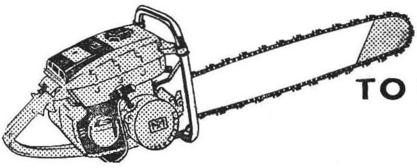
IRISH FORESTRY

Journal of the Society of Irish Foresters

Published Twice Yearly

Vol. XVII. No. 1. SPRING, 1960. Price 5/-



IRISH FORESTRY

CONTENTS

(The views expressed in the articles and notes in this journal are not necessarily the views of the Editor or of the Society of Irish Foresters.)

COVER PHOTOGRAPH: State plantations at Glendalough, Co. Wicklow.
(Photo—N. Morris)

SOCIETY OF IRISH FORESTERS

President:
M. SWAN, 17, Landscape Crescent, Churchtown, Dublin.

Vice-President:
M. McNAMARA, 37, Collins Avenue, Ballymun, Dublin.

Secretary:
T. CLEAR, Agricultural College, Glasnevin, Dublin.

Treasurer:
L. GALLAGHER, Agricultural College, Glasnevin, Dublin.

Hon. Auditor:
D. M. CRAIG, 85, Harcourt Street, Dublin.

Editor:
R. N. O'CARROLL, 12, Dundela Avenue, Sandycove, Co. Dublin.

Business Editor:
M. SHARKEY, "Kylemore," Hyde Park Avenue, Blackrock, Dublin.

Grade I Councillors:
1960-61
D. P. MANGAN, 80, St. Aidan's Drive, Goatstown, Dublin.
H. M. FITZPATRICK, Kendalstown, Delgany, Co. Wicklow.
1960
M. COSGRAVE, Ballydowling, Glenealy, Co. Wicklow.
A. M. S. HANAN, Woodlands, Killarney Road, Bray.

Grade II Councillors:
1960-61
T. F. HARDING, Powerscourt Arms Hotel, Enniskerry.
1960
D. M. O'SULLIVAN, Shanballymore, Mallow.

Associate Councillors:
1960-61
MISS L. FURLONG, "Silveracre," Howth Road, Dublin.
1960
J. GALVIN, Park Cottage, Wexford.

IRISH FORESTRY

Volume XVII. Spring, 1960. Number 1

The Development of the Eucalypts In Irish Conditions

By O. V. Mooney

TWO previous contributions dealing with the eucalypt species have appeared in *Irish Forestry*. The first, "Notes on Eucalyptus Species at Avondale, Co. Wicklow" by Mr. M. O'Beirne appeared in Vol. II, No. 1, May 1945. This article dealt generally with the natural distribution, growth and botanical features of the eucalypts and in particular with the performance of certain species which had been introduced and planted at Avondale, Co. Wicklow, from 1908 onwards. Reference was also made to the eucalypts planted at Ballymanus, Glenealy Forest in 1934-35, the development of which will be dealt with in some detail in this article. Seed sowing and nursery treatment was adverted to briefly and the general attributes of the genus summarised.

The second contribution was a note on the raising of eucalypts in the nursery, by P. Ryan, presented in Vol. XIII, No. 2, Winter 1956, and dealt with the merits of the difficult techniques of sowing and transplanting as best suited to conditions in Ireland.

An editorial in Vol. XIII, No. 2, 1956, also gave a summary of the capabilities of the genus and naming the species which have proven hardy here suggested that more attention might be directed to the wood producing potentialities of the species in Ireland.

The intention of this article is to record the growth and production of measurable stands and single trees that have survived from the plantings of numerous eucalypt species in Ireland and to direct attention to observed silvicultural characteristics and to make known the results of limited utilisation studies that so far have been carried out.

Owing to lack of time for a country-wide survey of eucalypts growing in Ireland practically all detailed observations recorded here are confined to Counties Wicklow and Dublin, but from what is known generally of the growth of the species throughout Ireland experience from these counties might be applied in most seaboard regions of our coastal counties and with particular safety to the south-west of the country.

Eucalyptus globulus is illustrative: This species is hardy and grows well along the coast and for some four miles inland in Co. Dublin and Co. Wicklow, but efforts to grow it at Avondale, Co. Wicklow, some ten miles inland, have failed due to frost. In the south-west, however, it is found 20 miles inland and on the shores of Lough Corrib in Co. Galway about 35 miles inland from the western seaboard.

Eucalyptus globulus is listed as being resistant to temperatures down to 20° F. (Eucalypts for planting, F.A.O. 1955) and the fact that it has proved hardy quite far inland even to 15° F. min. temperature line (See Fig. 1) suggests that other species which have been grown successfully at Avondale might prove frost hardy much further inland where frosts are more severe.

Some thirty-five species of Eucalypts have been raised from time to time since 1909 by the Forestry Division of The Department of Lands, mostly from seed from Tasmania and New South Wales, but a study of surviving stands, groups of trees, and single trees of twenty years of age and more suggest that of those tried only ten species can be grown successfully to proper timber tree form. These species are as follows: *E. Johnstoni, E. Muelleri, E. urnigera, E. viminalis, E. ovata, E. Dalrympleana, E. radiata, E. gigantia, E. obliqua,* and *E. globulus*. Within this list of species there are considerable variations as to frost resistance between the individual species but *E. Johnstoni, E. Muelleri* and *E. urnigera* have proved very hardy over a wide range of territory and are outstanding for this reason. *E. ovata, E. Dalrympleana* and *E. delegatensis* are also reliable but their range of trial has been more confined.

Apart from some few known private collections, notably that of Mr. Walpole at Mount Usher, Co. Wicklow, the most important plantings of *Eucalyptus* were made in 1909 and subsequently at Avondale and in 1934, 1935, 1937 on various selected sites throughout the country. Most of these trial plantings were made as small groups of trees and where successful have seldom developed into assessible stands, but one area at Glenealy Forest was laid down to various species in a compact block of some six acres and standing volume estimates of some significance have been possible.

As the information derived from estimates of standing volume of these stands are of importance in considering the potential of the eucalypt species in Ireland the following details from an assessment made in July and August 1957 at Ballymanus Property of Glenealy Forest are presented.

Series 1:

Species	Year of Planting	S.P.A.	Mean Tree Total Height	Mean Tree B.H.Q.Q.	V.P.A. cu. ft. Hoppus	Actual No. of Trees per Plot
*E. Muelleri**	1934	505	69′	$7\frac{1}{2}$	6,124	62
E. radiata	1934	786	42′	$5\frac{1}{4}$	2,822	28
E. viminalis (Mountain type)	1934	—	—	—	—	Few scrub trees
E. Dalrympleana	1934	501	57′	7	4,371	29
E. urnigera	1934	704	70′	$6\frac{1}{2}$	6,507	80

* *E. Johnstoni* (Maiden) is now given as the accepted name for *E. Muelleri* (T. B. Moore) F.A.O. 1955, but *E. Muelleri* is also associated with *E. subcrenulata.* In

The elevation above sea level of the above plots is 560′, the aspect south-east, on a medium moderately exposed slope.

The eucalypts were planted in 50% mixture with Japanese larch at $4\frac{1}{2}' \times 4\frac{1}{2}'$ spacing. The plantation was laid down on an old oak woodland site in which the predominant vegetation was probably *Luzula syvatica, Rubus fruticosus, Ilex aquifolium, Corylus avellana.* The existing vegetation is similar but *Pteris acquilinium, Vaccinium myrtillus,* and *Hedera helix* is also in evidence. It is of interest to note that the natural climax tendency on the ground outside the stand is towards *Calluna vulgaris* and *Vaccinium myrtillus.* The soil is mainly drift derivative. There is a humus layer of 1″ at the surface and then about 3″ of grey-brown earth over a very deep compact red drift which is packed with small stones and is sometimes sticky in texture.

Information on the individual species are as follows:

E. Muelleri. The seed is thought to have come from Tasmania. 98 plants were planted originally and there were no recored losses due to frost during the history of the stand so far, the reduction in numbers to 62 being due to thinning mainly. The trees are straight, of very fine form and finely branched and have a healthy well furnished live crown. Top heights in October 1959 were measured at 87′.

E. radiata. The seed origin was from the Forestry Service of New South Wales. No losses due to frost are recorded, the reduction from the original number of 50 to 28 trees being due to thinnings and other causes. The tree form is fairly good but the crown development is restricted and the live crown is confined to the upper 1/5th of the trees.

E. viminalis. This is probably the mountain type of *E. viminalis* and its origin is recorded tentatively as from Victoria. In this case 20 plants were put down originally and 10 plants were destroyed in the frosts of 1939-40 and 1944. Seven forked trees remained and in 1959 only four malformed stems survived, the biggest having grown only to about 25′ under partial overhead shade from an oak standard.

E. Dalrympleana. The seed of this lot was probably sent by the Forestry Service of New South Wales but the location of the collection is not recorded. There is no record of fatality through frost and the reduction of trees from 54 to 29 was due to thinning mainly. The tree form is good and the live crown occupies about one quarter the height of the tree.

E. urnigera. The origin of seed for this stand is obscure. There were no losses due to frost, the reduction in numbers from 144 to 80 being mainly due to thinning. The form of the trees in this stand is good though the branching is coarse and the crowns heavier than with *E. Muelleri.* The live crowns which are vigorous and well furnished occupy 1/3rd the total height of the tree. Top heights in October 1959 were recorded at 81′.

---

this article the nomenclature used is that which has been found in the records or on labels of trees and no atempt has been made to change the originally recorded name to the contemporary version.

The most impressive observation in this group of plots is the high present standing volume and height growth of *E. Muelleri* and *E. urnigera.* From the early suppression of the Japanese larch these trees have grown at 9′ × 9′ spacing and have a remarkable tolerance of side crown competition with fine branched stems and good form, particularly *E. Muelleri.* It seems that it should be possible to grow 6,000 hoppus feet of pulpwood and small timber trees at 23 years without thinning. The indications are that at their wider spacing, say 15′ × 15′ trees of 10″ Q.G.B.H. could be grown at 25 years.

E. Dalrympleana is also a good tree in this series of plots and deserves further notice as there is another record of good *E. Dalrympleana* of the same origin from Dundalk Forest, Ravensdale Property.

The conifer plantations surrounding the series of eucalypt plots under review do not exceed 20′ in height and the eucalypts stand out at least 50′ above the surrounding crops in full lateral exposure and have proved remarkably wind firm not one tree having blown down in the memorable storms of January-February, 1957.

Coppicing under full shade occurs from stumps of *E. urnigera, E. radiata,* and *E. Muelleri.*

A second series of eucalyptus plots were laid down in 1935 and 1937, at Compt. 11. Ballymanus, Glenealy Forest not far away from the plots already mentioned here from which the following information is available from assessments made also in July-August 1957, with the exception of the *E. viminalis* (Mountain variety) which was measured in October 1959 in Plot 6.

Series 2.

Species	Plot No.	Year of Planting	S.P.A.	Mean Tree Total Height	Mean Tree B.H.Q.G.	V.P.A. Hoppus cu. ft. O.B.	Actual No. of Trees planted in Plot
E. urnigera	8	1935	744	57½′	4¾	2,805	120
E. Muelleri	9	1935	899	70½′	5¼	5,441	300
E. Muelleri	11	1935	538	67′	6	5,549	244
E. Johnstoni	13	1935	961	61½′	6¾	7,851	35
E. amygdalina	14	1935	5 trees left	—	—	—	50
*E. gigantea**	15	1935	775	51′	6	4,448	25
E. viminalis (Mountain Var.)	6	1935	500	50′	4	1,250	3,768
E. viminalis (Coast Var.)	7 & 10	1935	Few scrubby trees	—	—	—	1,985
E. Muelleri	16 W	1937	1,040	61′	6¼	7,737	1,225
E. urnigera	16 X	1937	634	59′	5¼	3,005	530
E. viminalis	16 Y	1937	—	—	3	—	2,120

* The accepted contemporary name is *E. delegatensis.*

The plots in Series 2 were laid down at 600′ elevation on a moderately exposed S.E. slope and in site conditions very similar to those described in Series 1.

In the case of Series 2 no thinning had been carried out previous to the assessment, the trees planted in 1935 having been spaced at 6′ × 6′ and those planted in 1937 at 5′ × 5′.

The main points which attract attention in the 1935 and 1937 series of plots is the practically complete failure of *E. amygdalina* and *E. viminalis* (coastal variety) due to frost. Frost damage also reduced the numbers and cracked the boles of *E. viminalis* (Mountain variety). With the exception of plot 8 the standing volume figures for *E. Johnstoni, E. Muelleri,* and *E. urnigera* are remarkable. In the case of *E. Johnstoni* (Plot 13), *E. Muelleri* particularly and *E. urnigera* the close spacing and delayed thinning has produced shaft like trees of very fine form and they again exhibit very high tolerance to lateral crown competition and vigorous growth has been maintained. The *E. gigantia* (Plot 15) has not grown with the vigour of some of the other species but nevertheless demands attention because of its reputation as a producer of good utilisable constructional timber. There were no losses due to frost though the number planted, 35, was reduced to 25 from unknown causes. The crowns of *E. gigantia* are light and sparsely furnished and appear to lack vigour and the tolerance of lateral competition so noteworthy with *E. urnigera* and *E. Muelleri.* Top heights from the various species measured in October 1959 from the 1935 plots gave *E. gigantia* 69′, *E. Johnstoni* 71′, *E. Muelleri* 87′ *E. urnigera* 78′. In Plot Series II also the stands have proved very wind firm and as yet no tree is known to have blown down.

It must be emphasised at this stage that the practical difficulties of achieveing accurate figures for volume per acre in the various species plots under review were very great indeed. In some cases the plots consisted only of three lines of trees sometimes involving a number of marginal trees; in other cases the plots were very small, being only fractions of an acre with, very often, irregular outline and the difficulty of estimating the actual occupational area of the sands was acute in most cases. Also the arbitary Form Factor figure of .45 has been used throughout. For these reasons it is necessary to emphasise that the volume figures can only be regarded as estimates. Nevertheless the V.P.A. figures recorded for Plot Series I and II are sufficiently consistent to establish that exceptional volume production far above anything obtainable from the conifers usually grown here and probably comparable to, if not greater than, poplar, may be expected from certain eucalypts in reasonable growing conditions. Experience suggests that unlike poplar the eucalypts do not demand high fertility and can grow well on shallow dry mineral soils. There are one or two cases that suggest that eucalypts will grow on thin dry mineral peats but it is not considered likely that it will grow on deep peats or on any of the blanket bog types.

As a further illustration of the influence of initial spacing on the growth of *E. Muelleri* figures from a stand of *Eucalyptus* laid down in 1934 at Compt. 5, Bellvue Property, Delgany Forest are of interest.

The eucalypts in this stand were established, presumably, as nurses to hardwood groups which were sited at 20′ apart. The eucalypts were inter planted at about 21′ apart in the same line as the hardwood groups and the intervening spaces were filled in with Japanese larch at conventional spacings. The Japanese larch was either suppressed by the eucalypts or in turn interfered with the hardwood groups and had been completely removed at the time the recorded measurements were made. A small group of well grown *E. Muelleri* standing at their original spacings and with even lateral and vertical surrounding shade was selected (Plate 1). This group was measured for spacing, breast height girth and height the Form Factor of .45 being again used to find stem volume. From this exercise the following figures emerged.

Species	Age	Top Height	Av. Ht.	Max. Girth	Av. Girth	F.F.	Av. Tree Vol.	S.P.A.	V.P.A. Hoppus ft.
E. Muelleri	26	94′	87′	58″	50″	.45	43.55	120	5,226

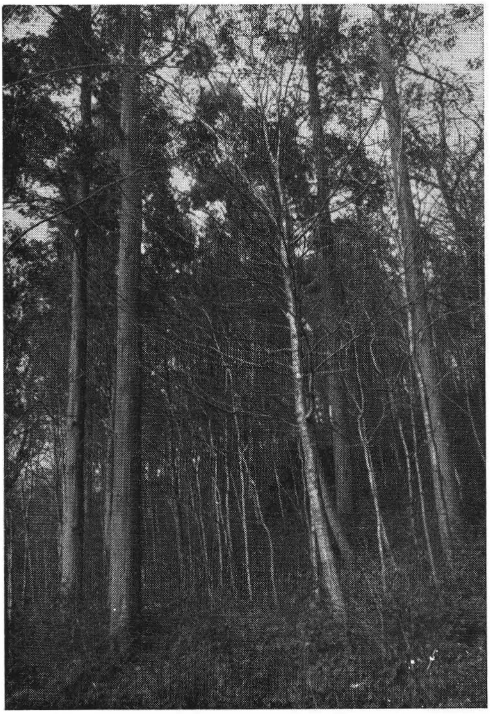


Plate 1. Group of *E. Muelleri* at Compt. 5, Bellevue Property, Delgany forest, Co. Wicklow.

The site on which this stand grows is at 350′ A.S.L. and is a favourable one of moderate fertility and exposure. The dimensions of the trees in this stand indicate that timber size trees can be grown at this spacing at 26 years but whether the wood would be sufficiently mature at this age to give good sawing results is not known, no trials having as yet been carried out.

Further measurements from single trees and trees from groups at Avondale measured in the autumn and winter 1959 may serve to give completeness to the record of the Forestry Division collection.

Species	Year of Planting	Total Height	Girth	Form	Condition
E. ovata	1909(?)	93′	64″	Good	Vigorous
E. urnigera	1909	114′	96″	Rough	Vigorous
E. Muelleri	1909	119′	$60\frac{1}{2}$″	Rough	Vigorous
E. obliqua	1909	81′	71″	Rough	Moderate Vigour
*E viminalis**	1909	120′	131″	Good	Moderate Vigour

* This tree has always been known as *E. ovata* but identification was reviewed recently and *E. viminalis* was confirmed by Kew.

In more recent times more plots were laid down in 1950. One plot in Compt. 1 failed practically completely for reasons not particularly associated with climatic conditions. A second plot in Compt. 1 was planted with *E. pauciflora* (11), *E. gigantia* (11), *E. cinerea* (11), *E. obliqua* (11), *E. Cordieri* (7), *E. Huberiana* (15), *E. Blakelyi* (22), *E. manifera* (11). In this plot one *E. mannifera* survived and six *E. gigantea*, most of the latter are growing well, the tallest being 35′ (Nov. 1959). The third plot in Compt. 5 contained *E. urnigera* and *E. Muelleri* (48), *E. rubida* (8), *E. bicostata* (23), *E. Dalrympleana* (7), *E. dives* (2), *E. phellandra* (41), *E. radiata* (4), *E. elaeophora* (5). Of these survivors to date are as follows: *E. Muelleri* and *E. urnigera* 17, *E. rubida* 3, *E. Dalrympleana* 6, *E. phellandra* 3. The original spacing of the eucalypts in this plot was 12′ × 12′ with Japanese larch nurses at 6′ × 6′. The Japanese larch has grown vigorously and may possibly have been responsible for suppressing weakly eucalypt plants in the early stages. On the other hand the nursing effect may have brought *E. rubida* and *E. phellandra* through the different early stages. Though the identity has not been botanically confirmed the latter two species are so far as the writer knows two new survivors in Ireland.

Any study of the eucalypts in Co. Wicklow, or indeed in Ireland, would be incomplete without a record of the well known collection at Mount Usher already referred to.

The main and original planting of eucalypts at Mount Usher were made in 1910, supplemented by occasional subsequent introductions, one of the most interesting being *E. subcrenulata* planted in 1949 which is now 47′ high. The site of these very beautiful gardens is a river flat at about 100′ above sea level and some 2 miles from the sea, and the climatic conditions must be regarded as mild though the lie of the land is somewhat suggestive of a frost hollow.

The following measurements we take from some of the more noteworthy trees in the collection and are tabulated with the yearly total rainfall in inches and the yearly minimum temperature Farenheit from 1949 to 1958 inclusive. This information was kindly made available by Mr. R. B. Walpole.

Notable Trees Measured, December 1959.

Species	Year of Planting	Top Height	Girth at 4′ 3″
*E. subcrenulata**	1949	47′	28″
E. viminalis	1910	110′	119″
E. viminalis	1910	95′	139″
E. delegatensis	1910	92′	74″
E. gigantea	1928	91′	103″
E. Muelleri	1910	114′	99″
E. urnigera	1910	89′	109″
E. coccifera	1910?	55′	
E. urnigera	1910	89′	91″
E. Stuartiana	1910	106′	128″
E. Stuartiana	1910	106′	120″
E. Johnstoni	1910	83′	61″
E. urnigera	1910	103′	123″
E. amygdalina	1948	33′	13″

* *E. subcrenulata* is now associated with *E. Muelleri.*

Total Annual Rainfall and Absolute Minimum Temperatures at Mount Usher.

Year	Total Rainfall	Minimum Temperatures	
1942 ...		24° F.	
1943 ...		26° F.	
1944 ...		26° F.	
1945 ...		12° F.	Feb. 19° F. and 12 weeks of frosts.
1946 ...		23° F.	
1947 ...		18° F.	Dec., Jan., Feb., Mar.
1948 ...		24° F.	
1949 ...		27° F.	
1950 ...	39.33″	22° F.	
1951 ...	46.96″	25° F.	
1952 ...	33.85″	26° F.	
1953 ...	28.87″	24° F.	
1954 ...	43.61″	25° F.	

1955	...	35.91″	22° F.	
1956	...	35.52″	16° F.	Feb.
1957	...	38.49″	24° F.	
1958	...	50.76″	22° F.	
1959	...		22° F.	

The trees recorded in Forestry Commission Bulletin No. 30 as having been killed by frost at Mount Usher are as follows: *E. amygdalina* 22° F., *E. obliqua* 22° F., *E. polyanthemos* 22° F., *E. regnans* 6° F., *E. rostrata* 18° F., *E. virgata.* Perhaps the most interesting of the trees seen at Mount Usher from a forester's point of view were *E. gigantia, E. delegatensis* and *E. subcrenulata.* The *E. delegatensis* was grown in a small group of trees and has very fine form with straight unforked stem. The *E. gigantia* was grown as a single tree with straight unforked well formed stem though rather heavily branched. The *E. subcrenulata* grown as a single tree has developed fine compact form and refined branching the height growth and vigour being remarkable. *E. Muelleri* and *E. Johnstoni* are consistent with their performance elsewhere in being trees of fine form and light branch. The record of 6° F. screen at Mount Usher must be regarded with some doubt and may have arisen from 16° F. in February 1956 or previous like temperature.

The Killiney district on the coast about 9 miles south of Dublin is remarkable for a number of fine specimens of *E. globulus* mostly as single trees in residential grounds. The grounds of the Canadian Ambassador's residence in particular contains groups and single trees of remarkable dimensions and in vigorous condition and these trees present a very fine spectacle.

Some of the taller trees measured in these grounds gave the following dimensions:—109′ high × 81″ B.H.G., 116′ high × 125″ B.H.G., 119′ high × 95″ B.H.G. and many of these trees which, incidentally, stand about 200 yards from the sea, developed at from 15′ up to 20′ apart and had undivided stems from about 60′ up to 80′ high which suggests an amazing V.P.A. potential under the circumstances.

These trees were probably planted about the turn of the century, possibly before but it was not possible to get a reliable estimate of their age.

Climate.

The most obvious climatic factor limiting the number of eucalypt species that can be grown is of course minimum temperature. Not only the actual minimum temperatures experienced but also the duration of sub-zero temperatures appear important in their influence in killing the species. The eucalypts are particularly vulnerable in the nursery stages and even hardy species such as *E. urnigera* may be killed by quite ordinary frosts. Frost tender species are usually eliminated in the sapling stages and those that pull through to the pole stages are likely to survive all but the most severe frosts. At the pole stage and afterwards the main injury caused by frost is frost crack which is a vertical splitting of the bark right through to the wood extending very often for 20′ up the tree. *E. viminalis* has proved particularly vulnerable to this type of damage here and frost crack is quite a feature with the species the big *E. viminalis* at Avondale being very deeply fissured in the frosts of 1939-40 which gave screen temperatures as low as and probably lower than 12° F.

Severe frosts are, however, quite capable of burning foliage completely on trees of very substantial size. This actually occurred during frosts in 1938, '39, '40, when complete defoliation of big trees of *E. Gunii, E. urnigera, E. cocifera* and *E. viminalis* with subsequent recovery was reported. In the severe frosts of December 1939 and January 1940 the foliage on big trees of *E. globulus* was completely burnt but the trees recovered and put out new foliage in the following season. The frosts of December 1939 and January 1940, considered one of the most severe frosts since 1934 were of long duration and killed *E. amygdalina* and *E. viminalis* in the Ballymanus plots.

Unfortunately, however, the all important records of temperatures are not reliable and no information is available for Avondale or Glenealy for the most noteworthy years of 1939-40 and 1945. Such records as there are cannot be satisfactorily related to the eucalypt sites where damage was caused and are not worth quoting.

For general appraisal of the situation it may serve some purpose to quote figures supplied by the Meteorological Office for recording stations nearest to the eucalyptus stands under review.

Station	December, 1939			January, 1940			January, 1945	
	Absolute Min.	Date	Mean for Month	Absolute Min.	Date	Mean for Month	Absolute Min.	Mean for Month
Dublin Airport	22.8° F.	—	41.8° F.	12.8° F.	—	40.0° F.	18° F.	35.3° F.
Phoenix Park	20.0° F.	29th	39.1° F.	12.0° F.	18th	33.9° F.	—	—
Hazelhatch	20.0° F.	29th	38.7° F.	12.0° F.	20th, 21st	33.9° F.	14° F.	34.1° F.
Newcastle	30.0° F.	29th	41.3° F.	12.0° F.	17th, 18th	34.9° F.	22° F.	38.0° F.

Newcastle Station lies some seven miles to the N.E. of Avondale, two miles south from Bellevue and four miles N.N.E. from Glenealy and is the nearest to the eucalypt stands described but lies at about 300′ A.S.L. and is less than two miles from the sea so that frosts would tend to be possibly more severe at Glenealy but definitely so at Avondale where the winter climate is regarded as severe, and winter temperatures there would be more comparable to those quoted for Hazelhatch.

In the meteorological records January 1940 is summarised as being "exceptionally cold with intense frost and considerable snow in the latter half of the month."

The severe conditions of the period are further emphasised by the record of 15 days of ground frost in December 1939, the average being 8 days, and of 19 days of ground frost in January 1940 where the average is about 13 days.

Another very severe period was experienced in 1947 when there were innumerable and sustained falls of snow from January to the end of March. In 1947 that year the January mean of 39.5° F. was quite high but February proved to be one of the severest months of recent times with an absolute minimum of 10° F. and a mean of 32.5° F. and seventeen days of ground frost. However, no particular damage to eucalypts was recorded, or is remembered, for that period. The possibility that the trees may be in a more vulnerable condition during December and January might therefore possibly be considered. If this were the case not only the degree and duration of the frost but also the month in which the frost occurred might have significance. On the other hand in February 1945 and 1947 most of the trees under discussion were well established and in a strong and vigorous condition. A perusal of records of Absolute Minimum Air Temperatures (in degrees Fahrenheit) recorded at certain stations during their effective periods gives the following interesting and relevant figures. On January 28th, 1945, 11° at Shannon, 15° at Cork, 4° at Claremorris, 18° at Mallaranny, between January 17th and 22nd, 1940, 14° at Tralee, 16° at Waterford, 19° at Carrick-on-Suir, so that out of a total of 21 stations recorded seven absolute minimum temperatures occurred in January 1940 and January 1945. Of general interest is the lowest temperature ever recorded —2° F. at Markree Castle in Co. Sligo on 16th January 1888, but this minimum appears to be quite exceptional.

However, the classification of the eucalypt species in order of their resistance to frost by C. Martin as published by F.A.O. in Eucalypts for Planting (1955) seems to bear some relation to experiences in this country and is as set out as follows :

Resistant To.

- 0° F. *E. vernicosa, E. bicolor, E. nephophila, E. Gunnii**.
- 5° F. *E. coccifera*, E. subcrenulata*, E. Johnstoni*, E. urnigera**.
- 10° F. *E. pauciflora, E. delegatensis*, E. rubida, E. stellulata, E. aggregata, E. cordata, E. Dalrympleana*, E. ovata**.
- 15° F. *E. viminalis*, E. obliqua*, E. Blakelyi, E. pulverulenta, E. bicostata, E. Robertsoni, E. melliodora, E. resinfera.*
- 20° F. *E. globulus*, E. regnans, E. amygdalina, E. Perriniana, E. elaeophora, E. saligna, E. linearis* and others.

From the above list the species marked with an asterisk have been grown successfully now for 20 years or more. A few *E. rubida, E. phellandera, E. mannifera,* have survived from the 1950 planting at Avondale but *E. Blakelyi, E. bicostata, E. elaeophora* failed in the early years after planting. *E. amygdalina* has survived since 1948 at Mount Usher but missed the bad frost years of 1945 and 1939-40 the latter of which killed most *E. amygdalina* at Glenealy. Comparison of the above list with the Absolute Minimum Temperature map of Ireland (Fig. 1) suggests the possible range of these species in our country though in the case of *E. globulus* of which we have some experience the 15° F. absolute minimum line looks a more appropriate limit than the 20° F. limitation. It does appear indeed, and it may well be true for other species also, that in Ireland *E. globulus* tends to survive lower temperatures than set out in the F.A.O. list.

The effects of other climatic factors on eucalypts in Ireland have not been studied and little is known on the subject, but high rainfall and a limited sunshine so often experienced does not seem to have a detrimental effect on growth, except in so far as it is greater in hotter and sunnier climates.

There is little doubt, however, that the species grown here have proved remarkably wind firm in our conditions in which gale force winds of up to 70 m.p.h. are not unusual. During the exceptional gales of January-February 1957 when gusts of over 100 m.p.h. were experienced little or no damage was caused with single eucalypts or in eucalypt stands.

Utilisation:

Though most of the wood from available eucalypt trees is too immature to give a range of material from which comprehensive findings particularly as to timber quality might be obtained, some preliminary exploration as to utility has been possible. Older trees have not as yet become conveniently available due to their amenity value or the importance of their position in a stand. Small saw logs from 23 year old *E. urnigera* were sawn in 1957 but the results were not encouraging. The wood which is white with a pink tint towards the centre of the tree cupped and twisted badly. Scantlings and smaller cuts became distorted into extarordinary shapes "collapse" being a prominent feature in all cuts.

On the other hand boards cut from a planked and seasoned eucalypt of over 50 years at Gorey Forest in 1958, probably *E. Gunnii* or *E. gigantia* were fairly stable and offered attractive face grain and colour. This eucalypt was unfortunately not identified at felling and is only thought *E. Gunnii* or *E. gigantia* from local association.

It is hoped in future to select old trees from time to time and put them through subjective systematic seasoning and milling tests but information obtained to date is of little value.

Two loads of *E. Muelleri* from 23 year old thinnings at Glenealy Forest were sent to Bowaters Irish Wallboard Mills Ltd. at Athy. The first consignment in January 1958 of 23¾ tons gave encouraging results which may be briefly summarised as follows, from information kindly made available by Irish Wallboard Ltd.

The eucalypt notwithstanding its weight (supplied fresh to mill) was handled easily by the chipper, giving chips of suitable size.

Defibration was satisfactory but considerable foaming occurred in the stock chests and board machine.

The finished board was different in colour from the normal conifer board being purple tinged to a slight extent. The board was satisfactory except for one point, that of its high moisture absorbtion capacity which might give rise to movement in the board after manufacture.

The following figures are of interest.

	Sp. Wt.	Percentage Bark	Lbs./Cu. Ft.	Percentage Moisture Content Wood	Bark
Scots Pine	0.650	7.3	40.6	55.6	44.4
Douglas Fir	0.670	12.5	41.8	50.7	63.4
Spruce	0.694	8.7	43.4	57.4	63.4
Larch	0.654	14.7	40.9	43.5	43.8
Eucalyptus	1.050	8.5	65.6	45.0	62.6

Finished Product.

	Thickness MM.	Lbs./Sq. ft.	Bending Strength P.S.I.	Tensile Strength P.S.I.
Eucalyptus	3.20	.69	7,781	4,445
Conifer Thinnings	3.43	.70	6,631	3,451

	Breaking Load Lbs.	Water Absorbtion 2 hrs.	24 hrs.	Swelling 2 hrs.	24 hrs.	Moisture %	Sp. Wt.
Eucalyptus	55	16.1	46.9	7.6	26.6	5.7	1.031
Conifer Thinnings	54	4.9	14.2	3.1	11.0	7.9	1.029

A further consignment of *E. Muelleri* from the same plots as previously was sent to Athy in July 1958. This consignment weighed $21\frac{1}{2}$ tons and if anything gave more encouraging results than the first consignment, a prominent though unexplained feature being the reduction of moisture absorbtion to 26% for 24 hours as compared with 47% for 24 hours in the January consignment. There was a decrease of 17% in the strength of the board after humidifying.

Comparison.

	Thickness	Bending Strength P.S.I. Untempered	Tempered & Humidified	Lbs./Sq. ft.	Breaking Load Lbs.	Tensile Strength P.S.I.
Conifer Thinnings 11/7/58	3.477	6,404	7,185	.74	60	5,467
Eucalyptus 11/7/58	3.476	9,159	7,569	.76	66	4,402
Eucalyptus 5/2/58	3.200	7,143	7,781	.69	55	4,445

	Swelling 2 hrs.	24 hrs.	Moisture Absorbtion % 2 hrs.	24 hrs.	Moisture Content %
Conifer Thinnings 11/7/58	3.72	12.9	6.08	17.4	—
Eucalyptus 11/7/58	6.79	19.7	12.27	26.0	7.4
Eucalyptus 5/2/58	7.6	26.6	16.1	46.9	5.7

Note: .34% (Solid) Lauxite (Phenolic resin) used in board of 11/7/58 but not in board of 5/2/58.

The foregoing trials indicate that satisfactory Hardboard can be manufactured from 23 year old *E. Muelleri* grown in Eire.

Some time after these trials were carried out information came to hand to the effect that the process liquors from eucalypts are acid to an extent that they corrode the plattens in the manufacturing hydraulic press, reducing their normal effective life considerably thereby. This

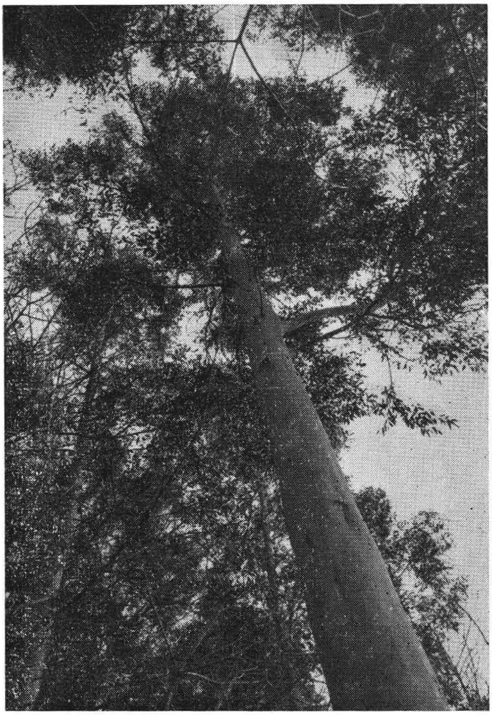


Plate 2. *E. Muelleri* (Ht. 89′, B.H.G. 58″) at Delgany forest indicating shaft-like stem and crown form.

presents a serious difficulty but great problems have been overcome in pulping processes in Australia, Portugal and other countries, and in Australia they continue to manufacture hardboard in spite of this difficulty.

In December 1958 and January 1959, 36 heavy poles of *E. viminalis, E. urnigera, E. Johnstoni* and *E. Muelleri* were selected and felled for trial as transmission poles. These trees were planted from 1935-37 and were taken from Ballymanus in the plots already referred to and from groups and single eucalypt trees in the immediate vicinity of these plots. The poles accepted under E.S.B. specification ranged from 6½″ to 9¼″ top diameter and 28′ to 39½′ in length while the top heights were *E. viminalis* 62′, *E. Muelleri* 78′, *E. Johnstoni* 73′, *E. urnigera* 71′. Although this trial is not yet complete, the poles not having as yet passed through the transmission fitness tests, it is of interest because of the phenomena of end and longitudinal splitting that took place at felling time.

Preparation had been made to apply special oil gloss paint and to cut circular grooves on the ends after felling, as end splitting was anticipated. Although this work was carried out with controls it unfortunately gave no result of value as the end splitting of the trees occurred simultaneously to felling, thus nullifying any favourable effect the paint or circular chiselling might make. These splits occurred mainly across the pith being from 1″ to 7″ long at felling and radiating outwards with time. Some splits also occurred in the direction of the annual rings. There was no fault in felling but the forester reported sharp reports from the trees while still on the saw before the tree went over. Longitudinal splits of some length and depth appeared on the outside of the poles with the passing of time thus degrading their appearance and quality considerably. It was noted that the one tree which got "hung up" in another tree in falling, an *E. viminalis,* did not split. This unfortunate defect in the eucalypts was well known here already, but in the view of some is influenced in its intensity by the season of felling. Research to overcome this defect should be worth while if the poles pass the other tests for transmission as beautifully straight poles for this purpose can be grown within 25 years, particularly with *E. Johnstoni.*

In limited trials carried out with *E. Muelleri* for pit propping, stout props of 16″ to 28″ with 4½″ diameters for specialised use gave service comparable to other coniferous props in use and were considered satisfactory. Split lengths 2½″ thick tried as 4′ to 3′ sleepers became shaken, as might be expected, and did not therefore give satisfactory results.

Heart wood samples from *E. Muelleri, E. viminalis, E. Dalrympleana, E. urnigera, E. radiata, E. gigantia, E. Johnstoni* were supplied to British Leather Manufacturers Research Association for detailed study and research into the chemical make-up of the wood in regard to the possibility of extracting tannins useful in leather processing.

Conclusion.

There is little doubt that a limited number of eucalypt species can be grown successfully in Ireland and some of them can out-produce any other tree species of which we have experience. The poplars may possibly challenge the eucalypts in growth but poplars must usually be given most favourable site conditions where a eucalypt will grow well over a wide range of conditions which include dry shallow mineral soil types in exposed situations. Indeed, in this respect the eucalypts have not yet been fully extended by trials at high elevations on difficult mineral soil types. Experience suggests that eucalypts will do fairly well on certain types of mineral peats but the prospect of their succeeding on deep peats or blanket bog types is not regarded hopefully. In contrast also to poplars some of the eucalypts show exceptional tolerance to lateral competition and can produce vigorous high yielding stands at close spacings such as 6′ × 6′. In this regard some of the species, particularly *E. Johnstoni* produce trees of very fine form, even when growing at 20′ apart. Eucalypts can be regenerated either by coppice shoots or by natural seed fall and most years there is an abundance of fruit and viable seed born on the trees. The seed germinates readily in the nursery but thereafter the seedlings are difficult to handle and planting losses may often be high. It is considered, however, that if sown early in May and well protected from late frosts that seedlings can, under normal conditions of growth, be transplanted into boxes in late July and taken to the planting site in boxes and planted the following winter or summer as may be convenient, without any losses. Where wide spacing is adopted, say 20′ × 20′ this method might well be quite economically exploited. Also, the new techniques of transporting plants from nursery to planting site in polythene bags should give good results.

Although fibre board of good quality has been manufactured from Eucalyptus grown in Ireland, this success has been marred by the fact that the process liquors corrode the mill machinery. This difficulty might be overcome in some way or another and deserves appraisal in the light of the fact that there is no other tree that will produce as much timber in so short a time under our conditions. The economic balance of this consideration deserves attention.

Limited sawing trials with immature timber have given poor results but good boards have been sawn and seasoned from old trees and show very attractive facial grains and have remained stable. No proper conclusions can be drawn at this stage and more intensive conversion trials are indicated as more mature trees become available.

Other lines of investigation still in the early stages are trials of eucalyptus for tannin, pit props and transmission poles. Developments from the latter study will be followed with keen interest because if some way can be found to overcome the difficulty of serious splitting after felling the eucalypts—particularly *E. Johnstoni*—have ideal tree form for this purpose.

There is no doubt, however, that the deep splitting of the tree in the round soon after felling, together with the marked tendency to collapse in the sawn wood, is a major obstacle to the acceptance of the species in general forestry practice in Ireland. Perhaps the development of such species as *E. delegatensis* and *E. gunnii* which have so far been neglected may give better results in regard to saw timber utilisation.

It is surprising that the eucalypts have not attracted more attention from horticulturalists and arboriculturalists, for they have many qualities to recommend them for planting. Its proven ability to withstand wind and its exceptionally fast growth should recommend it as a shelter belt tree over a wide range of mineral soils, excluding heavy wet soils and peaty sites. The fact that it grows well on dry light soils suggests it for use in shelter belts near the sea.

For amenity in parks and demesnes the eucalypts are very acceptable while the full retention of foliage during the winter months make it a valuable tree for screening purposes, and in this respect—provided there is plenty of room and that it is not put too near dwelling houses, it is unsurpassed.

Eucalyptus wood of many species, some of which can be grown here, is accepted as raw material for the cellulose industries and is being planted in a big way in Spain, South Africa, Brazil, Portugal, Morroco and many other countries and if the species could compete and out-produce the faster growing conifers here on the difficult mineral soil types such as are found in Co. Tipperary and Co. Cork Old Red Sandstone mountains they should win consideration in the economics of forestry practice. Meanwhile experience up till now justifies, in the writer's opinion, perseverance in research in this field and extension of trials into more difficult site types and through a greater range of possible species.

Acknowledgements.

In preparing this article the writer derived great help from the records of the Department of Lands, Forestry Division and is indebted to the work of the Officers of Research and Assessment Sections for much information particularly in regard to growth. The co-operation and help of the Foresters at Glenealy, Delgany, Avondale and Dundrum Sawmill is also recorded with appreciation.

My thanks are also due to Mr. R. B. Walpole for the facilities he provided not only in visiting Mount Usher but also for his help and interest in providing any relevant records in his possession.

I am grateful to His Excellency the Canadian Ambassador and Mrs. Rive for permission to visit the grounds of their residence and for the courtesy extended to me at the time of my visit.

On the utilisation side valuable work was carried out by Bowaters Irish Wallboard Mills Ltd. and my thanks are due to Mr. Shackleton for co-operation and permission to publish figures obtained in his laboratory.

I am also indebted to the Meteorological Office for much helpful

information supplied as well as to Castlecomer Colleries Ltd. who reported on pitwood tests.

REFERENCES.

Anon., 1955. Eucalypts for Planting. *F.A.O. For. & For. Prod. Stud.* No. 11.

Blakely, W. F., 1955. A Key to the Eucalypts. *For. Timb. Bur. Aust.*

Fitzpatrick, H. M., 1933. The Trees of Ireland—Native and Introduced. *Scient. Proc., R.D.S.* 20, 597-656.

Jacobs, M. R., 1955. Growth Habits of the Eucalypts. *For. Timb. Bur. Aust.*

Macdonald, J., Wood, R. F., Edwards, M. V. and Aldhous, J. R., 1957. Exotic Forest Trees in Great Britain. *Bull. For. Comm.* No. 30.

Martin, D., 1959. Eucalypts in Ireland. *Lecture given to the Royal Society of Tasmania,* 7th April, 1959.

O'Beirne, M., 1945. Notes on Eucalyptus Species at Avondale, Co. Wicklow. *Irish Forestry,* 2, 23-26.

Ryan, P., 1956. Note on the Raising of Eucalypts in the Nursery. *Irish Forestry,* 13, 71-72.

Simmonds, J. H., 1927. Eucalypts in New Zealand. *Brett, Auckland, New Zealand.*

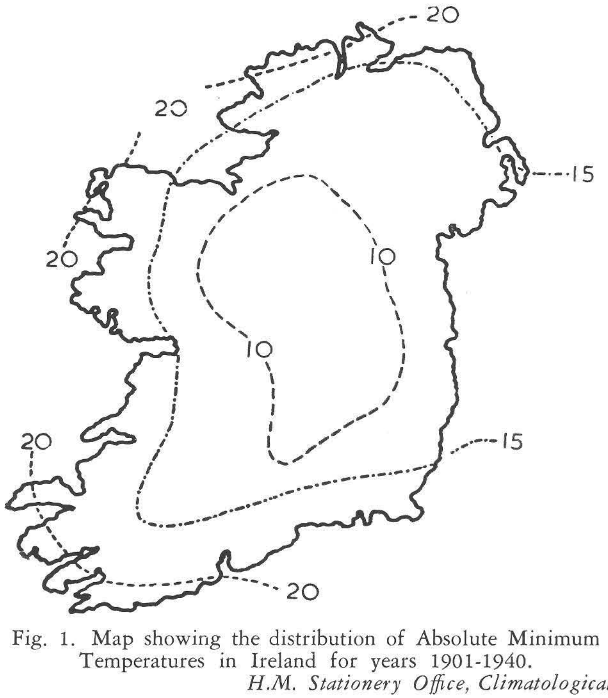


Fig. 1. Map showing the distribution of Absolute Minimum Temperatures in Ireland for years 1901-1940.
H.M. Stationery Office, Climatological Atlas.

An Assessor's Observations on Irish Conifer Crops

By G. GALLAGHER

THE work of assessment provides, for the forester involved in this occupation, an excellent opportunity to observe how native and exotic conifers are adapting themselves to present-day forest conditions in this country. He has the advantage of being able to see, concentrated in a relatively short period, conifer stands of the majority of common and not so common species through various parts of the country. Our forests are now at the stage where some of the more obvious merits and defects of our planted crops are coming to light; and I have been able to observe many of these in the most promising aspect, and conversely.

To commence I would like to mention Scots pine, it being one of the few indigenous conifers we possess and one of our most tried species, though, indeed, the fact that the Scots pine we now plant and that which formed our ancient forests is the same is open to controversy. The overall impression that one gets is rather pessimistic and that, far from being adaptable to a wide variety of conditions, the species is more than slightly limited to favourable sites. Most of our Scots pine plantations are twenty to thirty years old but show startling differences in quality class. This was very apparent to me in the areas I worked in, viz. Tipperary, Wicklow and the south-east part of the country. The most disturbing aspect of Scots pine has been its failure on the Old Red Sandstone areas in Cork and Tipperary, especially in the vicinity of the Glen of Aherlow, Cahir and Clonmel. Here the effects of exposure, vegetation and soil conditions have caused stagnation in a number of areas, primarily on the higher slopes of the hills over 700 feet where there is a tendency to podsolisation with strong *Calluna* and *Ulex* vegetation. The Scots pine roots have not been able to penetrate to a very great depth and growth has been smothered by the vigorous opposing vegetation. On the lower and steeper slopes, and the non-peaty areas, there is a marked change and the best quality Scots pine is giving some 1,500 cubic feet* per acre at twenty-five to thirty years. These lower plantations, especially on good mineral soils where briar and bracken are predominant, show promising vigour but one cannot help wondering whether or not some more profitable species could have done as well. The oldest Scots pine I have seen over 60 years does not yield over 3,600 cu. ft. per acre. The impression I gained was that Scots pine shows promise on lower dry slopes and especially in the midland peat areas of cutaway bog rather than on the often tried high and dry mountain site types.

Sitka spruce, which we on assessment had ample opportunity of

* All volumes given in cubic feet, Hoppus measure, excluding thinnings.

observing, is a species of which a great portion of our forests now consist. Generally, observations showed that spruce appears to be a forest tree excellently suited to our country. In most areas visited, and in all areas that I have seen, spruce, except for sporadic patches, shows promise on the sites planted, these being primarily the wetter, higher slopes of up to, and over, 1,000 feet, and low-lying boggy areas. It has volumes of 1,000 to 2,000 cubic feet per acre, excluding thinnings, at twenty years, to 3,000 to 4,000 cubic feet at thirty years depending on quality class. The most promising areas are those where it is planted on moist hillsides yielding quality class I crops. I saw excellent stands of thirty years old Sitka spruce in Glengarra and Thomastown forests, an example of how well it does in these favourable conditions, and a very vigorous young crop at Coolgreany on bracken and *Molinia* covered slopes showed promise for the future. Sample plots taken by other assessors show very high volumes from our older Sitka spruce plantations in Dundrum, Baunreagh and Camolin. Sitka generally is holding its own in mixtures with Scots pine, Contorta pine and Norway spruce as seen in Carrick and Aughrim but the overall volume is, of course, not equal to that of the pure crop. The Sitka and Contorta mixture is rather promising for Irish forestry as on the more difficult *Calluna* peaty ground it shows promise of proving to be a stepping-stone to bridge the gap between good and poor conditions and yet yield a crop of relatively good volume (1,600 to 2,000 cu. ft. per acre at 20 years). Where these crops came away neither species seemed to suffer at the expense of the other. The apparent defects of Sitka spruce are its well known habit of checking when young in low lying, boggy and frosty areas and its sporadic failure on unploughed *Calluna* ground due to strong vegetation and the tendency of the soil to pan. As the majority of the plantations assessed are less than forty years old there is yet no appearance of butt rot as a danger to the timber crop although group dying of Sitka may yet prove dangerous. In many of our southern forests the failed Scots pine sites have been ploughed and replanted with Sitka spruce, as in Kilsheelan. The spruce, though as yet too young to show marked results, appears to be living up to its name of being one of our most promising forest trees thriving in a wide variety of conditions showing possibility of carrying forestry, with mechanical and chemical aid, to our more difficult sites.

Though it has since lost its rather exalted position in Irish forestry opinion, we on assessment had the opportunity of seeing many good stands of Douglas fir. Again, the greater number of Douglas stands are in the twenty-five to thirty-five year old age group with the exception of a few older estate plantations. Most of the forests in the counties of Louth, Tipperary, Waterford, Kilkenny, Wexford and Wicklow which I visited have well established stands of Douglas fir. The first impression gained of the species is that of an attractive and high volume producing tree. This, however, is rather deceptive as most of our Douglas is quality class III, sometimes reaching Q.C. I. In pre-Department plantations forty to fifty years old on favourable sites volume was infrequently greater than 4,000 cu. ft. per acre, 2,400 to 2,800 cu. ft. per acre for thirty years old trees, and rarely over 2,200 cu. ft. per acre for stands less than twenty-five years old. Most of the stands seen contained a small perceneage of European or Japanese larch; this, when low, had no detrimental effect but Douglas does do disappointingly in mixture, however, when not present in an appreciable majority and was often subdued by the larch. There are very few of the intermediate age-group stands, the planting of Douglas fir being reduced to a minimum at that time, but in the under ten years old group a number of promising young plantations can be seen—as in Monaghan and Shelton forests. Douglas does best on low-lying, fairly dry, unexposed slopes with a good mineral soil and vigorous grass, bracken and bramble vegetation. Especially good stands were seen in Carrick-on-Suir, Coolgreany and Aughrim. The species has been overrated in the past but, as a result, has been rather harshly treated. Given time it is still a tree that should prove its worth on suitable sites.

When on assessment we had a prelude of things to come in our observations of *Pinus contorta*. We were fortunate in being able to view many stands of this controversial species in various age groups and at different stages of development—though to the detriment of recording purposes most of the older plantations were on comparatively good sites. Plots taken in twenty years old contorta in Kilsheelan forest gave over 1,600 cubic feet per acre at altitude 1,000 ft. on peaty ground of *Molinia* vegetation. It was observed, however, that *Pinus contorta,* at this age, ir rather subject to windblow and distortion was evidenced in areas in Piltown, Slievenamon and Blessington forests. In *Pinus contorta* plantations the very marked difference between inland and coastal type contorta is illustrated markedly by stands in Aughrim and Clonmel forests where volumes up to 1,000 cu. ft. per acre accompany as yet almost unclosed stands. In general, *Pinus contorta* is showing promise on high exposed peaty ground where *Calluna* dominates, both in areas ploughed and unploughed—although I saw a small area in Kilsheelan that has become stunted like retarded mountain pine. As previously mentioned contorta pine + Sitka spruce mixtures are doing promisingly. Scots pine + contorta pine mixtures show substantial dominance of the contorta causing the majority of the Scots to die out. Very striking examples of Scots and contorta on the same site can be seen at Glengarra and Avoca where the *Pinus contorta* appear like sentinels over the rest of the crop. Present appearances show that faith in contorta appears to be justified.

Norway spruce, which is another of our well established species, was extensively covered by the assessment. One noticeable aspect of the tree in plantation was the scarcity of any large, failed areas on the sites planted. Though in places volume and stocking were low Norway spruce invariably, as far as I could see, closed to form a crop. I saw a number of fine old stands of fifty years old and over with volumes over 5,000 cu. ft. per acre at Carrick-on-Suir and Kilsheelan. Department planted crops of up to thirty-five years vary in volume from best quality at 3,000 cu. ft. per acre, excluding thinnings, to 2,500 in the lesser quality classes. Twenty years old crops have 1,700 to 2,000 cu. ft. per acre. Generally, all stands observed were vigorous though some of the younger plantations remain open until approaching the twenty years old age class. As most of our Norway spruce plantations are on good sites having good mineral or alluvial soil with plentiful vegetation and often bordering rivers and streams growth does not fall off at any stage. However, in all the south-east forests I was in, on rich sites, where birch, rowan and ash grow naturally these species grow quickly through the younger (fifteen to twenty-five years old) conifer plantations keeping the crop open and preventing full volume from being reached. Norway spruce shows a characteristic absence, at its early stages, of the check which is evident in Sitka spruce. In Aughrim forest there is an interesting area where Norway spruce has survived, though checked by opposing vegetation, mainly *Ulex,* and Sitka spruce has been completely swamped. On sites seen through the country Norway spruce shows itself to be a reliable, good volume producing tree.

One of our best known and longest established forest trees is European larch. Japanese larch has, however, in my opinion, proved itself superior to European larch in all conditions—as a volume producer, for adaptability to site and in quickness of growth—having seen both larches pure and in mixture in most forests visited on assessment. European larch is the commonest species in the fifty to sixty years old pre-Department plantations (many now at the felling stage), final volumes being 3,000 to 3,800 cu. ft. per acre. There are good-looking stands of this type in Kilsheelan, Piltown, Curraghmore, Aughrim and Carrick forests on best forest soils—many in the process of being felled for telegraph poles. The picture is rather different in younger plantations; though some produce 1,000 to 2,000 cu. ft. per acre, in a number of areas stagnation occurs. Very poor, cankered larch was seen at Monaghan and Aughrim. Young European larch shows itself to be a poor competitor against opposing vegetation, especially *Ulex*—as seen in Nier forest. It was also observed to be more liable to wind distortion than Japanese larch both in pure crops and in mixtures. The older plantations of Japanese larch (of thirty years approximately) yield volumes of up to 3,000 cubic feet per acre; twenty-five to thirty years over 2,000 cu. ft.; twenty to twenty-five years 1,200 to 1,500 cu. ft. In Coolgreany are examples of promising young stands which have subdued site vegetation and are relatively good volume producers at twenty years. Japanese larch appears in many of the forests assessed as wind shelter-belts and compartment margins. Growth on difficult sites tends to be patchy in areas, coming away vigorously between suppressed spots. A large percentage of larch, both European and Japanese appears in mixture with Scots pine; though height growth is satisfactory, there is a very marked fall in volume as compared with pure crops—the Scots pine suffering at the expense of the larch in 50-50 mixture and *vice versa* in mainly Scots pine mixtures. Larch with Sitka spruce does well and an encouraging stand of these species was seen in Piltown forest, volume and overall appearance were much better than the Scots pine larch mixture.

Besides these common forest species mentioned a number of stands of the rarer exotic species were observed, giving an indication of the number of trees that can thrive in good conditions here in Ireland. *Tsuga heterophylla,* now becoming popular, was seen quite frequently in various aspects. Most of these stands are just entering volume category and plots in twenty years old *Tsuga* have shown results of 2,000 cubic feet per acre—this being higher than first appearances indicate. It does satisfactorily on all the better quality Sitka spruce sites, slopes not too poor in soil and vegetation, i.e. an absence of peat with grasses, briar or bracken dominating. Lawson cypress and *Thuja plicata* are present, though not plentiful, in our woods. They are in volume and quality alike, in similar conditions, though less tolerant than *Tsuga* to vigorous vegetation. Cypress stands were noted in Thomastown yielding 2,500 cubic feet and over when twenty-five years old, though beside this area the volume fell remarkably due to suppression by shrub growth. A small, attractive stand of *Thuja* is present in Coolgreany forest and some fine, old *Thuja* was noted at Comeragh. *Cuppressus macrocarpa* of the same age as the Lawson yielded, in Dundalk, upwards of 3,000 cubic feet per acre in favourable forest conditions.

Of the firs *Abies grandis, Abies alba* and *Abies nobilis* hold a place, if small, in Irish forests. There are many huge individual trees of silver fir of enormous volume, some of them rating about 200 cubic feet per tree, which date from the nineteenth century and appear as remnants of old plantations. These are more interesting as curiosity pieces than of any great commercial value themselves. Very few younger stands can be seen due to the ravages of *Adelges musslini,* though some have managed to make the grade. Among the early Department plantings at Coolgreaney are some of *Abies alba* over 3,000 cu. ft. per acre at forty years—also some healthy youngsters can be seen at Kilsheelan—these are, however, among the rare survivors. *Abies grandis,* on the other hand, except for susceptibility to wind damage is adapting itself well and is a remarkable volume producer. There is an excellent stand thirty years old with 4,000 cu. ft. per acre at Roddenagh, Aughrim and well growing twenty years old stands surprisingly under old oak, bearing 2,000 cu. ft. per acre. *Abies nobilis,* as yet a dark horse, grows quickly but when young remains very open due to sporadic failure.

Among the less common pines planted we saw stands of radiata, Corsican and martitime pines. Most of the *Pinus radiata* was too young for measurement but where successfully established it has shown remarkable vigour and a ten years old stand on a low, dry hillside at Slievenamon has almost measurable volume. Timber appears to be very rough but would prove adequate for the less exacting modern uses of timber. Corsican pine does well in our eastern and southern forests, though where it has difficult vegetation to cope with it takes up to twenty years and more to close crown properly. Its Austrian variety, rougher in form, was seen growing well at Dundalk. Maritime pine has been planted at Curraghloe but is less satisfactory as a volume producer and generally hardy species than similar Corsican pine. A small but attractive looking stand of *Pinus strobus,* which escaped blister rust, was observed at Coolgreaney; over forty years old its volume was over 3,000 cubic feet per acre.

Finally, when carrying out this work we met, on occasion, the unexpected. To briefly record some of those seen, I wish to mention a very impressive sixty years old stand (the only one in the country) of *Cedrus deodara* at Glengarra of volume 6,500 cu. ft. per acre with individual heights over 100 feet; suckering of *Sequoia* in Gorey Forest; natural regeneration of fifty years old Sitka spruce, once more at Glengarra; and a remarkable contrast in height increment between Sitka spruce and Scots pine in some forests, spruce showing long twelve to eighteen inch leaders in contrast to Scots leaders which were unusually short and stubby due, probably, to climatic conditions in the last two summers.

Forestry aspects seen were many and varied and, though the time to form opinions was short, a lasting impression, I feel, of forestry to-day was gained by all of us in that brief period.

Soil Survey in Ireland with particular reference to Forestry.

By PIERCE RYAN

Introduction:

A recent Government White Paper on an extensive programme for economic expansion laid special emphasis on increasing production from the land of Ireland. It is rational to concede that our soils must play a fundamental role in any form of improved productivity from our land resources. The extent to which production can be increased to meet the targets of an economic expansion programme, depends ultimately on the potential of our soils to meet this demand, on the manner in which they are used and on the manuring and management practices that can be applied to them toward greater out-put. Proposed targets can only be met by better use of all the resources at our disposal, principal of which is the soil itself, by the application of the best possible scientific techniques, and by the greater over-all effort on the part of all concerned.

The limitations inherent in our soils and militating against certain forms of production can best be remedied on a sound scientific basis when the soils themselves are thoroughly studied and known. In the more advanced agricultural countries of the World a survey of soil resources is regarded as basic to and an integral part of all land use planning and improvement. It is not surprising therefore that the agricultural research programme formulated by the Institute of Agriculture for this country, should include as a fundamental primary project a complete survey of Irish soils.

Procedure and Functions served:

This survey is being made to determine and record the more stable, slow-to-change characteristics of soils, the similarities and differences amongst soils, their distribution and extent and their behaviour under different cultural treatments. Such a survey makes possible the segregation and classification of soils on the basis of parent geological material and of other physical and chemical properties within the soil profile and of relevant landscape features of the soil. Each soil therefore can be fitted into a particular category and as a result the more important properties amongst soils are distinguished and comparisons between soils can be made. From time to time a number of surveys for drainage planning, settlement planning and for various other purposes depending on the current requirement, can be drawn from the basic soil survey. These surveys may group together for a specific project, certain soils segregated on the soil map, but the soil survey remains the basic survey designed to serve many purposes, for although the combination of soil use and management practices may change periodically, the soils themselves undergo little change so that the basic soil map is lasting in its interpretation and use for many years.

Modern soil survey and classification is based fundamentally on a study of the soil profile (vertical section of soil from surface down to parent material inclusive) which reflects the influence of the various factors of soil formation, including climate, vegetation, drainage and type of parent material from which the soil was derived. The morphology of each soil is expressed in its profile, reflects the combined effects of the particular set of genetic factors responsible for its development. This concept, first established by the Russian soil scientists at the end of the last century, is now generally accepted. Detailed examination and description of soils in the field is then an important part of the surveyor's procedure. The soil profile is thoroughly studied and for different depths or horizons (layers) such important characteristics as colour, texture, structure, consistence, occurrence of lime, gypsum or soluble salts, occurrence of iron or manganese concretions or pans, nature and distribution of organic matter including plant roots and other soil fauna, thickness and arrangement of the horizons (layers) and their definition in the profiles, internal and external drainage status and the presence of a water table, nature of parent material and so on are noted and described. Field findings are checked and supplemented by physical and chemical analyses in the laboratory of samples selected from representative profiles. By this means all existing knowledge of soils is collected and may then be arranged in a systematic way in a soil classification. In this manner the nature of any particular soil may be specified and further, it may be compared or contrasted with any other particular soil.

Soil survey has a vital role to play in the many facets of land use and development including soils research and field experimentation, research application and advisory work, management and manuring, cropping and rotation practices, delineation of problem areas toward improved animal and crop production, horticulture and forestry planning and practice, land reclamation and drainage, land settlement and reallotment, consolidation of fragmented holdings and others. First and foremost a soil survey provides a valuable inventory of the soil resources of the country as regards inherent character, potential and extent. In the planning and conduct of research and experimentation in the field, proper selection of most representative sites and rational extension of experimental findings to large areas can be made with far greater confidence when the soils are surveyed and classified. It is obvious that all experimentation related to the soil assumes far greater value when the soil as a variable factor is recognised in full.

A major function of the soil survey will be the identification of a soil in a local area such as a farm, or a forest unit, for the purpose of applying results of research applicable to that area. At the present time soil analyses are being used as a guide to balanced manuring for various crops. However, different soils have, for instance, different powers of "fixing" phosphate or variable ability to release potash from potash-rich minerals of the soil itself. Thus, whereas our present soil test is a very useful guide in planning manurial treatments, it becomes a much more formidable guide when supplemented by survey information on the soils themselves. Several aspects of liming problem in soils can best be investigated and remedied with the help of soil survey. Soil survey also discloses the level of organic matter in soils—a highly important factor. Problems of soil management, such as the most desirable cultivation practices to adopt, or most suitable seeds mixtures or tree species to grow, or best rotation to follow and such like, can best be tackled on a soil survey basis.

In the course of carrying out a soil survey, areas where certain nutrient elements are either deficient or present in toxic quantities in the soil for plant or animal needs, can be effectively delineated. The condition can usually be associated with recognisable soil features which are recorded in the course of the survey. Thus, extensive areas can be treated for the condition rather than sporadic occurrences. Besides the prediction possibility is extremely valuable. Such a survey to delineate areas deficient in cobalt for ruminant nutrition was carried out in Ireland in 1954-'55 with very satisfactory results. Similar surveys for like purposes have proved their usefulness in New Zealand, Australia and elsewhere.

Soil survey information relative to soil-crop relationships is most pertinent in horticultural enterprises for different reasons. Horticulture usually occupies only a small proportion of the total cultivated area and production is on the intensive rather than the extensive margin. With the relatively high labour content and capital investment involved in horticultural enterprise and with the limited degree of rotation and diversification of cropping possible, it is most important to have the other factors of production as optimum as possible so only the most suitable soils should be selected. A soil survey to determine the areas most suitable for orchard crops was carried out in this country in 1943 and has since proved of great value to horticultural instructors and orchard owners in locating and managing orchards. At present also the guidance of soil survey is being used in the proper selection of the most suitable soil areas for soft fruit production and other horticultural projects.

In land reclamation and drainage, the nature of the soils themselves and more particularly of the subsurface layers may be the deciding factor in determining whether certain reclamation procedure may be successful or perhaps even too costly relative to the economic value of land. A soil survey for instance, would indicate the presence of subsurface layers such as an ironpan or hardpan which might render drainage uneconomic. The question of whether mole drainage or subsoiling could be substituted for the more expensive tile or stone drains or what combination of both systems could be adopted, or what the optimum depth and spacing of drains should be, can be decided with far greater confidence with the aid of soil survey information. Before any large scale reclamation is undertaken for development of alluvial or marine areas, a thorough survey should be carried out to assess the nature of the deposits, their potential as soils when reclaimed, the variability within the area which may affect the economic feasibility of the project.

Many other facets in the development of our land resources should properly be aligned with sound soil survey information. Foremost is that of land resettlement—a very salient problem in Ireland. All the noteworthy land reallotment schemes and those for the consolidation of fragmented holdings in the Netherlands, for instance, are built around soil survey data of the lands involved.

Soils of Ireland—Their Variability:

In Ireland the need for a soil survey is accentuated by the fact that our soils are more variable in general character than those of most other countries. The reasons for this great variation are related to some major factors influencing the genesis, formation and development of our soils. Foremost is the extent to which our country was glaciated throughout Ice Age times, leaving a great variety of mixed glacial drifts as parent materials from which our soils have formed. Our soils are more directly related to these superincumbent drift materials than they are to the solid geological formations. Although the glacial drifts of themselves are related in geological composition to the local solid geology of any area, nevertheless they also include extraneous materials and their physical fabric is quite variable from that of the parent formation. Besides a solid geological formation as mapped may comprise a mixture of geological types rather than a uniform type. For instance, *Old Red Sandstone* may include impure limestone, quartzite grits and clay shales. But even on a uniform and common parent geological material, soils display wide variations amosgst themselves due to other factors that influence them in their genesis, formation and development from the geological parent material.

In considering these other factors, let us recast our thoughts on the process of soil formation. In studying a soil profile, what we really see expressed in its morphology is a reflection of the combined influence on the parent geological material of a climatic factor, biotic factor, a time factor and a location on the landscape or relief factor. This is true for all mineral soils. Variations in the relative degree of influence of each of these major factors cause variations in the soils themselves.

Climate in its role in soil forming processes can be considered under two independent headings—*humidity* and *temperature*. The main climatic factor operative in this country is the rainfall-evaporation regime. With the ratio balanced well in favour of rainfall most of our soils tend to occur in the leached to podzolised categories. Apart from those we have extensive areas of gleyed soils where high water table gives ground-water gleys. The former may be a function of the physical constitution of the profile, probably inherited from the parent material, as in our Drumlin soils. The latter is most often a function of relief or position of the soil on the landscape topography where such soils occur in low relief or depressed sites. Temperature is an interdependent agent with humidity since the higher the temperature the greater will be the surface evaporation and the lower the rainfall-evaporation ratio, thus reducing the leaching tendency. Temperature also affects the rate of decomposition or organic residues in the soil resulting in the formation of either the mull-like humus of our better mineral soils or the mor-like humus of our strongly developed podzols.

A major component of the operative biotic factor in soil formation has been the vegetation influence. For instance, on similar parent materials with all other factors being equal, two soils may show variable profile character as a result of vegetation history. The broad distinctive influence of forest versus grassland on soil profile character is well recognised, but even more impressive is the general difference between coniferous and deciduous species. More impressive still is the specific action of beech litter as distinct from that of other hardwoods in this respect. Beech litter accumulation is conducive to podzolisation in the underlying profile with formation of a raw surface humus, whilst oak litter tends to maintain a brown forest soil and a mull humus. Dimbleby and Gill [1] claim that Holly litter brings about the conversion of raw humus—even *Calluna* raw humus—to mull humus. Even within the conifers variation in influence occurs. It has been suggested [2] that whereas very active mor-forming species such as spruce or pine will maintain a mull only on very fertile soils, there may be marginal species such as larch and Douglas fir able to maintain a mull on appreciably less fertile sites. Of course ground flora is equally variable in its influence on soil forming processes. Especially interesting here is the drastic action of *Vaccinium, Calluna* and Ericaceous species in inducing podzol conditions.

The influence of time or age is not so apparent in our soils, except in the extreme case of young alluvium in comparison with mature soils, but nevertheless it has played its part too. Relative to other areas of the world, few if any of our soils could be considered as very mature. Nevertheless, some of our more mature soil profiles may be twin profiles with a "fossil" profile underlying a more recent profile. Finally, in thinking of variable soils, we can never discount man's interference over the years with the "natural" trends of soil development.

Soil Survey with particular reference to Forestry:

When planning a new forest, the forester must endeavour to take into account those ecological factors that may affect the growth, health, yield and quality of his trees. So closely are soils and forestry related, one to the other, that their influence is mutual. Cases of where the influence of different species causes specific differences in soil profile character have been instanced. Likewise, different tree species are selective with regard to optimum soil conditions. In an enterprise so closely related to the soil, surely soil survey must have a major role to play. Besides the forester has very often to contend with land that may be considered unsuitable for agricultural use and this limits considerably his latitude in soils. Although forestry as a crop is capable of producing economically over a wide range of soils, nevertheless it is the soil that determines in many cases the economic feasibility of planting an area. Likewise, it is the soil which chiefly influences decisions on the species to plant for most profitable return.

Soils affect trees principally through soil, air and soil moisture. Seasonal available soil moisture commonly determines what species persist in any forest and their rate of growth. Four general soil characteristics affect the air and moisture supply—depth, surface porosity, subsoil permeability, and aspect. These factors then are all-important in a forest soil. Too much soil moisture is equally a problem as too little where tree growth and especially seedling establishment is concerned. Enough water at the right time is the all-important thing.

According to American research findings [3] soil temperature affects

(1) Dimbleby, G. W. and Gill, J. M. "Forestry" Vol. XXVIII, No. 2, 1955.
(2) Johnston, D. R. "Quar. Jour. of Forestry" Vol. XLVIII, No. 4, Oct. 1951.
(3) U.S.D.A. Yearbook of Agriculture, p. 723. 1957.

the germination of seeds, establishment of seedlings, and growth of trees. Best for germination is reckoned to be between 68°—75° F. Heavily shaded soils, cool northerly slopes and "cold" soils that warm slowly because of excessive moisture therefore may retard both germination and development. Certain forest diseases likewise can be related to soil conditions.

The fertility requirements of trees would seem to vary greatly, especially among the pines, but in any case these too are directly related to the soil. Fertilisation with potassium, phosphorus, magnesium and nitrogen has markedly increased growth in some areas. The quantities of nutrients taken up by forest crops are relatively large as indicated by Rennie [(1)]. But he points out that the quantities absorbed do not necessarily indicate the actual requirement for vigorous growth. Nevertheless, soils of very low inherent fertility may fail to supply the needs of the forest crop in which case they must be supplemented with fertiliser amendments for best results. Besides the essential major plant nutrients, certain tree species in particular respond to trace element application, e.g. Monterey Pine in Australia sdffers from Zn deficiency and Cu deficiency may be a distinct problem in different species on peat areas. According to American findings [(2)] "germination is inhibited and growth prevented on excessively acid or alkaline soils and by high concentrations of soluble salts". For example, "extreme acidity from oxidation of iron pyrite occasionally prevents both natural and artificial restoration of spoil banks and strip mines". The soil reaction and other chemical properties however, usually affect the development rather than the germination of seedlings. American workers [(2)] for instance have found that conifers will germinate over a wide range of pH 2.0 to pH 11.0, whilst seedlings in general develop best between pH 4.5 and 6.0, but species differ widely in their adaptability to soil reaction.

The supplies of nutrients and moisture that affect tree growth are closely associated with effective soil volume and its physical makeup. For this reason the presence of a pan or substratum such as occurs extensively in our podzols and soils with fragipan that limits these two factors, is one of grave moment. Texture, consistence and mottling of the subsoil and other factors, have all been related to growth rate frequently.

In forestry operations soil surveys have been used in a number of ways. Cropping problems of the soils present are made known in the course of a survey. In forest plantations, according to Stephens [(3)] "soil surveys have been used in the study of the relative productivity of various soil types, to study the instances of nutrient element deficiencies and to correct them by the application of suitable amendments. Both the latter operations are most readily carried out initially on sample plots and these should be located with regard to soil type. Furthermore,

(1) Rennie, P. J. "Plant and Soil" No. 7, 49-95, 1955.
(2) U.S.D.A. Yearbook of Agriculture, p. 723-724. 1957.
(3) Stephens, C. G. "F.A.O. Agricultural Studies" No. 20, p. 21, March, 1953.

soil maps of unplanted areas can be used for the selection of soils suitable for plantation purposes and to define those areas of soils which may be made suitable by such means as drainage, cultivation and the addition of mineral nutrients". Where natural forests have been cut over decisions whether to regenerate the area to forestry perhaps to assist watershed control, or to complete clearing to develop for agricultural purposes can be made with greater confidence with the aid of soil mapping and classification.

In general, however, the part played in forestry projects by soil survey in different countries is not so extensive as in Agriculture. For example, in New Zealand soil survey plays a lesser role in forestry than in agriculture. However, as Ward and Hocking [1] pointed out, "where there is a growing body of evidence that indicates that many of the cases of unthriftiness and mortality in forests can be traced to the soil, the forester has come to realise that the siting of trees without sufficient regard to soils can greatly affect the ultimate value of his forests. Thus any contribution made by the soil surveyor which extends the forester's understanding of the edaphic factor, enables him to utilise his soils more effectively." In a study of the application of soil survey to forest planning and practice, the same workers [1] have shown that the soil map and report are of real value to the forester: "they provide him with data essential to the proper understanding of sites and enable him to make the best possible use of his soils to establish a healthy and productive forest". Soil survey data also helps him to plan his forest in a shorter time and with greater confidence. The New Zealand forester, as is true for most countries, has little latitude in choosing his soils and consequently, must site his trees carefully on the soils most suited to their needs. The New Zealand studies of Ward and Hocking [1] at the Te Wara State Forest, stressed the need to strike a balance between the optimum use of each soil type and the limitations of forest management and economics. The soil survey there also made possible a workable compromise in land use where the more valuable soils agriculturally (recent soils and yellow-brown loams) were reserved for farming.

In the Netherlands, it has been found that productive tree species differ widely in their requirements with regard to soils. By careful study of existing forests a land classification for forestry purposes has been made for certain areas and is found most useful by foresters.

In Germany the State Geological Department produces the soil maps. These are used by the foresters in conjunction with vegetation survey maps and in co-operation with the soils and vegetation specialists to produce forest site maps. The site types of the district are then classified and grouped according to their sylvicultural values and their potential productivity.

---

(1) Ward, W. T., and Hocking, G. W. "N.Z. Journal of Science and Technology", B.Vol. 38, No. 3. November, 1956.

In Norway, investigations on forest soils is part of the programme of the National Forest Survey. Characteristics studied mainly include depth and origin of soil material, thickness of humus layer, profile type, mechanical composition and content of stones on the surface. Distinction is made between podsols and brown earths and integrades of these two are mapped separately. Each of these three groups is further broken down on more detailed examination. Soil-vegetation relationships are given full recognition in all cases.

In the United States, survey of soils for forestry purposes has received a new impetus in recent years. The University of California at Berkeley is particularly active in forest soils research. This impetus was due in greater part to the realisation that forestry could not be dealt with as an economic problem, while involving an unknown value—the soil. Few commercial interests could afford to invest capital for tree planting and related forest enterprises on land of an undetermined productive potential. Wilde (1) discusses what he calls a *"forest soil survey".* This survey supplies necessary information on site factors—climate, topography, ground water and *soil.* This characterisation of sites constitutes probably the most important step in the organisation of a forest project, and soil survey has a major part to play in this.

In Ireland the National Soil Survey can serve the interest of Irish Forestry, not alone by providing basic information on the soils themselves, but in many other aspects also. The basic survey of Irish soils is intended to serve as a foundation and source for various other surveys according to specific needs. Foremost amongst the latter will be land use capability surveys. Land will be classified on the basis of its relative ability to produce different crops and products under defined systems of management. Furthermore, a broad classification based on soil survey findings could segregate those soils not considered to be capable of high economic production under agriculture and then classify them in terms of their capacity ratings for forestry production. This would involve close collaboration between the forester and soil scientist. Perhaps a proportion of these latter soils may fall into land classes of but limited use for poorer type timber production or perhaps suitable only for wild life preserves and recration purposes.

Valuable observations on establishment and growth success of different species on certain soils in the country are available now no doubt, with many of our foresters. In how far can this valuable information be extended to other areas and be used with confidence in future forestry planning, until it is established that such areas have soils of similar nature to the observation sites. Likewise results of soil-tree species experiments, which of necessity must be confined to small areas can be projected with greater accuracy and confidence when the soil conditions are known. Furthermore, the productive capacity of different

(1) Wilde, S. A. "Forest Soils—Their Properties and Relation to Silviculture". The Ronald Press Co., New York, 1957.

species can be more accurately compared when allowance is made for soil differences.

From the point of view of maximum economic production of timber products, it is essential to site trees on the most favourable soil conditions available for the species and to know beforehand what the inherent limitations of such soils are, so that they may be amended. These limitations in this country are more often of a physical rather than a chemical nature, involving impervious substrata, iron pans, textural limitations, resultant poor drainage or poor root development. But they also include limitations in essential plant nutrient supply, or due to toxic substances, soil reaction, trace element supply and so on. When introducing new species from abroad for trial under native conditions here, both in propagating them and siting them later on, a full knowledge of relative soil conditions involved is all-important.

Perhaps where soil survey can make a very special contribution in this country is in arriving at a rational compromise between forestry and agriculture, where the conflict arises in deciding on optimum land use in many areas. In Ireland with the ever current demand for agricultural produce, one must accept that in many cases only the less suitable agricultural soils will be devoted to forestry. These include the vast areas of Podzols, and associated climatic peats of Western Ireland and scattered mountain areas elsewhere, the poorer Brown-Podzolics, some of the Hydromorphic soils in the Drumlin and other areas, the blanket peats in the West and elsewhere, and the cut-away basin peats of the Midlands. Within these poorer soil groups the forester has to contend with a whole range of soil differences that will have an impact on his forestry planning and procedure.

However, in many hill-land areas, an agricultural system has been in operation for years, involving all gradations from mere hill-sheep ranching to small scale dairy farming or limited tillage farming. The ideal for such areas would seem to be to integrate forestry into the present system for more intensive economical land use. This would presuppose maintaining agriculture only on those soil areas most suitable for it and establishing forestry on the submarginal areas. But of course with the human element to be given foremost consideration in all such planning, the physical possibilities outlined must be modified in terms of the social desirability of such projects. Where hill-farming is concerned, it is desirable for winter food and shelter that a certain acreage of lowland accompany each stretch of hill grazing. With integration with forestry, it is usually possible to graze above the timber line in Summer and due to the forest shelter, utilise the lower slopes below the timber in the Winter, thus releasing lowland contiguous areas for a more conventional type of farming. It is better economically also to have an integrated grazing and forestry enterprise, as not only are they in part complementary, but they contribute toward better diversification of products. The information provided by soil survey is vital in the execution of programmes of this nature.

An integrated programme such as outlined above is perhaps the most desirable as a land use plan for many of our better hill areas, say on *Old Red Sandstones* that carry a mixture of leached Brown Earths, Brown Podzolics and Podzols. Equally well it should apply to the poorer Drumlin areas where a dairy industry based on grass production, under a very strict management system, integrated with well planned forestry, may quite conceivably be a solution to some of the problems there. But such an overall programme must be based on a knowledge of the soils since major profile differences occur amongst these soils even from one Drumlin to the next. More confident decisions can then be made on which soils should best be devoted to which enterprise, on how the individual soils must be managed toward greater output, on what drainage system to install to dispose of surplus water, on what grass seeds mixture or tree species that might best be planted, and on what manurial or liming procedure to follow for best results. With thorough soils knowledge, it is difficult to assess the most feasible procedure to adopt since economic and social factors enter the picture, but without such soils knowledge, it is well nigh impossible.

A few of the applications of soil survey in the field of forestry planning and programming have been covered. Nevertheless, it is certain that even these are adequate to assure us of the role that soil survey can play in this respect. Perhaps much more use will be made in future of the soils knowledge provided by Soil Survey in the forestry programme of this country. Greater collaboration and co-operation between the forester and the soil scientist should prove very rewarding to the efforts of both. It is hoped that such will be the case. Co-operation and co-ordination of effort are necessary to obtain, with the information available, the best possible practices of land use, management and conservation for every acre of land in the country, which coupled with current economic thinking, should achieve the most economic sustained output from our soil resources, on which the prosperity of this country as a whole, ultimately depends.

Scots Pine: A new approach at Windsor

By Leonard U. Gallagher

I suppose the most interesting aspect of the forest scene at Windsor is the freshness and individuality in the approach to silviculture as well as the alertness of the forester in charge to avail of the phenomena of the region. Before moving on to the main topic I would like to illustrate the above remark by pointing to one incident that occurred there. An area of some 640 acres was acquired by the Crown for Windsor Forest. This area had been used by the army as a tank testing ground and was, when taken over, completely derelict. But some six months later the entire area was replanted, the forester in charge having realised the very commendable efficacy of the tanks as bulldozers to clear the ground for regeneration!

Although there are other aspects, many and varied, of silvicultural interest at Windsor, this article will confine itself to those relating to Scots pine, particularly stressing an intriguing adaptation of modern methods for the promotion of natural regeneration. Most of the stands of Scots pine are being grown to fulfil a particular need, viz. the market for transmission poles. In England, as here, a very attractive price is being offered for material of this nature so that The Forestry Directorate has decided to avail of that market and to cultivate Scots pine for the purpose. Scots pine is, in the main, an easy seller so that if the transmission pole market falls the timber can quite readily be sold for other purposes.

Many of the now maturing stands were planted in the conventional manner and in recent years have been brought under selective treatment for future transmission pole production. But those young stands which have been planted since the termination of the Second World War have been sown either by hand or by nature. For natural regeneration the method adopted is as follows. The existing mature stand is felled to the margin and instead of leaving a number of standards scattered throughout the area a periphery of trees a few rows deep is allowed to remain. Where the amount of cleared woodland is large the area is divided into a number of blocks, each surrounded by its border of trees. Each cleared area is some ten acres in extent and its shape is approximately square, this being the best unit of form and size to ensure complete seeding of the ground. The Forestry Directorate has found that, without preparation of the ground, uniform stocking does not occur and the bare ground has to be planted up. But by introducing a bulldozer on to the site and allowing it to level the ground it was found that an acre of land could be cleared in a normal working day at a cost of £2 per hour. That is the only preparation necessary. In other words, the re-establishment of Scots pine, with an assured 100% stocking of the ground costs a mere £16 per acre. The beauty of the bulldozer work is that it does not merely prepare the ground for fruitful seeding but also clears out the stumps, removes any heavy vegetation and gives the seedlings a head start by leaving the ground free from competition. When the seeds germinate they come up in such numbers—25,000 per acre and upwards—that their abundance hinders the development of weeds. The next treatment of the area occurs some two to four years after establishment. At this stage the young trees are liberated by cutting swathes three feet wide through the plantation. These swathes are spaced two feet apart

Young natural regeneration with periphery of seed trees.

12 year old Scots pine with 3 ft. swathes removed.

and from these remaining bands of Scots the final crop is chosen either by selective thinning (or at this stage it might even be called "weeding"), or else by cutting further strips three feet wide at right angles to the first leaving "boxes" of pines 2 ft. by 2 ft. from which two or three trees are selected to remain and allowed to grow for some further years. Eventually the most promising trees of the groups are retained to form the crop. From then onwards the treatment simulates that of any normal even-aged stand. High pruning up to twenty feet is usually carried out; sometimes this is performed only on the best quality trees of the stand.

As an alternative to natural regeneration, or in an area that is being planted for the first time, the Scots pine seed may be sown broadcast. The ground is first prepared by bulldozer, as described above, or else by cultivator—if conditions are suitable. A mixture of seed and sawdust is then scattered broadcast over the ground. The sawdust allows for wider scattering of the seed and also, being visible on the soil, shows whether sowing is being carried out evenly, whether it is too light or too heavy. Once the area is established the trees are allowed to grow to height of one to two feet, as in the previous case and then the trees chosen for the final crop are isolated by mowing three feet swathes through the embryonic stand. For mowing a mechanical mower is used where the ground is suitable.

In some areas the pines were not thinned at an early age, but were allowed to grow for some twelve years. At this stage they were thinned by again cutting three feet lanes through them and allowing two feet lines of the species to remain. The accompanying photograph shows that the close proximity of the Scots to each other does not seem to have affected their vigour. In fact, one beneficial aspect of such close planting is the lightness of branching observed on the stems. Also the trees seem to have been rather drawn up due to the competition which, far from being detrimental, should give a good length of clean stem on which useful timber can be deposited. And further, no competing vegetation was observed; this would result in the trees being well above any encroaching growth which would tend to choke back the Scots once it was liberated. Even for twelve years old material a market has been found which offsets the cost of the thinning operation. The young stems removed from the strips are found to serve as useful bean-poles and are sold accordingly.

As a system of silvicultural establishment the method employed at Windsor Forest struck the author as being both a revolutionary approach to regeneration and one of practical simplicity. Its wider application rests on the capability of seeds of other species to germinate as prolifically under similar conditions. This may put rather a damper on the idea as little sign of natural regeneration has been noted in our most intensively used forest tree, Sitka spruce, (contorta pine as yet being rather an unknown entity in that respect). A forester may question the feasibility of introducing mechanisation to Scots pine sites but, except on steep slopes, this should not be too difficult as observation of the species shows that the high mountain areas and most of the poor, inaccessible areas are not suitable for Scots pine and therefore should not be contemplated for the purpose. Admittedly the areas observed at Windsor were on good, approachable sites, but even on more difficult ground machinery can be introduced with good effect. One may assume that the cost of establishing the plantation by hand-sowing rather than by natural regeneration would be more expensive but it is most unlikely that it should equal the cost involved in pit planting. Besides the obvious advantages of the method in localities where it may be applied, the venture is academically interesting in that it broadens the approach to forestry. This, I think, is its real attraction: text-book rules and established tradition, while not being discarded, are suitably modified to suit local conditions and current times. The inventiveness of the forest officers at Windsor surely shows that there is still room for new ideas. Any aspect of silvicultural endeavour, as well as all other research, may, at any time, produce a new and unique concept. Such ideas should never be denied their rights. They should be tried. They may not reach the heights expected, but often they exceed them.

Work Study and its Benefits to Management and Labour

By A. N. D. Tate *

WORK Study is a subject so vast in itself that it becomes difficult in a short article to indicate its true worth to Management and also its value to labour. It is really a research or analytical study of work itself and of all the conditions and aspects relating to work. The object of this analytical study is to reduce the unit cost of production or output by improving methods, materials, tools, and equipment; the unit cost is also reduced by improving productivity or the level of performance through the better use of the time element. In the process of this achievement the quality factor is maintained if not bettered.

Work Study in itself can only do what it is made to do. It is nothing else but a tool of management and, as a skilled painter can shape a masterpiece with his brush—his working tool—so can a progressive management shape itself into an efficient body by the proper use of work study. In doing this it will obtain optimum working conditions and results throughout its organisation. By investigating one set of problems, the weaknesses of all other functions affecting it will gradually be laid bare.

Now research or any other type of study must have definite terms of expression for measuring the results of its findings and also for general comparison purposes. These terms of expression or recognised bases of measurement must be acceptable under all conditions. To illustrate what I mean by a recognised base or unit of measurement let me please say this :—You would probably find it amusing if each member of a group of athletic officials insisted on his own 100 paces as being the correct distance for a 100 yard run or sprint. We would not be able to appreciate record runs because of the unreliable method of measuring distance. The confusion and uncertainty is avoided by the use of a standard yard measurement in which all have confidence. These varying paces for 100 yards could however be reconciled to the standard 100 yards if the corrective multiplying ratios of each member were known—we could in effect call this corrective ratio a rating factor. Progress in running the 100 yards therefore becomes measureable and results this year can be compared truthfully with those of years past—subject of course to conditions being the same.

Can I take this analogy a step further :—We all accept the standard yard as the true standard yard for linear measurement. This yard has

* Of *Associated Industrial Consultants.*

its elements of feet and inches and even fractions thereof. The varied summations of these elements comprising a yard will always equal yard unity. It does not really matter how we express the distance; it could be in feet or in inches. The terms of expression depends upon the range of measurement. You would not, for instance, dream of measuring the height of pruning in a forest in terms of inches. Yet for a Japanese miniature tree of the same variety you would find the inch quite convenient if pruning were prescribed. In the same way different operations in forestry have their own convenient terms of expression for measuring quantity of work. For example, drainage would be in yards, planting would be in numbers and so on. Yards of drain and numbers of plant etc. are therefore terms of work content in a sense, but a collection of such heterogeneous terms is not of much use in measuring the total capacity or volume of work in a forest—and provides no safe basis for comparison of productivity of different labour, tools or methods.

We must therefore find a common single unit. The most appropriate unit for forestry is the man-hour. The man-hour however is somewhat similar in character to the athletic official's measuring of a 100 yard run by pacing. We must adopt a more stable unit of measurement and this is the standard man-hour.

As the pacing of 100 yards can be resolved to a standard 100 yards, so also can the man-hour be resolved to a standard man-hour if a similar rating factor is employed and the result combined with a rest allowance. I will expand on this later on.

The standard man-hour is a definite unit of measurement and is to work measurement, and indeed to other aspects of Work Study, as the kilowatt-hour is to electricity or the therm is to gas. The standard man-hour is common throughout all forests working under the Incentive Bonus Scheme.

Now I think I should give you a definition of a standard hour :—"The hours allowed for any given task are not hours of continuous work. *Each hour contains within it an element of rest.* The proportion of rest to work varies according to the nature of strain imposed by the work." Adding work to rest must always give a total of one hour, or one minute if the standard minute is employed. The advantage of this unit of measurement or standard hour is that it can be used to measure and compare dissimilar types of work, the accuracy of the comparison being limited by the consistency of the time standards.

There are two major aspects of Work Study, viz., Method Study and Work Measurement. "Method Study is the systematic recording, analysis and critical examination of existing and proposed ways of doing work and the development and application of easier and more effective methods." I would prefer not to deal here with this aspect of Method Study, but mention of it is necessary so as to give the full meaning of Work Study.

Work Measurement which we are dealing with here is that phase of Work Study which deals with the time element and the amount of work done. "Work Measurement is the application of techniques designed to establish the work content of a specified task by determining the time required for carrying it out at a defined standard of performance by a qualified worker." The work content is measured in terms of standard man-hours.

It will be seen that a performance ratio is obtained if the standard hours allowed for a task is divided by the actual clock hours taken to complete the task. A standard performance is when this ratio is unity, and this has been set at 100 per cent. A variance from this level by a forest gives management its efficiency index and one which is reliable in all respects. On this efficiency index is based a system of bonus payments over and above a guaranteed basic wage for the implementation of incentive working conditions. Earnings of labour are therefore related to effort once a basic level of performance has been reached; the guarantee of basic wages is a safeguard to labour.

What are the advantages of work measurement? They are numerous but in general terms work measurement provides the basic information necessary for all the activities of organising and controlling the work of any undertaking in which the time element plays a part. It gives to labour more money for more work done, it gives to management a higher productivity with a consequent lowering of unit cost. Other advantages are:—

(a) In comparing the efficiency of alternative methods.
(b) In allocating work to a group of workers for balanced working.
(c) In providing information for planning and scheduling of production including plant and labour requirements.
(d) In providing information on which estimates for tenders, selling prices and delivery promises can be made, or rather based.
(e) In providing information for labour cost control and enabling standard costs to be fixed and maintained.

The basic procedure in work study generally is:—

(1) Select the work to be studied.
(2) Record all relevant data.
(3) Measure each element in time.
(4) Examine relevant data and element times.
(5) Compile a standard time for the task.
(6) Define precisely what item (5) refers to.

The value of work study lies in the fact that by carrying out its systematic procedures a quite ordinary man can achieve results as good as or better than the less systematic genius were able to achieve in the past. It is a means of raising productivity but looking after labours at the same time, it is systematic, and it is the most accurate means yet evolved of setting standard of performances on which the effective planning and control of productivity depends. The benefits resulting from Work Study start at once and continue as long as the operation continues in the improved form. It is tool which can be applied everywhere. It can be used with success wherever manual work is done or plant operated not only in manufacturing shops but in offices, stores, laboratories and service industries. Its adaptability is such that it can be applied with success even to field operations of a varied nature such as one finds in forestry and proves itself all the more useful in reducing a mass of varying operating conditions to a co-ordinated pattern.

Review

Report by the Minister for Lands on Forestry for the period 1st April, 1957 to the 31st March, 1958

(*The Stationery Office, Dublin. 2s.*)

WHEN this report came to hand with the editor's request for a review one was rather inclined to take the easy way out and reproduce the main features of the report from the summary so temptingly supplied. However, there is little point in a review that simply repeats or rehashes the information presented in a summary of this kind. Short of reproducing the whole publication one would fail to do justice to the range of information presented. There is an enormous amount and range of statistical data compressed into a booklet of twenty-eight pages and the only feeling that one has on scanning the tables that crowd the pages is that there is so much left unsaid, so little by way of comment that would bring more life into this skeleton of facts. A record area of 23,268 acres of productive forestry land was acquired during the year. This is very heartening indeed and is a fine tribute to the work of the acquisition staff concerned. It would, however, be so interesting to know where this land was acquired—the counties figured in this expansion of forestry and what types of land were acquired. The absence of the once familiar map showing the location of the forestry centres and the table showing the progress of forestry operations in the various forests during the season is keenly felt by the reviewer. It would be a great pity if the Annual Reports were to be so condensed that all references to progress by forest or by county were completely eliminated.

Looking back over earlier reports one cannot fail to be struck by the remarkable expansion that has taken place in the twenty-five years since forestry came under the Minister for Lands and Fisheries. In 1933 the area held was 52,604½ acres—at the end of 1957/58 there were 365,230 acres. The total wooded area held by the State in 1933/34 was 50,533 acres and by the 31st March, 1958 the figure had grown to 257,467 acres. It is interesting to observe that the afforested area, owned by the State here, now considerably exceeds that owned by the State in Denmark.

Among other remarkable changes that have taken place over the twenty-five years is the development of mechanical preparation of ground. The total area mechanically prepared for planting in 1957/58 was 9,472 acres. In 1933 the prospect of mechanical preparation was scarcely envisaged, and mound planting was still a novelty. To-day hand-mounding is outmoded and is applied only where ploughing is not feasible. The change in species used is also remarkable when one considers how conservative foresters are said to be. The spruces are as popular as ever—even more so—with Sitka heading the list at 43.2% of the various species planted and Norway at 9% showing up well, in the year 1957/58. In 1933 the figures were: Sitka 27¼% and Norway 15½%. The dramatic decline of Scots pine, however, is worthy of note. It has fallen from top place, with a representation of 31½% in 1933, to 4.5% in 1957/58. If this decline continues there is every indication that Scots pine will so fall from statistical grace that it will be lost to anonymity, like Douglas fir, among other conifers. The writing is on the wall for the old favourite European larch which has fallen from 8¼% in 1933 to 0.7% in 1958 and must surely disappear from the lists in the near future. The relatively unknown contorta pine of 1933, with its then 6½% representation, has now jumped to an unchallenged second place at 30.2% in 1958. These changes have taken place in less than half a forestry rotation and well within the working life of a forester. It is doubtful if a forestry organisation anywhere, at any time, has had to deal with an expansion of this kind which has also involved such radical changes in techniques, sites and species. It is also unlikely that the next twenty-five years will see such dramatic changes.

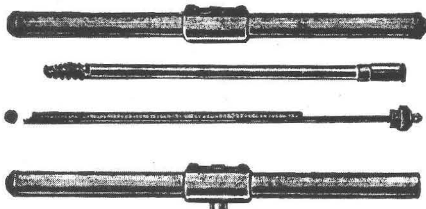
One naturally looks to the sales and production side of a report of this kind and here again there is remarkable evidence of heartening expansion. Total forest income from all sources, including timber sales, for the year was £331,967. The volume of material sold was 5.3 million cubic feet. While comparisons in this field with the 1933 figures are apt to be misleading due to changes in money values it is still indicative of the changed times to see that the total income in 1933 was £5,487.

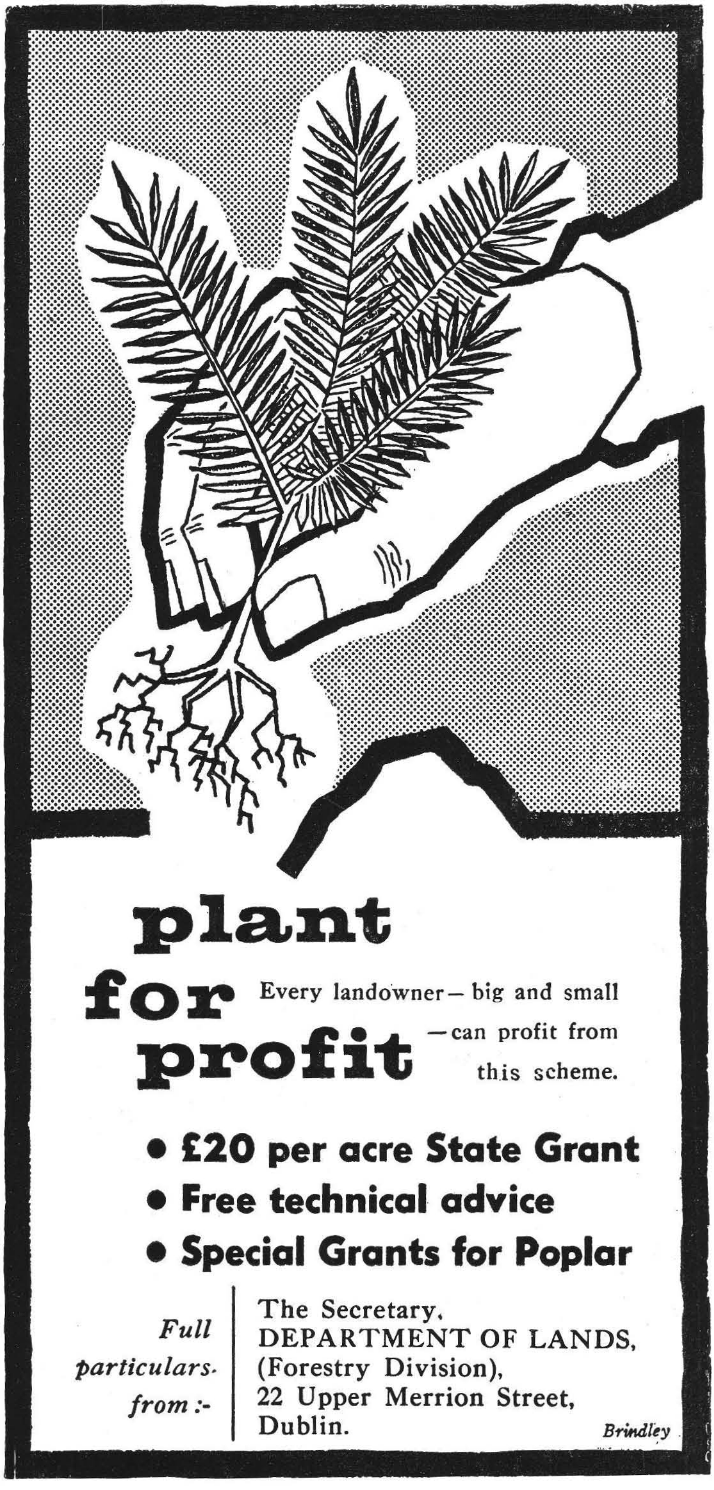
Private planting in 1958 was at a low level with only 424 acres planted under the planting grant scheme. Measures to stimulate private planting forecast in the report included the raising of the planting grant to £20 per acre and the provision of a free technical advisory service. In 1933 the planting grant was £4 per acre and the area planted was a mere 127 acres. Thus, private forestry has been in a moribund condition for over a quarter of a century and there is little to enthuse about in the recent statistics. The increased grant and the intensive propaganda drive of the last two years must surely bring a much needed revival in this important branch of forestry endeavour and one will look with interest to this section of future reports.

In conclusion, one must remark that this report fails, somehow, to do justice to the work of the Forestry Division or its officials. While self praise is no praise there is every justification for a certain amount of trumpet blowing from a branch of the Government Service with such a remarkable record for concrete achievement and work well done.

T.C.

NOTES





The Earlsfort Press Ltd., 85 Harcourt Street, Dublin.