. F. C. Hummel (1957) showed that in seven English counties the average area of woodland held by each owner was only some 50 acres. This scattered distribution, and small-scale ownership, adds greatly to the difficulties of management by the individual, and to the encouragement of better management by the state. A feature of the English landscape is the prevalence of small woods, often occupying less than 5 acres, and of timber trees growing along the hedgerows of hawthorn that enclose the agricultural fields. No individual county has more than 20 per cent of its surface under tree crops.

Despite the scattered character of the woodlands, and their varied composition, they constituted a large reserve of timber. This was found invaluable during the two World Wars of the present century, first between 1914 and 1918, and again between 1939 and 1945. But the timber supplies essential to the survival of the country were only secured by serious overfelling and this has brought major problems of forest management in its train. Between the two World Wars, from 1918 to 1939, the amount of re-planting done on the private estates was disappointing: indeed it has been estimated that it only kept pace with current felling and did nothing to make good the wartime losses.

But since 1945 proprietors have shown much greater interest in replanting felled woodland, and the work is proceeding even faster than anticipated. The 1963 rate of planting by private owners was 32,000 acres (13,000 hectares) a year. Although the resources of some private individuals seldom extend beyond the re-planting of existing woods, others are carrying out extensive programmes of planting on new ground.

Regional Trends in Species

Because so much of our woodland has been planted, and also because the same species were so widely used, it is not possible to define regional forest types in Britain. The distribution of tree species was investigated in the Forestry Commission Census of 1947, which showed that broadleaved trees predominated in England but conifers led elsewhere. Oak was then the principal tree over most of England, except for the Chiltern Hills North-west of London, where beech is more important; Scots pine was the principal tree in Scotland, and particularly so in the North-east. Even in the woods planted by the Forestry Commission, a considerable choice of species has been possible in many districts, resulting in regional trends rather than distinct types.

A major trend that has become evident in the distribution of conifers is that Norway and Sitka spruces, and the Lodgepole pine (*Pinus contorta*), tend to be favoured in the north and west of Britain, where conditions are generally cool and moist: whereas the Scots and Corsican pines are preferred in the south and east where the climate is generally warmer and drier.

Development of Urban Demands for Timber

A feature of the Industrial Revolution, which changed Britain's economy during the nineteenth century, was a great increase in the demand for timber and forest products of all kinds. This demand arose mainly in the growing industrial towns and seaports, and it was found easiest to meet it by imports. There were several reasons for this: the main call was for softwoods, and at that time Britain's mature coniferous woods were very limited in extent and could not supply the quantities needed; second, very large quantities of softwood were available from North America and Northern Europe, at prices which proved cheap in relation to the sums received for British exports of coal and manufactured goods; third, transport was also cheap since timber provided a return cargo for ships engaged in the export trade. Hence it came about that the main industries concerned with timber and wood pulp were concentrated around the seaports rather than in the forests. In 1914, about 95 per cent of the country's timber needs were being met by imports.

Allied with this process was a growing concentration of the population in big towns and cities remote from the forests, but well served by water transport. Consequently the timber grown on private estates tended to be used locally for agricultural work, where little transport was needed and it could best compete with cheap imports.

The Present Work of the Forestry Commission

Establishment of the Forestry Commission

Prior to 1885 the Government took little interest in forestry; it was generally believed that the unaided work of private owners, together with the plentiful imports, could meet all foreseeable needs. The only national forests consisted of small remnants of the mediæval royal hunting grounds, such as the New Forest and the Dean Forest, which had a combined area of 118,000 acres (50,000 hectares); but of this only some 60,000 acres (25,000 hectares)

was under tree crops. From 1885 to 1919, various efforts were made to encourage the growing of timber, and eventually the Forestry Act of 1919 established the Forestry Commission as the Government Authority responsible for such work. The immediate cause for this action was the need to remedy the country's economic and strategic dependence on overseas sources of timber.

This Commission, as constituted under the various Forestry Acts, 1919 to 1963, and subsequent legislation, consists of ten members appointed by the Queen for a set term of years. The Commission is responsible to the two Government Ministers concerned with agricultural affairs, namely the Minister of Agriculture Fisheries, and Food, and the Secretary of State for Scotland. The Ministers act jointly in matters of general policy, but the Minister of Agriculture has a special concern for England and Wales, and the Secretary of State a like concern for Scotland.

The Commission is required to make an annual report to Parliament. Funds for its operations are provided in part by the Treasury, and in part from sales of timber and other receipts from its estates. The principal duties entrusted to the Commission are the promotion of forestry and the maintenance of an adequate reserve of growing timber within Great Britain, and it has wide legal powers to pursue these objectives. Its staff are recruited, and operate, under the same conditions as members of the Civil Service.

Forest Policy: The 1943 Proposals

Proposals were outlined in a formal report entitled *Post-War Forest Policy*, which was presented to Parliament in 1943, when the second World War was again making evident the need for home supplies of wood. This report proposed a fifty-year programme, during which time there would be built up a forest estate—partly in private ownership and partly under national ownership—covering 5 million acres (2 million hectares) equivalent to 10 per cent of the country's land surface. When fully established, this might yield about 400 million cubic feet (11 million cubic metres) of timber each year, in true measure under bark (equivalent, on a sustained yield basis, to about one-third of the amount of the country's likely consumption). A larger contribution to the country's needs could of course, be provided during a short emergency, but only by over-cutting the growing stock.

It should be noted that it was not proposed to make the country independent of overseas timber supplies, which would continue to provide a major part of all timber and timber products used. But the present extreme dependence, which involves a heavy drain on foreign exchange and is a strategic liability, would be greatly reduced.

Forest Policy: The 1963 Objectives

The present practice is for the Government to review policy every five years: it then makes firm plans for five years ahead, together with outline plans for the ensuing five years. The last review took place in 1963, when the following decisions were made:

Over the next decade, from 1964 to 1973, the Forestry Commission will aim at planting a further 450,000 acres (180,000 hectares). It will continue to concentrate on acquiring land in the upland areas, particularly in Scotland and Wales, where population is declining and where the expansion of forestry can bring considerable social and employment benefits.

The Commission will acquire land in other areas where there are good economic reasons or where planting can maintain or improve the beauty of

the landscape. The planting programme for each year, and its distribution between the three countries, will be determined from time to time by the forestry Ministers.

The Commission, in preparing its future programmes, will bear in mind the need, wherever possible, to provide public access and recreation, and will devote more attention to increasing the beauty of the landscape.

Grant schemes for private owners will be continued, and no limits have been set on private planting.

The policy of steady expansion in both public and private forestry means that a growing volume of home-produced timber will be coming on to the market, to the benefit of the balance of payments.

The national policy is, in brief, as follows:—

- (a) To increase the production of wood as a raw material for industry (i) by extending the area of forests at a steady rate, in accordance with sound land use: and (ii) by making each forest as productive as possible.
- (b) Within the limits set by their other objectives to manage the forest estate as profitably as possible.
- (c) To provide employment in rural areas, especially those most affected by depopulation, and in so doing to maintain a skilled labour force.
- (d) To help in maintaining an efficient home timber trade.
- (e) To give due attention to the aesthetic and protective roles of the forest and to encourage open air recreation.
- (f) To foster industrial and social development ancillary to forestry.
- (g) To encourage the orderly development of private forestry, and specifically to assist in creating conditions in which produce from private as well as Commission forests can be marketed to best advantage.

Statistics of Forest Land

The Forestry Commission now (1963) holds 2,552,855 acres (1,000,000 hectares) of land. Of this 1,450,000 acres (580,000 hectares) is under tree crops. Of the remainder, 800,000 acres (300,000 hectares) consist of land unsuitable for afforestation; this is mainly mountain tops in Scotland and Wales, which have to be taken over with the better ground. Such land is used for rough grazing and also, in the Forest Parks, for recreation.

There is a balance of 302,000 acres (120,000 hectares) which consists of land suitable for planting, but yet afforested. Each year about 50,000 acres (20,000 hectares) of this is planted up, and a like area of fresh land is acquired. This working balance of "plantable land" is found essential in practice, because it takes time to effect the change in land-use from grazing, etc., to forestry.

Woodlands under private ownership (1963) cover approximately 2,760,000 acres (112,000 hectares) but this figure includes many very small and scattered areas. It is estimated that by the end of the century the private owners will retain some 2,000,000 acres (800,000 hectares) of efficiently managed and productive forest, excluding very small woods and shelterbelts. They currently plant 32,000 acres (13,000 hectares) annually.

Forestry Commission Activities

Under its central headquarters in London, the Forestry Commission organises its work on a territorial basis, with a Director of Forestry for England, also in London, one for Scotland in Edinburgh, and one for Wales at Aberystwyth. A Director of Research, stationed at the Alice Holt Research Station, near Farnham in Surrey, is responsible for such specialised fields as research, statistics, seed supplies, and work study. Each country is divided into smaller charges, known as Conservancies, comprising a group of about eight counties or parts of counties. Over Great Britain as a whole there are eleven Conservancies and two smaller charges, for the New and the Dean Forests respectively. Each Director or Conservator is a senior forest officer with a complement of office and field staff.

In each of the three countries a National Forestry Committee assists the Director and the Commission in the framing of policy, while each Conservancy has a Regional Advisory Committee representative of local interests, particularly as regards the private estates. Special Committees advise on research and timber utilisation.

The activities of the Commission are organised on three main lines:

- (1) Formation and Management of National Forests.
- (2) Encouragement of Forestry on Private Estates.
- (3) Research, Development and Education.

For convenience, these activities are reviewed separately below, but in practice one forest officer commonly deals with both national forests and private estates in his own district. He is thus fully familiar with local conditions, and can advise woodland owners on the basis of his own recent experience. Specialist officers are, of course, more closely concerned with one particular activity.

Direct Action in National Forests

Since 1919, over 500 national forests have been set up by the Commission. The land for these is acquired from private ownership either by purchase or by lease for a long term of years. Such land comes from two main sources—former woodland which owners are unable or unwilling to manage themselves, and mountains or moorlands of low value for grazing. Further land is steadily being acquired at the current rate of 50,000 acres (20,000 hectares) each year. All land is acquired by negotiation with willing sellers, and not by compulsion, so it can only be taken up as it comes on to the market. Owing to the large number of private landowners, suitable land is often available only in small blocks, which can only gradually be built up into a forest of reasonable extent.

The Commission raises nearly all the trees it uses in its own forest nurseries. The current rate of planting in the Commission's own forests is some 50,000 acres (20,000 hectares) a year. This involves the raising and planting of about 120 million young trees. The work of afforestation or replanting is done by direct labour. The labour force, which numbers over 11,000 persons, is supervised by resident Foresters. Each group of forests is controlled by a District Forest Officer. To ensure a sufficient number of labourers, particularly in the Northern and Western regions where population is sparse, the Commission has found it necessary to build houses on a large scale.

These sometimes form small groups of cottages or smallholdings, and sometimes larger "forest villages". The planning and management of these housing schemes, together with the management of property other than forests, is entrusted to specially trained Estate Officers. Altogether there are 4,500 houses for forest workers, and about 40 more are built each year.

To make possible the transport of forest produce from the woods, it has been found essential to extend the existing network of roads and tracks, particularly in the hilly northern and western districts. These now extend to 7,500 miles (11,200 kilometres) and a further 450 miles (700 kilometres) or so, is added each year. By using machinery such as bulldozers and graders, it has been found possible to build gravel roads of a sufficiently high standard at low cost. This work is supervised by professional Engineers.

At present little mature timber is harvested from the Commission's forests, since most crops are under forty years of age. The bulk of the produce takes the form of thinnings from coniferous woods. The marking of such thinnings is always undertaken by the Commission's staff, but subsequently the trees selected for removal may be sold, as they stand, to timber merchants, who fell, remove, and market them. Alternatively, the felling and transport may be carried out by the Commission's workmen, and the resulting material be sold as poles at the roadside, or further prepared and delivered to the purchaser's factory or yard. The method of sale adopted depends mainly on local conditions and the prices offered; but it is considered advisable to do enough direct marketing to keep in touch with new methods and prevailing costs and prices.

Plans for planting and the ancillary work, thinning, road making and fire protection, are in force at all forests, and these are rapidly being developed into comprehensive Working Plans covering all aspects of management.

Main Forest Regions

Land for afforestation has been acquired wherever it has become available, and consequently there are one or more forests in nearly every county throughout Great Britain. But the larger forests, or forest groups, are naturally placed in certain regions where ample suitable land, too poor for sustained farm use, is to be found. In the North of England, there is a large forest region around Kielder, on the Scottish Border, and another called Allerston on the Yorkshire Moors near Scarborough. In Eastern England there is a large forest called Sherwood in Nottinghamshire, and another called Thetford Chase in Norfolk and Suffolk. The New Forest in Hampshire is the largest in the South, and the Dean Forest in Gloucestershire the largest in the West. In South Wales there is a big forest called Coed Morgannwg in Glamorgan; while North Wales has a group of extensive new woodlands in its main valleys.

In Scotland, the greatest concentration of new forests lies in the Highlands along the Great Glen that runs from Inverness to Fort William. Farther East, there is a string of new woods between Inverness and Aberdeen, along the foothills of the Grampian Mountains. West of Glasgow, the county of Argyll has a large concentration of Commission forests; while in the South-western region called Galloway there is a big forest group around Glentworth.

Certain of these larger forest regions have been declared Forest Parks, with the object of encouraging the public to use the tracks through the woods to the hills that lie beyond, and to enjoy some of the most magnificent scenery in the country. Camping sites have been opened and guide books published. There are eight of these parks and, together with the New Forest, they provide 600,000 acres of land for public recreation.

Assistance to Woodland Owners

Woodlands in private ownership form parts of very numerous estates, whose individual holdings vary from over 10,000 acres (4,000 hectares) to as little as 5 acres (2 hectares). All owners are being encouraged to manage their woods in the most efficient way, by the aid of free technical advice from the Forestry Commission, and by schemes for planned management and financial assistance.

Estates having any considerable extent of woodland, usually from 100 acres (40 hectares) upwards though there is no strict limit of size, are asked to prepare simple working plans which are revised at five-yearly intervals. The management of the woodlands in accordance with the agreed plan is supervised by a Commission Forest Officer, who visits the estate at least once a year; but ownership of the woods, and their ordinary management, rests entirely with the owners. If the owner signs a legal covenant, binding himself to follow this "Plan of Operations", the woods are regarded as "Dedicated" to timber production and he receives a grant for planting or replanting each area and a further grant for managing his woodlands. If the owner merely agrees to follow the "Plan of Operations" without legally binding himself, he receives the same planting grant but no grants for management. These "Dedication" and "Approved Woodlands" schemes, introduced in 1947, have been adopted by an increasing number of people, and 3,000 woodland owners, holding between them 900,000 acres (360,000 hectares), have already agreed to manage their woodlands under working plans.

For the smaller properties, simple Planting Grants are made available, the only condition being that the work must be thoroughly done and the resulting plantations maintained for at least five years.

The rates of grant paid are reviewed from time to time to keep them in line with current costs. At present the simple Planting Grant is £22 4s. per acre (£55 10s. per hectare), which represents about one-third of the average cost. Woodland owners may also claim certain concessions in national taxation.

In order to conserve the country's limited reserves of standing timber, a system of felling licences has been introduced. Small exemptions are made to allow of minor fellings for such purposes as farm repairs, but in general no substantial quantity of timber may be cut without a licence. In general, licences are freely obtainable for felling mature woods, or for thinning, but not for the clear felling of young plantations. An important feature of the system is that the owner may be, and in practice usually is, required to replant felled woodland.

Research

The Commission's research activities are based on the Alice Holt Research Station, situated close to Farnham in Surrey, some 40 miles south-west of London; there is also an office in Edinburgh that deals with field work in Scotland and northern England. The experiments and field trials are dispersed over a large number of forests and nurseries, because the wide differences in topography, soil and climate that occur in Britain make it essential to sample a large range of conditions. The main subject of research is silviculture, but there are also sections concerned with genetics, pathology, entomology, the development of machinery, and the utilisation of forest produce, while a further section covers mensuration of tree crops, studies of growth and yield, census or stocktaking of woodlands, economics and working plans. All these sections are aided by a central library and documentation bureau, a photographic section, and a statistician. The Commission also operates a work study section.

The general scope of the Commission's direct research and investigation lies with the immediate practical problems of the forester. For some of the more fundamental work, it is the practice to enlist the help of specialists attached to the universities, and to make them appropriate financial grants.

The financial provision for all forms of research amounts to about 3 per cent of the Commission's total expenditure. Thirty graduate forest officers are employed full time on research work.

The principal fields of research up till now have been the raising of trees in nurseries, and their planting and establishment in the forests. This is in line with the very large programme of afforestation by artificial methods that is being pursued in Britain. The improved methods that have been developed as a result of such investigations have already amply repaid the effort and expense involved. For example, plants suitable for use in the forest are now regularly raised in two years, instead of requiring three or four years in the nursery as previously; and this means a big saving in cost and also in nursery area. The introduction of various methods of soil preparation by ploughing has led to much more rapid rates of growth in young plantations on very varied types of ground; land considered doubtful for afforestation only ten years ago can now be planted up with confidence.

As the new forests get taller, the emphasis of research is shifting towards problems of management, and the utilisation of their increasing output of thinnings. But planting trials are still in progress to discover, for example, whether afforestation can be carried out on still poorer soils or more exposed sites in the north and west. Provenance studies, and the formation of seed orchards for the large scale production of seed of known high quality parentage, are other fields in which investigations are being actively carried on.

The results of research are made known by means of an Annual Report on Forest Research, by bulletins and shorter papers issued at irregular intervals, and by contributions to scientific journals.

Education

Four Universities—Oxford, Edinburgh, Aberdeen and Wales—offer courses in forestry, and Forest Officers normally obtain a degree at one of them. The Commission undertakes the training of men for posts as Foresters in its own woods or on private estates. There are four training schools—one in England, two in Scotland and one in Wales, and the course of practical and classroom instruction, which is given free of charge to selected men, lasts two years.

The number of University graduate Forest Officers, Estate Officers, Scientific Officers and Engineers employed is 316, and the number of trained supervisory Foresters and Engineers, etc., is 1,410. The labourers engaged in the forests number over 11,000, while 900 people are employed in all grades of office administration and clerical work (1963 figures).

The Commission also organises short courses of a few weeks' duration for adult forest workers and woodmen. Other courses, lasting only one week, are arranged for woodland owners, estate agents, and others professionally engaged in forestry. Most of these, together with refresher courses for the Commission's own staff, are held at a residential centre called Northerwood House in the New Forest

Finance

The current (1963) level of annual expenditure on the Commission's own estates is £11,500,000. Income from sales of timber, rents, royalties, etc., amounts to £3,300,000. During the present phase of developing large areas of young woodlands, expenditure is naturally far in excess of receipts, but this situation will be remedied as more woods approach maturity and give higher yields of timber. £1,400,000 is expended as grants and other forms of assistance to private woodland owners, £400,000 on research and £300,000 on the education of foresters, and other special services.

The net state investment in home forestry is now about £11 million per year, whereas the annual cost of timber and forest produce imported from abroad amounts to some £460 million (1960 figure).

Other Agencies concerned with Forestry

There are several other official bodies or national institutions that are concerned with forestry; all of them work in co-operation, to varying degrees, with the Forestry Commission. The two Departments concerned with farming, that is the Ministry of Agriculture, Fisheries and Food in England and Wales, and the Department of Agriculture and Fisheries for Scotland, encourage the planting of shelterbelts to protect farm lands, and give grants towards the cost. The Ministry of Housing and Local Government and the Scottish Development Department deal with the scenic aspect of trees, more particularly in the towns, and make legal orders for the preservation of trees or woods of exceptional natural beauty. The Nature Conservancy maintains woodland nature reserves, and promotes the study of the biological sciences. Research into the properties and uses of timber is undertaken by the Forest Products Research Laboratory at Princes Risborough in Buckinghamshire, about 40 miles north-west of London, which comes under the Department of Scientific and Industrial Research.

The Forestry Universities not only train forest officers but also carry out research. There are two Royal Forestry Societies, one for Scotland and another for England and Wales, which organise meetings and visits to woodlands, and publish journals; their membership includes woodland owners, land agents, timber merchants, and professional foresters of all grades. There is also a more strictly professional Society of Foresters of Great Britain, which issues the journal "Forestry". World forestry literature is abstracted by the Commonwealth Forestry Bureau at Oxford which publishes "Forestry Abstracts".

In several districts there are also Co-operative Forestry Societies which are essentially commercial in character; they provide their members, who are usually the owners of fairly small areas of woodland, with professional assistance in planting, management, and marketing timber. The interests of the woodland owners as a whole are represented by the Timber Growers Organisation (in England and Wales) and by the Scottish Woodland Owners Association.

The Principal Trees Grown

A major change is in progress in the composition of Britain's forests, involving a swing from the native broadleaved trees, principally oak and beech, towards coniferous trees, all but one of which have been introduced

from abroad. This trend is shown in a general way by the table that appears below; for various reasons this cannot be taken as an exact comparison; but it shows the prevailing trend.

Species					Percentage of High Forest occupied in 1947	Percentage of Forestry Commission planting in 1963
Oak	...	...	...	...	24	—
Beech	...	...	...	...	9	2
Ash	...	...	...	...	5	—
Birch	...	...	...	...	3	—
Sycamore	...	...	...	...	3	—
Elm	...	...	...	...	1	—
Sweet Chestnut	...	...	...	...	1	—
All other Broadleaved trees	...	...	...	...	1	1
Total Broadleaved					47	3
Scots pine	...	...	...	...	20	16
Sitka spruce	...	...	...	...	9	32
Norway spruce	...	...	...	...	8	8
European larch	...	...	...	...	8	1
Japanese larch	...	...	...	...	3	3
Corsican pine	...	...	...	...	2	5
Douglas fir	...	...	...	...	2	4
Lodgepole pine	...	...	...	...	—	18
All other conifers*	...	...	...	...	1	10
Total Conifers					53	97
Grand Total, All Trees					100	100

* Includes Western hemlock (*Tsuga heterophylla*); Western red cedar (*Thuja plicata*); Hybrid larch (*Larix x eurolepis*); Serbian spruce (*Picea omorika*); Lawson cypress (*Chamaecyparis lawsoniana*); Grand fir (*Abies grandis*), and Noble fir (*Abies procera*).

This table compares the percentage area of high forest plantations under each kind of tree in 1947 (the last date for which complete figures are available), with the percentage of each tree used currently (1963) by the Forestry Commission. At present, the Commission's work covers 62 per cent of all planting done, and it is known that planting on private estates follows similar trends. Hence the left-hand column indicates the past composition of the woodlands, and the right-hand column the likely future composition, if current practice continues. The most remarkable change is the reduction in the proportion of broadleaved trees, with oak falling most markedly. Several conifers show large increases in the proportion planted, particularly Sitka spruce and Lodgepole pine. Reasons for these changes are discussed later.

Obviously there must be good reasons for such a remarkable alteration in the character of a country's forests, and these are, of course, basically economic. The current demand for timber and forest products, such as wood

pulp, in Britain, is for 90 per cent softwood and 10 per cent hardwood. Further, while softwood of any grade is acceptable for one purpose or another, the markets for hardwoods require large logs of high quality, whereas smaller or inferior material is difficult to dispose of at a reasonable price. Then the rate of volume production of the conifers, on nearly any site, is commonly greater than that of the broadleaved trees, and the extra price obtained for high quality broadleaved timber seldom compensates for this shortcoming in growth rate. Finally, much of the land available for afforestation, especially among the northern and western hills, is incapable of growing broadleaved trees to a marketable size, whereas it will produce conifers of reasonable dimensions. Consequently, both the Forestry Commission, which exists to meet the needs of industry, and the private owners who have to consider even more closely their likely financial returns, are both concentrating on the planting of conifers. Broadleaved trees are only used in places where past experience suggests a future crop of rapid growth and high quality; such situations are far more frequent in the Midlands, the South and the East of England, than elsewhere.

Since Britain has only one native timber-producing conifer, the Scots pine, which is a relatively low volume producer and unsuited to certain conditions of soil and exposure, recourse has been had to several kinds of introduced coniferous trees. The number tried experimentally reaches 100, but as a result of trial and error, only 15 are now grown on a commercial scale.

Scots Pine (*Pinus sylvestris* L.)

This native tree retains its well-merited place in our forests because it has a fairly wide tolerance of soil and site. It also gives better results than most other trees on many of the less fertile moors, characterised by a growth of pure heather, *Calluna vulgaris*, over subsoils of sand or gravel, in the low rainfall areas on the eastern side of the country. Its main drawback is its moderate rate of growth, and this often causes faster-growing conifers to be preferred. But its timber is widely known and well-liked, and thinnings of all sizes are marketable; timber of this species is imported in great quantities from Northern Europe under the trade name of "redwood" and hence all users are familiar with it. Scots pine is planted all over Britain, but the principal pine-woods lie in North-East Scotland and in Eastern England. In 1947 woods of Scots pine covered 360,000 acres (147,000 hectares); the Commission now plants about 9,000 acres (3,600 hectares) of it annually, and it is widely used on private estates.

Corsican Pine (*Pinus nigra* var. *calabrica* Schneid., syn var. *maritima* Melville)

Although this Mediterranean tree might appear to be well outside its climatic range in Britain, it thrives amid the warm, dry conditions that are found along the eastern side. In lowlands with a low rainfall and a warm summer it grows rapidly, producing substantially more timber per acre than the native Scots pine. It has proved particularly useful for afforesting sand dunes, since it withstands both drought and salt winds. On the other hand, it has failed when planted under the high rainfall and cool moist conditions of the north-western hills. There is some evidence that this species may also be successful on the heavy soils of England which used to grow rather indifferent oak. About 2,000 acres (800 hectares) are planted annually.

Lodgepole Pine (*Pinus contorta* Douglas)

This tree has recently come into prominence following extensive trials by the Research Branch; in 1947, there were only 3,260 acres (1,200 hectares) of

it in the country, whereas today some 10,000 acres (4,000 hectares) are planted annually. The reason for this is the surprising tolerance of the coastal strains (though not the others) to severe exposure and high rainfall on infertile peaty soils in the north and west, where no other tree will thrive. Although it is regarded primarily as a pioneer, there are indications that its timber is equal to Scots pine, with a faster rate of growth.

Other Pines (*Pinus* species)

The Austrian pine, *Pinus nigra* var. *austriaca*, Asch. and Graeb, always shows poor form in Britain, and is used only for shelterbelts, not for timber. Monterey pine, *P. radiata*, and maritime pine, *P. pinaster*, are hardy only in the south, but are used in Devon and Cornwall. No five-needled pine is grown commercially, since the species best suited to growth in Britain all suffer from blister rust (*Cronartium ribicola*), aphids (*Adelges strobi*), or both these pests together. Efforts are being made to find a rust-resistant five-needled pine.

Norway Spruce (*Picea abies* Karsten)

The common European spruce has been widely planted on private estates since the eighteenth century, and is still much used there and in Commission forests. It grows well on moist grassy sites and on old woodlands in most parts of the country. In the south and east it is unsatisfactory, however, on all but the dampest of ground, where rainfall is less than 30 inches a year. It does not thrive on acid heaths with a vegetation of pure heather (*Calluna vulgaris*) nor on very acid peats, and it cannot stand severe exposure, particularly to the salt winds found on the west coast. Elsewhere, it proves a rapid producer of a useful timber, which is also imported in quantity from Northern Europe as "whitewood" and hence is familiar to users everywhere. Thinnings have proved very suitable for paper pulp and chipboard, amongst other uses. Young trees and the tops of older ones are sold each winter as decorative "Christmas trees". In 1947, Norway spruce plantations covered 133,000 acres (53,200 hectares); current planting by the Commission is at the rate of 5,000 acres (2,000 hectares), a year, and much is also used on private estates.

Sitka Spruce (*Picea sitchensis* Carr.)

This western North American spruce is used to an even greater extent than the Norway spruce, because of three virtues: it is much more resistant to exposure at high elevations, or near the sea; it tolerates considerably more acid peats or heathy vegetation; and it produces timber at a rather more rapid rate. Like the Norway spruce, it is unhappy during the warm dry summers in the south-east, but is entirely at home under the high rainfall and moist, cool conditions of the north-west. Another failing is a susceptibility to damage by late spring frosts in valley bottoms; hence Norway spruce is used there instead. Rapid height growth is common, many trees only 30 years old exceed 100 feet. The timber closely resembles that of Norway spruce, and is used for much the same purposes. Sitka spruce plantations covered 167,000 acres (65,000 hectares) in 1947; the Commission plants about 17,000 acres (6,500 hectares) annually.

Other Spruces (*Picea* species)

The Serbian spruce (*Picea omorika* Pancic) shows promise on difficult peaty ground, but planting is restricted by limited seed supply. Several other species have been tried, but none adopted generally.

European Larch (*Larix decidua* Miller)

The common European larch has been very widely planted on private estates since the eighteenth century, but the experience of the Forestry Commission has been that it is only a success on selected fertile and well-watered sites, away from severe exposure. Extensive provenance experiments have shown that strains from high mountain regions are unsuited to the British climate; trees of wrong provenance suffer from canker and other diseases causing die-back; plants raised from seed gathered at lower elevations in Europe, or in Scotland, prove much hardier. Larch timber is valued for its naturally durable heartwood, and thinnings are widely used for fencing and estate repairs. Large logs furnish planks for the wooden fishing boats that are still built in Scotland. European larch plantations covered 133,000 acres (52,000 hectares) in 1947; the Commission currently plants 1,000 acres (400 hectares) annually, and private owners probably use as much.

Japanese Larch (*Larix leptolepis* Gord.)

Since the beginning of the present century this larch has been planted on an increasing scale, because it appears better suited to a wider range of British conditions than the European species. Its rate of growth, especially in youth, is considerably greater, an increase in height of 3 feet a year being quite usual. It stands more exposure and tolerates less fertile soils than does the European species. Japanese larch has proved very useful for planting on hillsides covered with bracken fern (*Pteridium aquilinum*); it is also a good tree for suppressing unwanted regrowth of cleared broadleaved coppice. At first, on the basis of tests carried out too early on young, very fast grown samples, its timber was adjudged poorer than that of European larch; more recent tests made on normal samples suggest that it is just as strong, and therefore likely to find the same markets. There were only 55,000 acres (22,000 hectares) of Japanese larch in Britain in 1947; but the Commission now plants 2,000 acres (800 hectares) annually, and it is much used on private estates.

Hybrid Larch (*Larix eurolepis* Henry)

British foresters take a justified pride in this remarkable tree, a natural hybrid between European and Japanese larches which was discovered at Dunkeld in Scotland about 1904. The first and probably the second cross are even hardier and more tolerant of difficult soil conditions than the Japanese larch, and grow even faster. At present planting is limited by the shortage of seed, but seed orchards have been formed to ensure ample future supplies of first-generation hybrid seed; the two parent species have been planted together to ensure a high probability of cross-fertilization.

Douglas Fir (*Pseudotsuga taxifolia* Britton=*P. menziesii*)

This Western North American conifer has been planted on a moderate scale for over 100 years, but experience has shown that it only does well on selected ground. It thrives best on fertile slopes, preferably on former woodland. A drawback is its susceptibility to windthrow, on all but the firmest of ground. As against this, its rate of timber production is rapid, and the resulting timber, which is imported in quantity from British Columbia, has a high reputation in the timber trade. Only Douglas fir of coastal provenance (sometimes called "green Douglas") grows well as a timber tree in Britain; trees of inland provenances (such as the "blue Douglas") prove unsatisfactory. Douglas fir is particularly useful for planting amid thickets of *Rhododendron ponticum*; since its dense shade suppresses regrowth. Douglas fir is being increasingly used in mixture with beech. About 2,000 acres are planted annually.

Silviculture

The prevailing concern in British silviculture is the establishment and tending of large areas of coniferous crops, partly on fresh ground and partly on former woodland, mainly by artificial methods; of necessity these crops are even-aged, though many soon become uneven-sized. Other forms of silviculture, such as those involving natural regeneration and uneven-aged crops, are the subject of much interest and study, but they involve only a small proportion of the area dealt with each year. As examples of natural regeneration, oak has been successfully treated in the New Forest and the Forest of Dean, and beech is commonly regenerated naturally in the Chiltern Hills north-west of London; Scots pine regenerates readily in the South of England, but unfortunately more slowly and less certainly in Northern Scotland. On some private estates and a few Commission forests, particularly in Scotland, the Swiss *Méthode du Contrôle* is being applied experimentally to crops of woodlands suitable for selection management. These operations follow conventional lines developed on the Continent; whereas the artificial regeneration methods are perhaps of greater interest because of their large scale, their degree of mechanisation, and the introduction of new ideas and methods.

Seed Supplies

Seed of only a few species, notably oak, beech, Scots pine and European larch, is generally available in sufficient quantity from home sources; because of the emphasis on exotic conifers, much of the seed used must be imported. Seed orchards have, however, been established in order to ensure home supplies of seed of selected strains of the main trees grown. In practice, the Forestry Commission imports nearly all the seed used for both its own and private estate planting; great care is taken to ensure that only suitable provenances are obtained. Forest Tree Seed Associations, representative of the woodland owners, the nurserymen, and the Forestry Commission, have been established in Scotland, and in England and Wales, to ensure the supply of seed and plants of known, certified origin.

Nurseries

The Commission's nurseries cover altogether 1,850 acres (720 hectares) and a considerable further area is worked by commercial nurserymen to supply private estates. Owing to the risk of introducing fresh pests and diseases, quarantine regulations forbid the import of nearly all conifers, except as seed, from abroad. Hence nearly all planting stocks used are raised in Britain; the annual output from Commission nurseries averages 116 million transplants; current stocks run at 260 million seedlings and 150 million transplants. Most of the work is concentrated in large nurseries, usually one or two in each Conservancy, and at these the Forester in charge devotes all his time to nursery work. The aim everywhere is to raise large, sturdy, transplants, cheaply, in as short a time as possible. For many species, one year in the seedbed and one year in the transplant bed suffices; others need two years in the seedbeds but plants older than four years are seldom used. Very little forest planting is done with seedlings; extensive trials have shown such plants to be too unreliable in the forest. Direct sowing in the forest is likewise unsatisfactory.

Heathland Nurseries and Seedbed Methods

Since 1945, the trend has been to raise seedlings in what are called "heathland nurseries", because they are deliberately established on poor sandy soil amid the heaths. Although such ground is poor in nutrients, it is quite free from the common weeds found on arable land, and it can be easily and cheaply

cultivated with tractor-drawn implements. It is usual to add an organic manure to bring the soil into the right condition; the standard material is spent hops, a by-product of the beer-brewing industry which is available cheaply in sufficient quantities in most parts of the country. Spent hops are completely weed-free, whereas farmyard manure always brings with it a quantity of weed seeds. A heavy initial dressing of spent hops is needed for new nurseries, about 20 tons to the acre (50 metric tonnes per hectare).

The spent hops alone do not provide enough nutrients for optimum growth. Therefore inorganic fertilisers containing nitrogen, potassium, and phosphorus are added in forms and quantities which are prescribed by the Research Branch. The resulting seedlings are large, sturdy and well rooted; for example, Scots pine seedlings one year old are often 6 inches high, and fit for transplanting.

Both broadcast and drill sowing methods are used; the latter method is sometimes mechanised. Coarse sand or grit is always used to cover seed; fine sand or earth is found to cake and to lessen the yield. Lath screens are often used to shield seedbeds from frost, or occasionally in the south, from strong sun. Irrigation is seldom found necessary, but a few nurseries have installations.

Transplanting

The need to transplant about 260 million seedlings annually, in the Commission's nurseries, has led to a concentration on mechanical methods. American machines on the cabbage-planter principle are used, however, only on a very small scale, since they will only operate economically on a large expanse of flat sandy soil, which is seldom available in Britain. The basis of transplanting therefore remains the wooden board, familiar on the Continent, into which the seedlings are inserted by hand, usually by women or boys. The preparation of the soil, the opening up of the trench, and the subsequent earthing up of the roots are done by tractor-drawn implements. One successful arrangement of these is known as the "Ledmore Lining-Out (i.e. Transplanting) Plough", designed by Forester Rose at Ledmore Nursery in Scotland. It performs all three operations efficiently and cheaply, yet is small enough to be drawn by the "Ferguson" wheeled tractor commonly used in nurseries. A similar machine is the "York" transplanting plough, invented by Forester Sharp. The lifting of transplants when large enough for the forest is also mechanised, using a sledge-like implement drawn by a tractor.

Weed Control by Oil and Chemical Sprays

Where weeds are troublesome, either in seedbeds or transplant lines, their control is made easier and cheaper by spraying small quantities of selected oils and chemicals with the aid of compressed air. A form of tractor fuel (Diesel fuel) has been found very effective for spraying seedbeds, after sowing but before tree seedlings appear; to some extent it acts selectively, killing weed seedlings but doing little or no damage to conifers. Transplant beds are treated with "Simazine", which stops weed seeds germinating. Polythene bags are used for the transport of the young trees to the forests, to check any drying out.

Ground Preparation on Afforestation Areas

Probably the most remarkable feature of current British forest practice is the attention paid to thorough ground preparation by mechanical ploughing and subsoiling on all suitable new afforestation areas. Former woodland still holding sound stumps, steep slopes, or rocky ground, cannot readily be ploughed, but elsewhere some form of cultivation is the rule. The expense of

this work is considered to be well repaid by the better and more even growth of the young plantations, the lower weeding costs, and the reduced risk of damage by fire during the first few years. Complete ploughing is not found satisfactory or worth while; the ploughing of furrows about 5 feet (1.5 metres) apart is considered best; depths of 9 inches to 1½ feet (23 to 46 cms.) are used. This technique originated in trials of the Belgian method of draining combined with planting on turfs, in the 1930s. For many years hand drainage and turf planting was followed with good results on peaty land. From 1935 onwards various ploughs, drawn by tractors, were developed to produce both drains and turfs mechanically, at lower cost than hand work.

Ploughing as now carried out falls into three main classes:

- (a) On peaty soils, to provide drains and turfs.
- (b) On heaths with podsoles to cultivate the soil to break the "hard pan" layer below ground, and to suppress heather.
- (c) On grassland, to provide shallow cultivation and to suppress vegetation.

Different types of plough and tractor are employed for each kind of ground.

The usual planting distance for conifers is 5 feet (1.5 metres); close spacings are used for broadleaved trees. On mineral soils planting by the notch method is the rule. On peat soils, planting is done in turfs or mounds, and for this work the Belgian semi-circular spade is favoured at several forests. Elsewhere a straight-bladed notching spade, or a mattock, is the usual tool. High rates of planting are achieved, with satisfactory results. It is usual for one man to plant 500 to 1,500 trees per day. Ploughing enables small trees to be planted successfully; transplants from 6 to 12 inches (15 to 30 cms.) are favoured for bare ground. Larger transplants from 12 to 24 inches (30 to 60 cms.) are used in former woodland.

Drainage is mechanised where possible, the most useful tool on peaty ground being a single-furrow, tractor-drawn plough; but hand work is always needed to complete the network of drains.

Fencing is nearly always required around plantations in Britain. In most districts rabbits are still present, and wire netting fences are needed locally to keep them out. At present their numbers have been reduced by the myxomatosis disease, but it is feared that they will again increase. Deer, particularly red deer, *Cervus elephas*, cause damage in the Scottish Highlands, where it is often necessary to erect fences 6 feet (2 metres) high. Roe deer (*Capreolus capreolus*) are also troublesome locally. Deer are controlled by carefully planned shooting.

Replanting of Former Woodland

This follows conventional lines except in one important particular. Where any light cover, for example of birch or hazel, exists on the ground, it is usual to preserve it, thinning it out if required, and to plant the fresh crop beneath it. This preservation of overhead cover is found to give better early growth than that obtained by a complete clearance of the ground prior to replanting. Another advantage is the sparser weed growth that results, and consequently the cheapening of early maintenance.

Tending Young Plantations

Little weeding is needed on ploughed ground, as vegetation around the young trees is suppressed and does not return for two or three years. Elsewhere,

one or two weedings each year are often needed to safeguard the young trees; the bracken fern, *Pteridium aquilinum*, and the bramble shrubs, *Rubus* species, are particularly troublesome weeds in many areas. Plantations on former woodland are often invaded by unwanted birch trees, and by climbers such as honeysuckle, *Lonicera periclymenum*, which must be cut out at a later stage.

A common practice in Britain, though one that is seldom followed elsewhere, is the "brashing", or pruning away of side branches from young conifers up to a height of 6 feet, using two-handed curved pruning saws. A limited amount of pruning of selected stems, to a height of eighteen to twenty feet, is carried out at later date, but in selected crops only.

Fire risk in young plantations is high, since even in high rainfall areas a dry spell in spring coincides with the presence of dry and inflammable vegetation. The lay-out of roads, rides and compartments at all forests is planned with fire risk in mind. Water supplies are organised and fire towers are built at the larger forests. The main reliance in fire fighting is placed on specially equipped lorries, manned by trained teams of forest workers. These lorries carry a water supply of about 400 gallons, together with mechanical pumps deliberately designed to supply this slowly through small hose pipes. They can reach most parts of the forests, and are used for the first attack, applying water more to aid beating by hand, than to extinguish the fire directly. This first prompt attack often controls the fire, at least until the public fire brigades, with more powerful pumps and bigger hoses, can be brought into action. A good system of communication by telephone and short-wave radio ("walkie-talkie") is organised for fire-fighting control in the larger areas. There is close co-operation with the local public fire services.

Measures to protect tree crops from insect pests or fungal diseases are only occasionally necessary. The most general one is the treatment of the stumps of felled conifers with creosote to check infection of the crop's inter-linked root system by the Heart-rot fungus, *Fomes annosus*. The spraying of insecticides from the air has, however, been used with good effect on a few isolated epidemics of the Pine looper moth (*Bupalus piniarius*).

Thinning

Crops of conifers are usually ready for their first thinning between 20 and 25 years after planting. The intensity of thinning is a question to which much thought is directed, but practice varies according to species and the views held by various foresters. Most thinnings, however, may be classed as "free thinnings", though "crown thinnings" are coming increasingly into favour. Markets for poles and small trees removed as thinnings are often difficult and costs must be closely watched. For many years to come thinnings will form the major source of produce from Commission forests; they are estimated to account for half the total yield of an average plantation, since their aggregate volume equals that of the final crop.

Rate of Timber Production

The rate of growth of coniferous tree crops in Britain is often high by the standards of Northern Europe or North America. Careful measurements have been made for nearly 40 years by the Commission's Research Branch which maintains a large number of sample plots, and yield tables have been published. These records show that on good sites in the high rainfall areas of the north and west, certain introduced conifers such as Sitka spruce and Douglas fir may show a mean annual increment of 200 or even 300 hoppus feet per acre (18 to 27 cubic metres per hectare) per annum over the first fifty years. Such rapid

growth is not of course found for all species nor in all districts, but a relatively slow growing tree like the Scots pine commonly produces 100 hoppus feet per acre (9 cubic metres per hectare) per annum. Little precise information is so far available on the rates of growth of broadleaved trees, but they appear to resemble those found on the Continent.

It has often been suggested that the high rates of growth shown by certain conifers will be associated with timber of lower quality than normal. This important matter is currently under investigation by the Forest Products Research Laboratory. The research results obtained so far suggest that the fast grown material is not seriously inferior in strength to more slowly grown wood. It has been readily accepted for paper pulp, chipboard, boxboards and building uses.

Although home-grown timber is sold at prices well below those of imported material, transport from the outlying districts where many new forests are situated remains an adverse factor for the British forester.

Timber Consumption and Marketing

The current yearly rate of consumption of timber and other forest products (principally wood pulp and paper) in Great Britain is around 1,200 million true cubic feet (33.6 million cubic metres) calculated as round timber, under bark measure. This is equivalent to 24 cubic feet (0.67 cubic metres) per head for the 50 million people.

At present, home woodlands contribute only 10 per cent of this total, amounting to 120 million true cubic feet (3.36 million cubic metres). This is about the same as the current annual increment of the forests. The total volume of timber standing is estimated at 3,500 million true cubic feet (100 million cubic metres), equivalent to three years normal consumption. It is anticipated however, that the reserve, as well as the amount of timber harvested annually, will increase as young conifer plantations develop.

The marketing of the produce from British woodlands has to be fitted into its appropriate place beside the larger volume of timber imports. This is not an easy task, for timber users have become accustomed to overseas sources of supply and the importers' specifications and grades of material, and do not immediately change to home sources, even when comparable material becomes available at competitive prices.

Little difficulty is found in selling large logs of high quality oak, ash, beech, and sycamore. These have long been handled by old-established sawmills in the country towns, which have appropriate equipment to deal with them. The problems lie rather with the marketing of small-sized coniferous thinnings and the poorer hardwood material. Over the past ten years the Forestry Commission has been actively developing markets for such produce, and recently several timber-using industries, new to Britain, have been set up.

Two major old-established outlets for small trees are those for farm fencing and pit props for the mines. Throughout Great Britain generally, a high proportion of timber used for agricultural purposes is drawn from home woodlands, and so is the mining timber.

Recently developed outlets include:

(a) *Small Sawmill Timber*. Several new sawmills, especially designed to handle the small trees removed as thinnings, have been set up. A notable one is that at Strachur, in Argyll, West Scotland; it operates on the Swedish Ari system, and has its own seasoning plant.

(b) *Chipboard* (Particle Board). Factories have been established at Annan, in the south-west of Scotland; at Inverness in north Scotland; at Hexham in north-east England; and at Thetford in East Anglia. These are planned to produce a high-grade material from thinnings of spruce or pine plantations.

(c) *Fibreboard*. Factories making various kinds of hardboard or insulation board are operating in the London area, in south-east England and at Queensferry in North Wales.

(d) *Paper Pulp*. A major recent development is the building, by a commercial firm with Government support, of a paper mill at Fort William in the western highlands of Scotland. This mill, to be opened in 1965, will cost £20 million and use 267,000 tons of pulpwood from the Scottish forests every year. Most species of conifer will be accepted, and the process will be a sulphite semi-chemical one.

The use of spruce pulpwood for mechanical pulp is already well established, notably at Ellesmere Port in Cheshire, where there is a big newsprint factory that operates partly on imported, and partly on home-grown material.

Hardwood paper pulp is made on an extensive scale at the Sudbrook mill, near Chepstow in Monmouthshire.

(e) *Wood Wool*. Factories to make this substance, used mainly for packing, have been established in England, Scotland and Wales.

All these establishments are operated by commercial firms, who have consulted the Forestry Commission regarding the availability of continual supplies of raw material, before establishing their plant. A feature of most arrangements is that the owners of private estates are able to supply material to the new factories on terms comparable to those agreed with the Commission.

Social Implications of Forestry

The value of forestry in providing employment in districts where other activities are failing to provide a sufficient livelihood for the people is well known. It has recently received attention in Britain because of the growing depopulation of certain rural districts, notably in the uplands of Central Wales, the North-Western Highlands and Islands of Scotland, and some parts of Northern England. The Commission has undertaken to extend its activities in some of these districts, and to carry out, if necessary, planting schemes that do not promise any high economic return. It is found that overall one forest worker is needed to every 100 acres (40 hectares) of woodland, whereas 1,000 acres (400 hectares) are needed to sustain one shepherd under rough grazing. Obviously, all new planting in such regions has to be sited so as to cause the least possible disturbance to existing farming practices; but past experience has been that the advent of plantations, which use only the poorer ground and provide badly needed shelter, does not diminish the agricultural output of such regions.

The broad approach that the Forestry Commission is making to this problem is not always to try to acquire land in very large blocks or to plant up whole farms, but rather to acquire the relatively less valuable parts of farms, even though the extent of individual blocks may be quite small. In other words they are trying to arrange that forestry is developed alongside, and in conjunction with, agriculture. The hill lands are undoubtedly producing far less than they could, but the improvement will be made not by a change of use to forestry as an independent venture, but rather by improving and perhaps altering the methods of farming at the same time that new forests are

established. A combined operation, in fact, is needed, designed to create or restore a balance between forestry and agriculture.

Until 45 years ago Great Britain in effect had no forest policy, and though a comparatively small number of the larger private woodland estates managed their woods efficiently, and some with considerable enterprise, the State took a very small part in forestry. It is only since 1919 that the State has played an active rôle both in establishing its own forests and encouraging the proper management of private woods. In the short period since the 1914-18 war—short, that is, in terms of forestry—Great Britain has gone far in making forestry take its proper place in the life and economy of the country. In doing this she has drawn heavily on the experience and wisdom of the countries of Europe who have much longer history and tradition of forestry than she has.

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CONVERSION FACTORS

N.B. All conversions in the text are approximate.

1 Hoppus foot = 1.273 true cubic feet = 0.036054 cubic metres.
(The Hoppus foot is used for trees and round timber; but the true cubic foot is used for sawn timber.)

1 true cubic foot = 0.785398 Hoppus foot = 0.0283171 cubic metres.

1 foot (linear measure) = 0.3048 metres.

1 mile = 1.6093 kilometres.

1 acre = 0.4047 hectare.

1 Hoppus foot per acre = 0.08905 cubic metres per hectare.

RECIPROCAL OF CONVERSION FACTORS

1 cubic metre = 27.7362 Hoppus feet = 35.305 true cubic feet.

1 metre = 3.28084 feet.

1 kilometre = 0.62137 miles.

1 hectare = 2.4704 acres.

1 cubic metre per hectare = 11.2294 Hoppus feet per acre.

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- (a) Royal Forestry Society of England, Wales and Northern Ireland, 49 Russell Square, London, W.C.1. (Museum 4892).
- (b) Royal Scottish Forestry Society, 7 Albyn Place, Edinburgh, 2. (Caledonian 7402).
- (c) Timber Growers Organisation (For England and Wales), 35 Belgrave Square, London, S.W.1. (Belgravia 5323).
- (d) Scottish Woodland Owners Association, Ltd., 6 Chester Street, Edinburgh 3. (Caledonian 1905).

- (e) Society of Foresters of Great Britain, at: Forestry Commission, Greystone Park, Moffat Road, Dumfries, Scotland. (Dumfries 2425).
- (f) Commonwealth Forestry Association, at: Royal Commonwealth Society, Northumberland Avenue, London, W.C.2. (Whitehall 7209).
- (g) Commonwealth Forestry Bureau, at: Commonwealth Forestry Institute, South Parks Road, Oxford. (Oxford 57891).
- (h) Forest Tree Seed Association of England and Wales, 25 Savile Row, London, W.1. (Regent 0221).
- (i) Scottish Forest Tree Seed Association, 25 Drumsheugh Gardens, Edinburgh 3. (Caledonian 4782).
- (k) Forest Products Research Laboratory (D.S.I.R.), Princes Risborough, Buckinghamshire (Princes Risborough 101).

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