3. The upland question

At the outbreak of the First World War, hardly anyone in Britain had foreseen the devastating consequences of the German submarine campaign for the wood supply of the country. Before the war 92 per cent of timber was imported occupying 12 per cent of total shipping space entering British ports.\(^1\) In addition modern warfare required immense quantities of wood for huts, hospitals, roads, barges, trenches, ammunition cases, provision boxes and a whole host of other purposes. Even more important was the use of wood in mining operations and a shortage of pit props meant no mining, no coal, no heating, and no transportation and thus hampering a modern war effort. Indeed, importation of such a bulky material as timber naturally created difficulty when tonnage became scarce due to the activities of the German U-boats. The Prime Minister, David Lloyd George, speaking to the House of Commons in January 1917 on the limitations of imports by the submarine menace, placed timber first as absorbing most of the tonnage. He concluded, ‘if tonnage is to be saved [wood production] is the first problem to be attacked’.\(^2\) It is here that the men who had lobbied for the creation of a state forestry authority before the war saw their chance. This time they were successful in the light of the emergency of looming timber shortages and because of the fact that the leading figures in forestry of the day, such as Lord Lovat, had contacts high up in the government hierarchy.\(^3\) As a result, a forestry sub-committee was added to the Government Reconstruction Committee with the mission to ‘consider and report upon the best means of conserving and developing the woodland resources of the United Kingdom, having regard to the experience gained during the war’.\(^4\) The forestry sub-committee was headed by Francis D. Acland (1874-1939), and became subsequently known as the ‘Acland Committee’. Roy Robinson of His Majesty's Office of Woods, and future chairman of the Forestry Commission, assisted Acland as secretary of the Committee. The Committee included most of the people who had played an important role in Scottish forestry before the war and who were destined to play major roles in the future Forestry Commission. Other committee members included Lord Lovat, who was to become the Forestry Commission’s first chairman, T.H. Middleton of the Board of Agriculture and Fisheries; Professor William Schlich from the Oxford School of Forestry; John Sutherland of the

\(^3\) Glasgow City Archives (hereafter GCA): T-PM 122/4/7/2 BBC forestry talk no. 2, 29 March 1928.
Board of Agriculture for Scotland and who became the Forestry Commission's first Technical Commissioner; and John Stirling Maxwell, who went on to become a Commissioner and third Chairman of the Forestry Commission.\(^5\)

The work of the Committee was not easy because of the lack of information on the extent and quality of the country’s wood reserves. In his history of the Forestry Commission George Ryle,\(^6\) commented that ‘the sub-committee examined in great detail the available, if rather unreliable, statistics in regard to the acreage of woodlands ... and land suitable for expansion’.\(^7\) It is almost certain that the Committee relied heavily on Lovat’s knowledge of the extent of woodland and land suitable for forestry in upland Scotland that he had gained during the Great Glen survey of 1911. Notwithstanding the lack of reliable statistics, the Acland Committee was not prevented from producing a report that recommended the introduction of an adequate nation wide forest policy. The timber shortage caused by the First World War did not need hard statistics to prove the need for such a policy.

After a description of British forestry before the war, the Acland report next looked at the depredations on the forests in Britain as a result of the war. It concluded that dependence on imported timber had proven a source of strategic weakness in time of war and had caused a serious shortage of timber. The forestry sub-committee believed that a timber famine would be inevitable not only in a future war but also in peacetime because of the escalating world demand for timber. In this context, the sub-committee showed a deep concern about the over-exploitation of Canada’s natural forests.\(^8\) The Acland report also emphasised the social and economic benefits of afforestation such as rural employment and a strengthened Highland economy. The Acland Committee regarded the creation of smallholdings by a new State forestry agency as one of the cornerstones of forestry policy. In their view forestry was a means to repopulate upland rural areas and to create a secure supply of labour to carry out the massive planting programme. They envisaged that ‘the small holdings will be grouped together on the best land within or near the forests so as to economise labour in the working of the holdings, ... and to provide an ample supply of ... labour for [forestry] work. Families settled on new holdings in forest areas will be a net addition to the resident rural population’.\(^9\)

The final conclusions of the Acland report formulated three objectives for a British forest policy: firstly maintaining an adequate reserve of standing timber in case of any emergency, secondly the desire to make better use of uncultivated

\(^{5}\) Ibid.
\(^{6}\) G.B. Ryle was deputy director of the Forestry Commission from 1963 to 1965.
\(^{8}\) Ibid., p. 5,14, 27.
\(^{9}\) *Report of the Sub-Committee on Forestry*, p. 28.
3. The upland question

and derelict land and thirdly, the general well-being of rural Britain, including rural employment. These three objectives remained the justification for British forest policy for almost 40 years.

The Acland Committee concluded that in order to meet these objectives the woods of Great Britain should be gradually increased from 1.2 million hectares to 3.12 million hectares. It suggested further that in the first ten years 61,000 hectares should be planted by the state and 20,000 hectares by private landowners receiving state assistance. The planting had to be supervised and conducted by a state forest authority ‘equipped with funds and powers to survey, purchase, lease and plant land and generally to administer the areas acquired’. The Committee advised the Government to create a forest authority with the responsibility to co-ordinate and carry out forest policy in Britain, and that it should be called the Forestry Commission.

It is must be borne in mind that the Acland Committee considered forests as the source of a commodity: timber. The main purpose of the forestry programme was the economic wellbeing and security of the country: ‘the true justification for national afforestation is the wellbeing of the country. Wood is one of the prime necessities of life’. Wood was placed here on the same footing as grain and other agricultural products and the report concluded that ‘next to food, [timber] is the article of which an abundant supply is most essential to the nation’. Considerations such as amenity, wildlife and nature conservation were not mentioned in the report because this was not within the merits of the Acland Committee and the Forestry Commission was simply not envisaged as a nature conservation organisation.

The Government implemented the recommendations of the Acland Report almost to the letter and in the summer of 1919 the Forestry Bill was smoothly rushed through parliament and received Royal assent in August of that year. The discussions in parliament focussed on issues such as the organisation of the Commission, employment in rural areas and finance. Again, environmental issues were not raised because they were not an issue in the context of the aims and objectives of the proposed national forestry policy. The Forestry Act of 1919 established the Forestry Commission and charged it with the responsibility for ‘promoting the interests of forestry, the development of afforestation, and the production and supply of timber, in the United Kingdom’.

The main goal of the Forestry Commission was to establish strategic wood reserves in order to decrease reliance on imports in case of another war. The

10 Ibid., p. 5.
11 Ibid., p. 76.
13 Forestry Act 1919, 3-1.
Commission had two main roles: it was to function as a ‘forestry enterprise’, which would acquire, plant and manage forested lands. Its second function was to serve as a ‘forestry authority’ that would administer licenses for felling and grants for planting. The Forestry Commission was given public authority over all of Great Britain (including Ireland) and the legal status of a government department. It was the first state-controlled production industry in Britain.

**Practical problems**

The Forestry Act that established the Forestry Commission came into force in September 1919. The first Forestry Commissioners were appointed on 29 November of the same year and on 7 December they held their first meeting in London. After the meeting, chairman Lovat and commissioner Clinton decided on a wager and a little competition to see who could plant the Commission’s first trees. When Lovat arrived at Elgin in Scotland he was handed a telegramme from Clinton informing him that the Commission’s first trees, all broadleaves, were planted at Eggesford forest in Devon. The Forestry Commission’s planting programme in England had started a few hours ahead of Scotland.

These first trees, a number of beech and larch, were only the beginning of the large planting programme the Commission was embarking on. However, these first trees were planted on fertile and accessible land unlike the majority of the millions of trees that followed. The creation of large new forests was difficult because the majority of land available for forestry was on poor soils in the upland and exposed to severe climatic conditions. It was realised from the early days of the Forestry Commission that the best grounds had to be reserved for agriculture to secure food production. After the two World Wars food production was perceived as more important than the production of timber because it helped to reduce imports of agricultural products, saving money, and provided a strategic advantage in time of war. A quote from a little booklet on afforestation written by John Boyd, head forester of Corrour estate, just after the First World War illustrates this concern:

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17 John Boyd was forester on the Corrour estate, owned by John Stirling Maxwell. He oversaw planting experiments conducted here and contributed considerably to the knowledge of planting on elevated peat.
...it must be borne in mind that all land suitable for cultivation, excepting such small areas as are required for nursery purposes, will be excluded from planting in any well-considered planting scheme.\textsuperscript{18}

Furthermore, as the Forestry Commission began to acquire land, it could only afford to purchase cheap, marginal, upland areas that were mainly used as grazing lands. In order to reduce the costs of forestry, the Commission also had to carry out land acquisition on a large-scale, and the only place where inexpensive land was held in large unit ownership was in the Scottish uplands and, to a lesser extent, in northern England. In addition, it was still widely believed that these marginal upland areas were economically wasted and had generally degenerated from a more fertile turning into a ‘...wide desert where no life is found’. This was blamed on a combination of a wet climate and agricultural mal-practices: ‘Selective grazing by sheep or deer, and, in this region of high rainfall, the tragic practice of moor burning, have hastened the process of regression into utter wasteland’.\textsuperscript{19} This perception of the Scottish uplands as a ‘wet desert’ was made popular by the famous Scottish ecologist Frank Fraser Darling a decade later.\textsuperscript{20}

In general, the upland areas available for forestry were characterised by high elevation, the presence of peat and heather, low soil fertility, high rainfall and high wind exposure, which meant that these grounds were not particularly suitable for forestry. When the Forestry Commission started its work, it included some old woodland areas, such as Eggesford Forest in the south of England, where the ground was fertile and which were within existing forestry science experience. However, for the reasons explained above, it was necessary to push beyond the limits of traditional estate forestry into the poorer upland grazing, heathland and moorland. It was here that the Commission was confronted with the problem that large-scale planting of upland peat lands far outstripped contemporary experience, as was observed by Henry M. Steven (1893-1969), Professor of Forestry at Aberdeen University: ‘This raised many technical difficulties because … their successful afforestation was a battle with nature’.\textsuperscript{21}

The Forestry Commission faced four interlinked problems: which species grow best on upland soils; how to cultivate wet and peaty soils on a large scale; how to deal with extreme varying climatic and soil conditions and how to deal with wind exposure.

\textsuperscript{18} John Boyd, \textit{Afforestation} (London/Edinburgh, 1918), p. 17.
Choice of tree species

During the 18th and 19th centuries Scottish forestry was centred on the counties on the east side of Scotland between the Firth of Tay and Moray coast. These included the counties of Inverness, Nairn, Moray, Banff, Aberdeen and Angus and further south Fife and the Lothians. As a result of the work of the Forestry Commission, there was a striking shift of forest cover to the counties in the west, north and south of Scotland, most notably Argyll, Ayrshire, Kirkcudbrightshire and Ross and Cromarty. This break with tradition, as Anderson calls it, was most visible in the shift of tree species planted. During the 19th century tree planters had favoured European larch, Scots pine and Norway spruce and to a lesser extent various broadleaves, in particular oak. In 1889 the vice-president of the Royal Scottish Arboricultural Society observed in his opening address at the thirty-sixth annual meeting of the Society that oak was no longer worth cultivating, while the replacement of oak timber by iron for shipbuilding had made oak forests unprofitable. On the other hand he doubted if plantations of conifers would succeed in replacing broadleaves and he warned: ‘the newer coniferous trees are not to be recommended as plantation trees’. It seems that by the late 19th century broadleaved trees and the native Scots pine were still preferred over the newly imported North American conifers.

With the creation of the Forestry Commission in 1919 the situation changed dramatically because it required the afforestation of large areas of treeless and less fertile uplands. In addition the Ackland report had called for the greatest possible production from the land, which required the planting of high yielding species, in particular conifers. It was these developments that caused the break with tradition and brought non-native conifers into the prominent place that they came to occupy in the Scottish forests and woodlands of the 20th century.

When the Forestry Commission was established in 1919 all non-native conifers that we see today in Britain had already been grown successfully in Scotland. From the second half of the 19th century Douglas fir was increasingly planted and around the turn of the 20th century Sitka spruce, Japanese larch and Corsican pine appeared increasingly in the landscape. The question remained which tree would be most suited for the harsh conditions of the Scottish uplands that were available to the Forestry Commission. In addition no one had planted any of these non-native conifers on a large scale in these areas and for this reason much research was devoted to the selection of suitable tree species.

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Initially much effort was put into the selection of tree species with the objective of matching tree species to the right soil conditions, or, to put it another way, to find the trees that grow best on a certain soil. Some trees demand fertile soils to grow well and these trees are called exacting species, for example beech, ash, elm, oak and silver fir. At the other extreme are a few trees that will accommodate themselves to poor soils and they are called accommodating species and include pines, spruces, birch and willow. This distinction has huge consequences. Because broadleaf trees are more demanding than conifers, it is for this reason that conifers came to dominate plantations on poor upland soils.25

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<td>8.2</td>
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Table 3.1: Percentage of forest area by principal species and planting year classes, 1995.

Source: The Scottish Government/Forestry Commission.26

The shift in the composition of the Scottish woodlands can be observed in the change in the area of principle species in planting year classes from latter half of the 19th century up to 1995 (table 3.1). In 1995 the remaining areas of productive forest planted before 1921 are predominantly broadleaves, such as oak and birch, because these trees were more popular in the pre-Forestry Commission era. However, it is important to keep in mind that these figures do not provide the full picture of the composition of pre-1919 woodlands due to the fact that most of the conifers planted in that period had been harvested by the 1990s. From the 1920s onwards, conifers are more abundant in younger forests, with conifers contributing over 90 per cent of trees planted after 1960.

![Figure 3.1: Scots pine in Glen Affric.](photo)

Photo: Justine Kemp.

Over time, the range of conifers narrowed to a few species, in particular the Sitka spruce. As can be seen from table 3.1, the total land area planted with Scots pine came second only to Sitka spruce. However, the data gives a false impression of the levels of planting of this tree during the period 1919-1970. During the first decade of its existence, almost half of the trees planted by the Forestry Commission were Scots pine, but by the 1970s the planting of this tree
was almost negligible.\textsuperscript{27} Scots pine was initially the most planted tree because it was believed that this species, being the only native pine in Britain, grew well under most conditions in Scotland.\textsuperscript{28} It is true that Scots pine will grow under a wide variety of conditions but even by the early 1920s Henry Steven, then Forestry Commission research officer for Scotland, recognised that Scots pine would not do well on poorly drained peat soils. If planted on wet moorland, Scots pine will survive but grows too slowly to be of any commercial value. For this reason plantations of Scots pine were mainly located on the dryer soils of the east of Scotland. For the poor upland moors Steven observed ‘…[that] it will be necessary to seek for some more productive species for conditions which previous forestry experience has considered suitable for Scots pine’.\textsuperscript{29}

By 1933, the experiments at Inverliever had shown that only a few conifers were suitable for planting on wet peat soils. Scots pine thrives in areas where Sitka spruce, lodgepole pine and other spruces are likely to fail because the soil is too sandy and dry. Scots pine does well on well-drained sands, gravels and other well-drained sites. As a result Scots pine was dismissed as a useful tree on wet peat and confined to the drier sandy soils in the east of Scotland and to drier heath lands. On the wetter sites Sitka and Norway spruce overtook Scots pine as the most planted trees from the 1930s onwards. Norway spruce was planted on moist waterlogged sites of medium to high fertility, including the less acid peats, but because Norway spruce is less accommodating the proportion of planting fell in comparison with Stika spruce and lodgepole pine from the 1940s onwards.\textsuperscript{30} Lodgepole pine resembles Scots pine and, like the latter, is tolerant of poor soils and can tolerate wet conditions much better than Scots pine. It is therefore widely planted at high elevations on the poorest soils of western Scotland and will grow well with only low inputs of fertiliser. Its hollow roots bring air into the ground which helps to dry out water logged peat. Lodgepole pine is widely planted as a nurse to provide shelter for other trees, usually in mixtures of Sitka spruce. This practice almost ceased by the 1960s in favour of Sitka spruce because it was cheaper to concentrate on only one species.\textsuperscript{31}

The use of Sitka spruce had a profound impact on the shape of British forestry. Early in the 20th century J.D. Crozier had suggested that it was the best tree for producing timber on elevated land with wet soils, echoing the prophetic words of the famous tree seed collector David Douglas that Sitka spruce ‘would

\begin{itemize}
\item \textsuperscript{27} Mark Avery and Roderick Leslie, \textit{Birds and Forestry} (London: Poyser, 1990), pp. 7-8.
\item \textsuperscript{28} Ibid., p. 69.
\item \textsuperscript{29} H.M. Steven, ‘Coniferous Forest Trees in Great Britain’, \textit{Transaction of the Royal Scottish Arboricultural Society}, 34 (1920) 1, 61-82, p. 63.
\end{itemize}
Conquering the Highlands

thrive in such places in Britain where even \textit{P. sylvestris} finds no shelter'.

The ascent of Sitka spruce to become the most prominent plantation tree in Scotland began in the 1920s when Henry Steven wrote that he did not know 'a species, ..., which gives greater promise than Sitka spruce'. As head of the Scottish research branch he recommended that 'its various problems should be investigated without delay'.

It was in conjunction with research into new planting techniques for marginal grounds that Sitka spruce began to assume its dominant position on difficult sites. Because of its suitability for planting on the upland peat areas of Scotland, more research has been devoted to Sitka spruce in Scotland than to any other tree species during the 20th century.

![Figure 3.2: Sitka spruce plantation.](https://www.geograph.org.uk)

Photo: Steve Partridge, from www.geograph.org.uk with permission.


33 Steven, ‘Coniferous Forest Trees in Great Britain’, p. 77.

By the late 1920s many foresters had determined that Sitka spruce was the more suitable tree for wet and windy upland sites in Scotland. Although Sitka appears very well adapted to the conditions of the Scottish uplands, it has a few problems that prevented it from becoming the dominant tree in the interwar period. Sitka spruce thrives in a wet climate, but it does not grow in waterlogged conditions, and it hardly grows in competition with heather unless the heather is killed or enough fertiliser is added to enable it to outgrow the heather. It needed the development of the Cuthbertson plough in the 1940s and 1950s that could cultivate deep peat and suppress the heather, the aerial application of fertiliser and mechanical drainage that would fully unlock the potential of Sitka spruce in Scotland.\textsuperscript{35} For this reason, ground preparation became one of the major research areas for the Forestry Commission during the inter-war years.

**Ground preparation**

Fortunately, the Forestry Commission did not have to invent everything from scratch. In previous centuries, Scottish foresters had created a corpus of technical knowledge unrivalled in Britain. This experience was mainly gained during the hundred years between 1750 and 1850, when landowners in Scotland planted for pleasure but also started to create commercial forests, although their main aim was to enhance the amenity of the estates and not timber production. The arrival of exotic conifers from all parts of the world, but especially North America, helped to increase the interest in forestry among estate owners. Around 1890 most of the exotic conifers planted in Scotland were between 35 and 60 years old and the majority of these trees had been planted on fertile and sheltered sites where they thrived.\textsuperscript{36} Hardly any attempt had been made to grow these trees on more difficult sites and it was only around the turn of the 20th century that experiments were initiated and the work done by John Stirling Maxwell at Corrour and by the Office of Woods at Inverliever was breaking new ground.

The Corrour estate is situated on Rannoch Moor in the middle of the Highlands around Loch Ossian in Inverness-shire, just east of the West Highland Railway line to Fort William. John Stirling Maxwell bought the estate in 1892 and he began the forestry plantations to improve the landscape and to create shelter for deer, but also to find out ‘whether it is possible to convert bad moorland soil into forest at this altitude in Scotland’.\textsuperscript{37} The conditions around Loch Ossian are not very well suited for forestry; the site being situated above 380 metres

\textsuperscript{35} Smout et al., *The Native Woodlands*, p. 285.


\textsuperscript{37} John Stirling Maxwell, *Loch Ossian Plantations* (Glasgow, 1913), p. 5.
(1250 feet)\textsuperscript{38} with poor, water logged peaty soils and very exposed slopes. In order to prove that such upland sites could be successfully planted Stirling Maxwell, with the help of his foresters Simon Cameron and John Boyd, tried several experiments involving planting on peat soils in the early years of the 20th century.

\textbf{Figure 3.3: Loch Ossian and the Corrour plantations.}

Photo: Jan Oosthoek.

The idea of forestry trail plantations on high peat lands was first proposed by botanist Professor Augustine Henry, who occupied a chair in forestry at the Royal College of Science in Dublin. He suggested to John Stirling Maxwell that he visit Belgium to see the planting experiments on peat in the Hertogenwald near the German border. This visit was made in 1906 and the Belgium planting method was soon after introduced on Stirling Maxwell’s Corrour estate.\textsuperscript{39}

\begin{itemize}
  \item \textsuperscript{38} Because of its location in the North Atlantic, 350 meters of altitude corresponds with a sub-alpine climate in Scotland.
  \item \textsuperscript{39} J.A.B. MacDonald, ‘John Stirling Maxwell: an Appreciation’, \textit{Forestry}, 30 (1957) 1, 46.
\end{itemize}
Figure 3.4: Belgium system for planting on peat.

The Belgium Forest Service had developed a method by which a network of ditches was created to drain the peat. The surface material that came out of the drains, referred to as turf, was dragged out of the drain and turned upside down in rows several feet apart and left to dry. By planting time the turf would have settled and dried sufficiently to be easily slit open to insert a tree, spreading out the roots under the turf. With the original Belgium method a circular plug was cut from the centre of the turf, creating a hole in which the young plant was placed and the hole filled with a mix of sand, gravel and manure. However, the Corrour experiments showed that spreading the roots under the turf provided the young tree with a better nutrient supply and more stability. A tree planted according to the Corrour method stands in the centre of the turf with its roots sandwiched between the two layers of rotting vegetation, which release nutrients, provide aeration, and keep roots away from the peat soil which may still be too wet and cold.\footnote{John Stirling Maxwell, ‘The Planting of High Moorlands’, \textit{Transaction of the Royal Scottish Arboricultural Society}, 20 (1907) 1, 1-7, pp. 3-4; John Stirling Maxwell, ‘Belgian System of Planting on Turfs’, \textit{Transaction of the Royal Scottish Arboricultural Society}, 23 (1910) 2, 153-157, pp. 153, 155; T.A. Robbie, \textit{Teach Yourself Forestry} (London: English Universities Press 1955), pp. 92-93.}

The experiments showed that the conifers planted in the turfs thrived, proving that it was possible to plant trees successfully in deep peat at higher elevations. One of the most important innovations at Corrour was the use of phosphatic fertilisers to give the young trees a growth boost.\footnote{Stirling Maxwell, \textit{Loch Ossian Plantations}, p. 46.} The general value of the Loch Ossian plantations for Scottish forestry was that it demonstrated the benefits of both a raised planting position in turfs and the use of phosphate fertiliser. The experiments at Corrour laid the foundation for modern ploughing techniques on peat land that were developed in subsequent decades based on the pioneering work done by Stirling Maxwell.

Another important demonstration forest was created by the Office of Woods at Inverliever on the shores of Loch Awe in Argyll. The experiments at Inverliever were focussed on trying different tree species and planting methods on different soils. The work at Inverliever differed from that at Loch Ossian in some important ways. Whereas the latter was designed as an experiment in peat without a strong commercial objective, the former was laid out as the first large-scale plantation of conifers on land with hugely differing soil and environmental conditions as if it were a commercial undertaking. Inverliever Forest, being situated on the north side of Loch Awe, was thought to be reasonably representative of large areas of plantable land in the west of Scotland. In 1912 Roy Robinson (1883–1952), a future chairman of the Forestry Commission, was put in charge of Inverliever and together with the local forester, John Boyd, started a scheme that was meant as a model for large-scale afforestation of upland areas. They set out to develop a standard procedure for selecting land for afforestation. The land was
first surveyed in advance of planting to find out which parts were expected to produce good timber. From these surveys it became clear that soil conditions and exposure to wind were factors that played a major part in limiting tree growth, while existing vegetation also affected the growth of young trees. Robinson and Boyd also classified types of vegetation as an indicator of the character and condition of the soil and as a measure for the productivity of the site. The second group of experiments was related to large-scale planting of spruces on poor sites. Unlike the trails at Loch Ossian most of the trees were directly planted in the peat soil and no fertilisers were applied.42

In 1920 Inverliever Forest was taken over by the Forestry Commission from the Office of Woods and, because the forest was a decade ahead of the first plantations of the Commission, it was carefully monitored. The examination of its development, silviculture and management provided the Commission with invaluable information on the problems of afforestation and silviculture of fast growing conifers on difficult sites.43 Unfortunately, the manual planting of trees at Inverliever and Corrour was a slow process and the scale of forest expansion envisaged over the whole country required solutions that would make mass cultivation of the uplands efficient, fast and affordable.

The Forestry Commission picked up the work done at Corrour and Inverliever in the early 1920s. In the autumn of 1919 the Commission appointed Henry Steven as research officer for Scotland and a year later in 1920 a Research Branch was set up. One of the first problems the Research Branch faced was the question of how to establish quickly and efficiently large-scale plantations in the uplands peat areas of Scotland, Northern England and Wales that had not been under forest vegetation before.44 The work at Corrour and Inverliever had proved that the development of forests on peat was possible, but the costs were very high and growth slow. The Research Branch continued the research and concentrated on testing different tree species, improving the turf planting methods and the use of fertilisers, and on drainage work and later ploughing.

Between 1925 and 1928 the well-known Scottish forester Mark Anderson (1895-1961) designed a series of experiments to improve the turf planting method that was carried out on the Lon Mor, which means ‘Great Damp’ in Gaelic. This upland area is part of Inchnacardoch Forest and is situated just northwest of Fort Augustus above the Great Glen. Anderson’s experiments confirmed the findings of the Corrour planting trails and by 1929, turf planting had been adopted in every district on the peat soils suitable for forestry.45 Unfortunately, there was still no immediate hope of turning out the required turfs by mechanical means on

42 NAS: FC7/6 Notes on Inverliever Forest by Roy L. Robinson, 1923, 195.
a large scale, but the new method was making the best use yet of manual labour and ordinary, non-mechanical draining tools. Additional problems related to turf planting were the fact that it did not improve drainage sufficiently, and it did not break through podzolic iron pans to enable roots to penetrate deeper into the soil and thus achieving better stability.\(^{46}\) Equally importantly, it was simply not practical to dig drainage ditches and create turf ridges by hand on the thousands of square kilometres that had to be planted.

![Experimental ploughing on the Lon Mor, ca. 1927. Man viewed from the back standing on the plough is Mark Anderson.](image)

**Figure 3.5:** Experimental ploughing on the Lon Mor, ca. 1927. Man viewed from the back standing on the plough is Mark Anderson.

Photo: Forestry Commission, with permission.

In 1925 when Mark Anderson took the Scottish research over from Steven, he realised that, if the land could be ploughed, it would solve all these problems and make it possible to cultivate upland moors and plant them economically on a large scale.\(^ {47}\) In 1927 a horse drawn agricultural plough was tested by Anderson on the Lon Mor. These trials were only moderately successful but it showed that shallow drainage ditches could be produced with the turfs inverted beside them. A year later the experiment was repeated at Glen Righ, just south of Fort William, with three horses instead of two. Both experiments showed that it was difficult to plough at depth and to keep the plough at one level and the horses

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\(^{46}\) Personal comment Jim Atterson, 13 August 1999.

\(^{47}\) Davies, *The Scottish Forester*, p. 33.
were not able to drag the plough through hard knolls. This was the last attempt of deep pleat ploughing by the Research Branch until 1939 but it showed that ploughing had potential.\textsuperscript{48}

According to the first edition of the Forestry Commission's Handbook, \textit{Forestry Practice}, published in 1933 only dry heath areas was considered ploughable.\textsuperscript{49} The obstacle to plough deep peat was their low bearing pressure which excluded the use of wheeled tractors. On shallow peat, for example, in Castleton Forest in Liddesdale in the Scottish Borders, tractors were used for ploughing by the mid-1930s. Around 1937 the advantages of crawler type tractors to deal with deep peat became obvious and the first trials were initiated. The first full-scale experiments with crawler tractor ploughing and turfing was carried out at Borgie in Naver Forest in the far north of Sutherland in 1939. These experiments were quite successful but the immediate adoption of large-scale ploughing was delayed because of the outbreak of war. The use of ploughs was further delayed by the fact that the wetter sites demanded more powerful tractors than the drier heathlands, but when these machines became available by the end of the Second World War the development of ploughs for the cultivation of the wet peatlands accelerated. Davie Ross, a Forestry Commission employee stationed at Minard in Argyll, western Scotland, designed one of the first specialised forest ploughs for use on wet sites. But it was James Cuthbertson, an engineer of plough manufacturer Biggar, who further developed Ross’ ideas. The result was the famous Cuthbertson Plough that combined with more powerful crawler tractors, made large-scale mechanical cultivation economically feasible by the late 1940s.\textsuperscript{50} A few years later ploughing for drainage and cultivation was an established practice and by 1970 the Forestry Commission ploughed at least 70 per cent of the annual afforested area.\textsuperscript{51}

Another important development in ground preparation for planting of peaty upland soils was the use of fertiliser. In the early phase of afforestation in Britain, much attention was given to matching species to site. But when forestry was pushed into poorer areas it became clear that fertiliser was needed to kick start trees to outgrow competing heather and other vegetation. The success of Sitka spruce in upland areas led foresters to plant this species on a wide range of sites of varying fertility. The value of adding phosphatic fertilisers at planting on the poorest sites was soon established, following the early fertilising trials carried out by John Stirling-Maxwell on the Corrour estates.

\textsuperscript{51} Wood, \textit{Forestry Research}, p. 68.
and in subsequent trials at Lon Mor by the Forestry Commission during the 1920s. As the plantations progressed, however, it became apparent that on some sites, subsequent applications of phosphates would be necessary. By the 1960s, afforestation was increasingly pushed into the least fertile sites, as land for afforestation became scarcer, and this contributed greatly to the increased use of fertilisers in forestry during the 1960s. From being considered as purely an aid to create new plantations, the application of fertilisers was also extended to topdressings of established stands showing nutrient deficiencies. By the late 1960s aerial fertilising using helicopters became a routine practice which made it possible to extend forestry into even poorer land.\textsuperscript{52}

By the end of the 1960s most problems related to the cultivation of the Scottish uplands for forestry had been solved. The result was the ability to successfully establish plantations of coniferous species on a wide range of sites, from the sands of the Moray Coast to the deep peat in the north and west of Scotland and the uplands heaths of the south and east. The emergence of ploughing, aerial fertilising and Sitka spruce as the dominant species made the large-scale afforestation of the post-war decades possible.

\textbf{Figure 3.6: Mechanical ploughing at Glenbranter in the early 1970s.}

Photo: Norman Davidson, from http://forestry-memories.org.uk with permission.

Figure 3.7: Aerial fertilising by helicopter.

Photo: Norman Davidson, from http://forestry-memories.org.uk with permission.