Progress Report on Research. April 1934.

I. Nursery Investigations.

The major results of the P.33 nursery experiments were summarised in the last report.

During the winter an investigation was carried out in both countries on the question of winter losses in seedbeds of Norway and Sitka spruce. The conclusion arrived at was that apart from occasional losses due to frost or to chafer attack losses did not occur on any large scale during the winter months. Discrepancies between stocktaking counts and actual output of usable seedlings were found to be due in the main to errors in stocktaking.

The experiments proposed for 1934 deal with the following lines of work

1.	Weed control with different chemicals.	Both countries.
2.	Covering with different grades of sand.	Scotland.
3.	Stratification of seed.	Both countries.
4.	Density of sowing J.L., E.L., S.P.	Both countries.
5.	Effect of early and late sowing upon size of seedlings.	England.
6.	Manuring experiment in cooperation with Macaulay Institute.	Scotland.
7.	Trial of special composts.	England.
8.	Thinning of seedbeds.	Scotland.
9.	Effect of early lifting and heeling-in upon root development.	England.

II. Plantation Experiments.

(1) Peat Soils. A. Scotland. On the Calluna-Scirpus types in the West the relative unsuitability of Sitka spruce becomes each year more apparent. With sufficiently heavy manuring and intensive drainage it may be possible to get Sitka spruce

established within a reasonably short period, say 10 years, but even this is uncertain and the cost would in any case be excessive. Of other species Japanese larch and Pinus contorta are decidedly the most promising but require basic slag if a very slow establishment is to be avoided. On the Lon Mor at Inchnacardoch Pinus contorta was planted in P.28 on Belgian turfs with slag. Two grades of plants were used and the larger grade has done much better than the smaller. After 6 growing seasons the position is as follows:

Grade I		Grade II	
Av. Height.	Av. Shoot.	Av. Height.	Av. Shoot.
28"	9"	16"	4½"

Sitka spruce in the same experiment were only 11 inches high with 1½ inch shoots. It remains to be seen if the P.contorta will maintain their present rate of growth but their roots are spreading well beyond the turfs and the prospects seem fairly favourable.

The Japanese larch on the shallow slope peat at Achnashellach and Inchnacardoch continue to grow well where basic slag was applied but growth falls off decidedly on exposed sites.

At Achnashellach a small area of badly checked and grazed Japanese larch on Scirpus peat was enclosed by a deer-and-rabbit-proof fence, to see if, with game excluded, the plants would emerge from check. Failures were beaten up on shallow turfs. Out of 123 original plants 92 (75%) have since died; most of the survivors have made no growth but a few have recovered or were never seriously in check. The turfed beat-up plants have grown well and now average 35" in height with 5" leading shoots; failures in these were only 10%.

Oregon alder planted in P.30 on slope peat at Inchnacardoch (in groups with slag) grew well in P.33. Twenty of the trees which are being measured each year have an average height of 5 feet 10 in. and put on a shoot of 17½ inches.

B. England and Wales. The peat areas in England and Wales are mostly of a more favourable type than the Calluna-Scirpus of the north west of Scotland and the prospects that Sitka spruce will eventually become established are much more promising.

Beddgelert. The worst parts of the Beddgelert peat bogs carry a vegetation rich in Scirpus and cotton grass but relatively poor in heather. Sitka spruce turf planted without slag in P.28 now average, in one experiment, 24 to 30 inches in height and are putting on shoots of 8 to 9 inches. It does not seem likely that these plants will go back into check. In another block on somewhat similar peat growth of Sitka spruce has been slower and the application of 1 ounce of slag at the time of planting has made a very significant difference. The assessment made at the end of 7 growing seasons gave the following result:

	Av. Height. in.	Av. length of leading shoot. in.
Unmanured	24	$4\frac{1}{2}$
Plus Basic slag	47	10

The slagged plants may reasonably be regarded as established while the unmanured are still on the border line. In yet a third area (P.28) at Beddgelert also on Scirpus-Cottongrass, but a worse type containing much Erica Tetralix, growth has been altogether poorer, the unmanured controls are still in check and even the slagged plants are not as good as the unmanured plants referred to in the first of the above experiments. The data are:

	Height. in.	Shoot. in.
Unmanured	13.3 ± 0.5	1.0 ± 0.2
Plus Basic slag	27.4 ± 1.4	5.5 ± 0.8

Here again the manure has had a very important effect upon growth, and it is worth noting that the P.33 shoot in the manured plots is slightly longer than that of the previous year. The effect of basic slag upon Sitka spruce on the worst types at Beddgelert is thus very different from that on the Scottish Calluna-Scirpus

types. In the latter the stimulus appears to be only temporary while on Scirpus-Cottongrass the improvement shows no signs of falling off and even if the control plants do eventually recover the manure should easily pay for itself in the improved rate of establishment.

Pinus contorta has been planted in some of the Beddgelert experiments and is generally doing well, it is less sensitive to vegetation type than Sitka spruce and does relatively better on the poorer soils.

North Tyne. In the North Tyne area there is relatively little Scirpus the prevailing types are Molinia, Cottongrass, and Calluna in varying proportions. The spruces are satisfactory when turf planted on the better types without Calluna but where Calluna but where Calluna has become dominant they are checking rather badly, e.g. in Experiment 4, P.27 where the position at the end of 7 growing seasons was as follows:

	Molinia-Cottongrass.		Calluna.	
	Height. in.	Shoot. in.	Height. in.	Shoot. in.
Sitka spruce	47	9.4	15	0.5

On the Calluna-rich type of peat the plants are completely in check.

The beneficial influence of turf planting as well as the effect of vegetation type are well shown in the following data from No 6 P.27 North Tyne. Species Sitka spruce.

Vegetation Type.	Method of Planting.	Height	Shoot
		in.	in.
Molinia with some Calluna	Turf planted	50	10.5
do.	Notched	23	5.5
Calluna with some Molinia	Turf planted	34	7
do,	Notched	18	4.5

Turf planting has approximately doubled the height of the plants on each vegetation type but the shoot data indicate that the notched plants are now beginning to get away.

Pinus contorta is not on the whole as good in this area as it is in the west of Scotland, the plants are slow in getting away but there has been much black game damage which has hindered their growth. In a P.29 experiment they are now beginning to grow well on a rather poor type of Cottongrass or bilberry-heather peat. The data below show the position at the end of P.32 i.e. after 4 growing seasons.

	Sitka spruce.		Pinus contorta.	
	Height. in.	Shoot. in.	Height. in.	Shoot. in.
Control Unmanured	11	1.5	9	4.2
Plus Basic slag	16	2.8	11	5.4

The current shoot growth is better than that of the spruce although the latter are somewhat taller.

Hamsterley. The only experiment on peat at Hamsterley was established in P.29. So far this experiment has been unexpectedly negative both as regards method of planting and effect of Basic slag (after 5 growing seasons). The data are as follows.

Treatment.	Sitka spruce.		Pinus contorta.	
	Height. in.	Shoot. in.	Height in.	Shoot. in.
Direct notched. Unmanured	12	2.0	10	2.0
Turf planted. Unmanured	14	2.7	10	2.8
Direct notched plus slag	15	2.7	10	2.1
Turf planted plus slag	16	3.0	8	2.4

Neither turf planting nor slagging has substantially improved growth. Black game damage has affected the pines.

Some experiments on the depth of planting spruce seedlings in turfs are of interest. Seedlings were planted on different dates in P.32 at Beddgelert and North Tyne, and half the plants were inserted at the normal depth, the other half being deeply planted with not more than an inch or so of shoot showing above the level of the turf. The Beddgelert trial gave more or less uniform results for the two methods and there was nothing to choose between the different dates of planting. At North Tyne however there were significantly fewer losses in the second year

in the deeply planted seedlings and the shoot growth was better. The data as to losses are given in the table below:

Season of Planting	Normal Planting		Deep Planting	
	Percentage Losses		Percentage Losses	
	1932	1933	1932	1933
November	15	34	5	8
January	12	49	3	17
March	4	23	3	6
April	3	20	9	9
May	8	38	13	18

With normal planting March and April were the most favourable dates. The deeply planted plots did almost equally well irrespective of date of planting.

(2) Upland Calluna Soils. A. Scotland. A large scale ploughing experiment carried out in P.29 on the poor ground at the top of Teindland has been recently assessed. The area was divided into three blocks. In Section A strips 10 feet wide were completely ploughed, leaving strips of equal width uncultivated. Section B acted as control and was planted on carefully prepared mounds (a very costly method). Section C was ploughed in three furrow strips, 5 feet apart. The whole area was planted with Pinus contorta and slag was applied to alternate bands running across the three sections. The data are as follows.

	Mean Height. in.	Mean Shoot. in.
Section A. Ten foot fully ploughed strips.		
Unmanured	9	1.5
Plus basic slag	24	8.5
Section B. Planting on Mounds.		
Unmanured	10	1.9
Plus basic slag	17	4.3
Section C. Three-furrow ploughed strips.		
Unmanured	9	1.7
Plus basic slag	20	7.3

On the ploughed sections the slagged plants are more than twice the height of the controls while the shoot growth has improved 5-fold. The full ploughing has given slightly better results than the three-furrow ploughing (both plus manure). Without manure there is ltle to choose between the three methods.

Japanese larch has been introduced at Teindland in P.32 and P.33 experiments on ploughed ground, they are starting well and appear promising,

B. England and Wales. The experiments on the deeply ploughed ground at Allerston are looking well. The special box-raised one-year seedlings of Corsican pine, European larch, and Sitka spruce which were planted in P.31 made very good growth during P.33. The Corsican pine are strong plants with leaders up to 12 inches in length; the European larch though irregular in growth are now up to a maximum of 4 feet in height and have put on shoots of up to 20 inches; the Sitka spruce are also good with leaders up to 12 inches in length. No manure was applied. This experiment is interesting because it shows that really strong one-year seedlings can make first class planting material on well-ploughed ground.

The importance of breaking up the soil is well shown in a method of planting experiment at Harwooddale. The species was Scots pine, the control (vertical notch) method resulted in 20% of losses and little growth was put on, while a form of mound planting gave the best result, losses being less than 1% and the plants put on shoots of up to 5 inches in length.

A preliminary investigation of gorse-invaded soils in North Wales showed that the species concerned is not the ordinary tall gorse (Ulex europaeus) but the western dwarf gorse Ulex gallii and that this species apparently tolerates quite poor soil conditions. There is no definite evidence to show that the gorse is in itself harmful to tree growth but it is liable to smother backward trees while the weeding necessary means a considerable addition to the cost of establishment.

Other gorse areas in the south west of England are to be examined during the summer.

(3) Dorset Heaths. The detailed assessments have not yet been fully worked up but it is clear that all species respond well to applications of basic slag. One-year seedlings of S.P. and J.L. did quite well in P.33 but there were many failures in Corsican pine.

(4) Thetford Forest. Some photometric studies made in the Scots pine plots which have been interplanted with beech showed a close relation between amount of shade and the vigour of the beech. Taking the most open conditions as having a light value of 1 (actually 10 to 15 seconds exposure with a Bee exposure meter using sensitive paper) the beech here were poor with small yellowed leaves and small buds. With a light value of $\frac{1}{3}$ to $\frac{1}{5}$ the beech were rather better but still yellowish and making little growth. With a light value of $\frac{1}{8}$ to $\frac{1}{10}$ the beech were normal healthy plants with good colour and buds and moderate growth. In the deepest shade (light value $\frac{1}{13}$ to $\frac{1}{18}$) the Scots pine branches were interlacing over the beech. The beech were vigorous with large, very dark green, leaves, abnormally large buds and long shoots. Exceptional readings were obtained where the light value was as low as $\frac{1}{24}$ but even here there was no indication that the shade was other than beneficial. The Scots pine ranged in height from 6 to 12 feet.

The hot summer played havoc with beech put into Scots pine only 3 to 4 feet in height in P.33. Losses were 66% in the seedlings and 50% in the transplants. This confirms previous experiments showing that unless the pine are well over 4 feet (best 6 to 8 feet) in height they do not give adequate shelter to the beech.

Douglas fir planted in P.28 in two one-acre blocks, one in the centre and one at the south end of the forest, have behaved very differently in the two areas. In the first case the plot is only half-stocked, and the survivors are very poor and uneven.

Frost damage and lack of weeding have both contributed to this result. The southern plot has been remarkably successful, the trees now average 6 feet in height and are putting on shoots of about 2 feet. The tallest tree is 15 feet in height.

The success of this plot coupled with the existence in the district of quite a number of thriving Douglas fir plantations (mostly mixed with Scots pine) suggests that the question of establishing Douglas fir on the Thetford soils deserves further investigation. It is proposed to make a detailed study during the summer of the local plantations of this species. If the right conditions can be found Douglas fir may be a very useful species for filling up gaps in the older pine plantations.

At Rendlesham Forest an investigation is to be carried out on the treatment of the older Scots pine plantations where, owing to Tortrix attack, many of the largest trees are badly shaped and developing into wolf trees. Plots are to be established in the form of long narrow strips, the trees will be classified and different treatments applied to the badly formed dominants.

(5) Chalk Soils. There is not much to add to the last report on the nurse crop experiments at Buriton. The alder range in height from 2 to 9 feet in the P.30 area on very shallow soil over chalk and from 2 to 10 feet in the P.31 area which is on deep soil. In the dry summer of 1933, some of the plants put on shoots of 3 to 4 feet. In spite of the dry season the beech introduced in P.33 under the alder suffered only 5% to 10% of losses.

A.P.33 experiment on the root and shoot pruning of beech promises to give interesting results. There were three methods (a) Plants unpruned. (b) Shoots cut back to 4 inches before planting. (c) Plants "stumped" i.e. shoots cut back to 4 inches and roots pruned back drastically. Losses were negligible in all plots but at the end of the year there was a great difference in the appearance of the plants. In the pruned plots the leaves were fresh and green in colour and shoot growth was slightly

longer while in the unpruned controls the leaves were shrivelled and yellow. The same experiment carried out with grey alder gave very similar results.

The beech hoeing experiment started at Friston in P.31 has given a definite result. The data are as follows:

	Unhoed.		Hoed.	
	Height. in.	Shoot. in.	Height. in.	Shoot. in.
February 1931	9	-	9	-
October 1931	11	2.2	13	4.4
October 1932	12	1.3	25	11.7
October 1933	16	4.0	43	18.5

The response to hoeing is interesting because the hoed plants are in full light being quite clear of vegetation, while the unhoed plants are partially sheltered in the long grass. Root competition is clearly a more important factor than excess of light. This result raises the question whether, at Thetford, where the beech have done so well under dense Scots pine shade, the improvement may not be partly due to the suppression of grass vegetation under the shade of the pine.

(b) Loam and Clay Soils (Hardwoods). The ash hoeing experiments in the Forest of Dean have now been fully assessed with the following result:

(a) Russells Inclosure No 36 P.31.

Method of Treatment.	Av. Height on planting. in.	Av. Height after 3 growing seasons. in.
A. Plots kept fully weeded but not hoed.	9.6	17.6
B. Plots weeded the first year only, not hoed.	10.2	18.3
C. Plots hoed twice each year	9.1	22.0

All the plants have grown well but there is a significant increase in the growth of the hoed C plots.

(b) Nagshead Inclosure No 40 P.32.

Method of Treatment.	Av. Height on planting. in.	Av.Height after 2 growing seasons. in.
A. Not hoed	21.3	31.0
B. Hoed.	22.8	49.5

The hoed plots have made remarkable growth and average 18 inches taller than the unhoed controls.

The P.31 weeding experiment at Fermyn Woods (Rockingham) shows that the best growth so far is in the unweeded plots but that many of the longer shoots now being put on are being bent down by the grass. This suggests that some weeding in the third year after planting may be desirable. In any case the further development of the plots will be interesting.

Oregon alder have grown well on heavy clay at Drayton, the trees averaging 3 ft. 4 in. in height after two growing seasons. This may be a useful preliminary species for planting on clay grassland.

III. Sample Plots Work.

Seven sample plots were remeasured, of which six were in Scotland and one in England, and nine new plots have been established. The new plots are as follows :-

Dunkeld, Perthshire.	2 in Hybrid larch.
Drummond Hill Forest.	2 in European larch and 2 in Sitka spruce.
Salcey Forest.	1 in Oak.
Rendlesham Forest.	2 in Black Italian Poplar.

The Dunkeld plots are of different age: the older plot is remarkable for its rate of growth. It is 27 years old, height 61 feet, number of stems per acre 520. Volume 3300 cubic feet. There are several trees over 70 feet in height and the girth runs up to 38 inches.

The Drummond Hill Larch are 20 years old and 33 feet in height; the Sitka spruce plots are the same age and 35 feet in height. The volumes are 600 and 2100 cubic feet respectively.

The Boughton ash plot is growing well, there are now 470 trees per acre with a height of 47 feet and volume of 1100 cubic feet. The age is 34 years.

The oak plot at Salcey is 25 years old and carries a stock of 1400 trees per acre. The trees are not well shaped and there are many comparatively large dead snags on the stems (apparently

the original planting distance was too wide). These snags were found to be attacked by the oak heart rot (Stereum spadiceum) and in some cases the rot had spread into the main stem. The snags and side branches were pruned off 50 of the dominant trees up to a height of 17 feet.

The Rendlesham poplar are 12 years old, after thinning there are 270 trees per acre with a mean height of 39 feet and girth of 17 inches. The volume per acre is 570 cubic feet.

IV. Research Work at Aberdeen.

Dr Laing has started his new investigation on the root and shoot development of newly planted European larch. The available literature has been studied and observations have begun on the periodicity of root growth in larch. An area at Durris has been reserved for field experiments.

Dr Fraser is taking up the study of humus types with reference to their identification in the field and their (forest) fertility. He has visited Rothamsted and discussed the problem with soil workers there. Some field experiments have been laid out at Durris.

V. Mycorrhiza Research - Dr M.C.Rayner.

The humus composts prepared by Dr Rayner have given remarkable results when applied to Wareham soil. The best results were obtained from a compost prepared from spent hops. This applied at the rate of 10 lb. per square yard before sowing produced exceptionally large one-year seedlings of Scots pine, Corsican pine, and Pinus contorta on ploughed but otherwise typical Wareham land. Further supplies of different composts have been made and these will be applied to three nurseries in England and to a small area of ploughed ground at Allerston. The effect of the composts upon mycorrhizal development will be determined when the plants are lifted.

VI. Research on Vole Disease - Dr C. Elton.

A further grant of £100 has been made to Dr Elton for continuing his investigations.

VII. Mycology and Pathology.

The work of Messrs Day and Peace on the effect of frost on forest trees has been published as an Oxford Forestry Memoir. Further work on the influence of different factors upon frost damage is in progress.

Ink disease has been found attacking chestnut coppice in Parkhurst Forest in the Isle of Wight.

VIII. Entomology.

(1) Pine Beetle. Mr H.S. Hanson of the Farnham House Laboratory has submitted an interesting report on his work of the past year in the New Forest. Data have been collected showing that the beetles breed more readily in the rough barked basal part of a Scots pine pole than in the thin barked tops and are also much less accessible to attack by the parasites. Mr Hanson considers that by proper management of fellings and by leaving some of the thin barked material on the ground to breed up a large population of parasites it will be possible to control the pest at a minimum of cost. Owing to a change in the method of financing the Farnham House Laboratory, which now works on a fee basis, it has become necessary to make a grant of £200 to the Laboratory for continuing the investigation during the financial year 1934/35.

The winding up of the work on other projects now frees Dr Chrystal's assistant Mr Brown to take up his part of the pine beetle investigation; he is concerned partly with the assessment of the damage caused by the pest and partly with a study of the biology of the beetle.

(2) Pine Shoot Moth. The pine sample plots in the Eastern Counties have been reassessed and the whole of the work to date is shortly to be written up for publication.

(3) Chafer Larvae. Delamere Nursery has been visited by the Entomologist and plans drawn for an attempt at control using paradichlorbenzene. This is a crystalline substance which is easy to apply and there is some reason to hope that it will be more effective than carbon bisulphide. It is remarkable that the most numerous chafer in the nurseries now appears to be the garden chafer, Phyllopertha which has only recently been recognised as a nursery pest. Comparatively little is known of its biology.

IX. Co-operation with Forest Products Research Laboratory.

The work of impregnating and testing the telegraph poles of Corsican pine, Norway spruce and Sitka spruce is proceeding at the Laboratory. The Corsican poles take creosote freely and their strength properties appear to be satisfactory.

A number of clean grown Sitka spruce poles have been sent to the Laboratory from Benmore for wood working tests. It is considered that these should give more reliable information than the earlier tests which were carried out with timber from larger but coarsely grown trees.