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In this issue:

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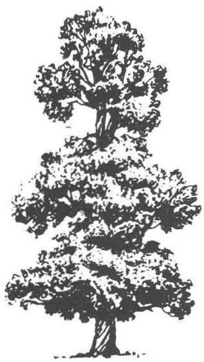

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The following notes are designed to aid the speedy processing of scientific contributions to the journal. Authors should comply with them in so far as this is possible.

1. Two copies of each paper should be submitted, in typescript, with double spacing and wide margins.

2. Diagrams and illustrations should be clearly drawn in black ink on good quality paper. Captions should be written on the back of each illustration. Illustrations, wherever possible, should be drawn in an upright position (x axis narrower than y). The approximate position of diagrams and illustrations in the text should be indicated in the margin.

3. Tables should not be incorporated in the body of the text, but should be submitted separately at the end (one table per page). Their approximate position in the text should be indicated in the margin.

4. Nomenclature, symbols and abbreviations should follow convention. The metric system should be used throughout.

5. References should be in the following form:
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6. A short summary of the paper should be included. It should precede the main body of the text.

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Contents

Note: The opinions expressed in the articles belong to the contributors

Cover: Successful establishment of lodgepole pine (Coastal) on open cast coalmine in Co. Carlow

(Photo: N. O'Carroll)

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Council

of the

Society of Irish Foresters

EDITORIAL

Conserving our Peatlands

Recently, a specialised group (the National Peatland Conservation Committee) was established under the auspices of An Taisce to highlight the urgent necessity for peatland conservation. The total area of peatland in Ireland is 1.34 million hectares, 16.2% of the island. A higher proportion of the land area of Ireland is covered by peatland than any other country in the world with the exception of Findland. Obviously our bogs are important to us. Generations of Irishmen have harvested peat for fuel, many of us burn turf in our homes, the work of Bord na Móna in the industrial exploitation of peatland is known all over the world. We think of bogs in terms of exploitation, traditionally for fuel but in latter years also for agriculture and for forestry. If we think of conservation at all it is to dismiss it as being unnecessary.

In fact our virgin peatlands are disappearing fast. The controversy over Pollardstown Fen is well known, but not many are aware of the threat to our Raised Bogs which occur in the midlands. Of the original 311,000 ha of Raised Bogs, 65,000 ha is classified as unmodified, but much of this is unsuitable for conservation. Large areas have been dried out by drainage and have lost their characteristic flora. Only a handful of true representatives of this important bog type remain. The situation with Blanket Bog is less critical as almost 75% of the total area remains unmodified to date. The greatest danger here is of fragmentation particularly by forestry plantations. Even a small plantation is an intrusion which interferes with the Blanket Bog landscape.

Foresters are in a unique position with regard to our peatlands. They have a long tradition as conservationists. The forest, even the intensively managed plantation, is much closer to a natural ecosystem than a field of potatoes or barley. In the Republic, the Minister for Fisheries and Forestry has responsibility for nature conservation and wildlife. Officers of the Forest and Wildlife Service are actively involved in the preservation of our native forest flora and in the protection of natural habitats for wildlife. Other officers of the same service are responsible for the development of virgin peatlands for forestry. The economic benefits of this exploitation are obvious. No one is suggesting that peatland afforestation should be halted or even significantly curtailed. The National Peatland Conservation Committee suggest that a representative series of sites, amounting to only a small percentage of our peatland area be preserved for the future for scientific, educational and aesthetic purposes.

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The Society of Irish Foresters was founded in 1942 to advance and spread in Ireland the knowledge of forestry in all its aspects.

The main activities of the society centre around:

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(b) Indoor and field meetings on forestry topics
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(d) Annual Forest Walks held on 2nd Sunday of September

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Submissions to the journal will be considered for publication and should be addressed to: Dr. E. P. Farrell, Editor, Irish Forestry, Department of Agricultural Chemistry and Soil Science, University College, Belfield, Dublin 4. The attention of contributors is drawn to "Notes for the Assistance of Contributors" on page 56.

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Factors that contribute to basal sweep in lodgepole pine

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INTRODUCTION

An increase in the presence of basal sweep in lodgepole pine (*Pinus contorta* Douglas ex Loud.) crops has occurred in recent years following widescale planting of vigorous coastal provenances from Washington and Oregon. The attributes of low nutrient requirements and tolerance of severe exposure makes these provenances ideal pioneer crops for difficult sites, but the high incidence of sweep on exposed areas causes difficulties in both the harvesting and conversion of the timber. Despite extensive experimentation the problem of basal sweep has not been fully resolved. This has resulted in the favouring of lower yielding but straighter provenances or alternative species. In some cases these options may not be economic due either to inherent slow growth rate or the necessity for increased fertiliser inputs. The reduction or elimination of basal sweep in the south coastal provenances would therefore increase the profitabilty of growing timber on these difficult sites.

It has been suggested that the underlying cause of basal sweep is the result of strong winds (occasionally wet snow) acting on a tree which has an imbalance between the root and the shoot during the early years after planting. Many factors were considered as contributing to this imbalance, including poor physical condition of the soil, inadequate aeration or drainage, incorrect planting technique, defective nursery stock as well as those genetic features of the trees themselves which control the growth of the root and shoot (Lines and Booth, 1972). The objective of this paper is to examine these aspects of basal sweep and discuss possible courses of action to overcome the problem.

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ENVIRONMENTAL ASPECTS OF ROOT DEVELOPMENT

Root systems of straight and swept trees:

It is generally known that basal sweep occurs in lodgepole pine as a result of trees being toppled by either wind or snow. However, what is not clear is the extent to which the roots and the aerial parts influence the stability of the trees and a study was initiated to examine morphological differences between straight and swept trees. The study was carried out in a nine year old one parent progeny test to ensure that the material being examined was of similar genetic background. The progeny test was established using conventional techniques of single mouldboard ploughing and slit planting of 1 + 1 transplants. A number of families were chosen at random and within these, two trees were further selected, one which had pronounced basal sweep and the other with a very straight stem. Both trees were of similar height, diameter and crown form to minimise any effect of vigour or crown architecture. Excavation of the root systems showed quite clearly that straight trees possessed a uniform radial arrangement of well developed lateral support roots around the stem. Trees with sweep had their lateral roots aligned in one direction or twisted around one another in such a way that they could not give adequate support to the main stem. As a result, the trees had toppled (Fig 1) and subsequent leader growth had grown vertically thus producing a bow in the lower stem.

Fig 1 Five year old south coastal lodgepole pine toppled by an autumn gale.

Root systems of planted and naturally seeded trees

Current establishment techniques appear to be the cause of basal sweep and a further investigation of planted and naturally seeded trees was undertaken to determine the impact of these techniques.

Two crops were selected which were growing on cutaway midland bog. This soil type was chosen because it provides an ideal rooting medium for conifers being free from stones, compaction and a high water table while at the same time being acidic and having good aeration. One of the crops was established using current techniques of double mouldboard ploughing and slit planting of 1 + 1 transplants, the other, by natural seeding after fire on an uncultivated site. Excavations of the root systems showed that naturally seeded trees possessed a common root structure with an even distribution of lateral support roots around the stem and a well defined tap root. Roots from the same tree seldom crossed or intertwined and all primary laterals originated from the tap root. In contrast, the planted trees had a much more variable root structure with a greater number of roots, usually of smaller diameter than the naturally seeded trees but often twisted and with no definite arrangement. Tap roots were almost entirely absent (Fig 2). Some root alignment along the ribbon was evident but this was not very pronounced since this particular peat type is relatively free draining. Basal sweep did occur to some extent in this crop but it is generally not a problem on this site type. The stem form of the naturally seeded crop was far superior to that which was planted, and the complete absence of basal sweep can be attributed to the stability of the natural root structure.

Both the progeny test and the midland bog sites were at low elevations but the findings at these sites were confirmed by root excavations of straight and swept trees in a severely exposed plantation at 500m. At this elevation trees with straight stems did not grow vertically but tended to have a definite lean away from the prevailing wind.

Physical factors that affect the structure of lodgepole pine root systems

During the early life of a crop two main areas can be identified as influencing the form of lodgepole pine root systems, namely, nursery practice and planting method and quality. As the crop develops the type of cultivation can also have a profound influence on the shape of the root system.

Nursery practice

The current method of producing bare root lodgepole pine

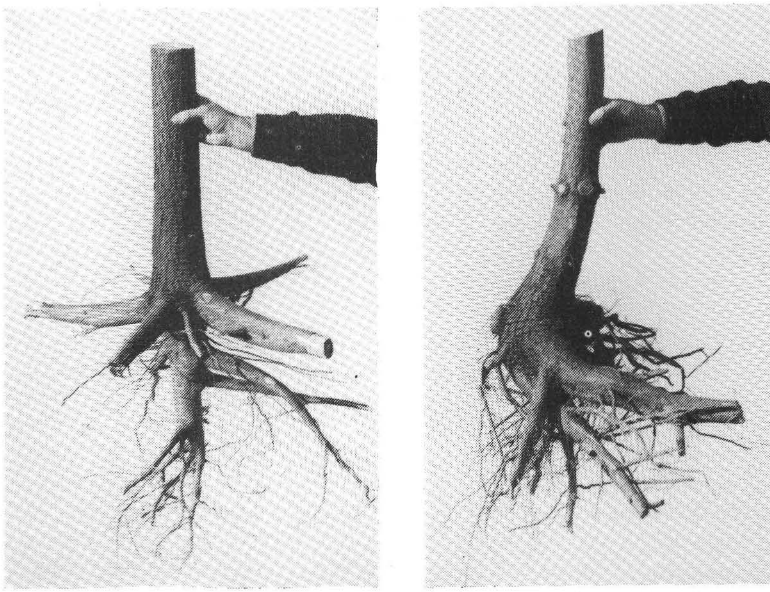

Fig 2 Effect of establishment techniques on the root structure of south coastal lodgepole pine. (Left) Natural seedling. (Right) Planted tree with basal sweep.

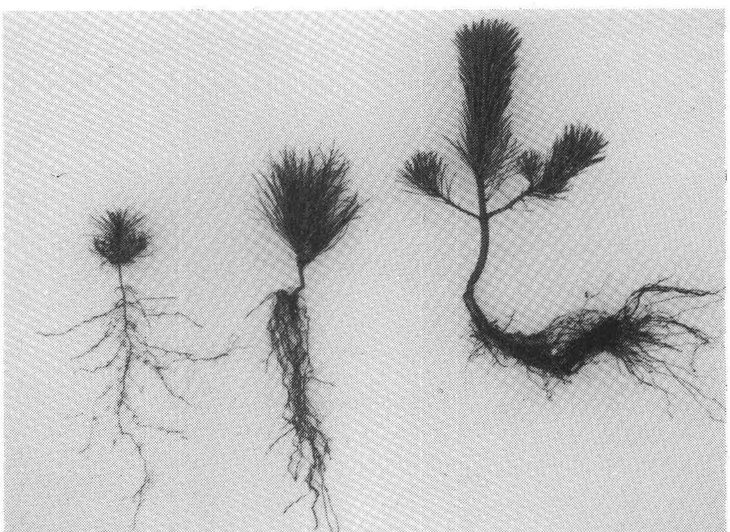

Fig 3 Root distortion induced by nursery and planting practice. (Left to Right) 1 year seedling with natural root form, 1 + 1 transplant, slit planted 1 + 1 transplant in the field for 1 year.

transplants is to sow seed broadcast in prepared seed beds, lift and line out the 1 year old seedlings. In the seedbeds the seedlings have the root form of the natural seedling with a pronounced tap root and an even radial arrangement of lateral roots arising from the tap root. Such root systems are very fine and delicate and highly susceptible to malformation during lifting and transplanting. Some form of root distortion is unavoidable no matter how carefully lining out is done (Fig 3). The badly deformed J-shaped root systems, which are a frequent occurrence in transplants lined out by traditional methods, have been reduced somewhat by the use of modern lining out ploughs, but despite their use, root distortion is still a problem in planting stock.

Containerised seedlings have been used on an experimental basis in both Britain and Ireland to try to reduce the incidence of basal sweep. It was argued that they would reduce the early rapid growth and low root/shoot ratio to which transplants were prone and thus produce a better balanced plant. Results to date appear encouraging and Lines (1980) reports that the tubed seedlings described by Low (1975) have markedly reduced the incidence of basal sweep, though without eliminating the problem completely. This can perhaps be attributed to the fact that root spiralling occurs in hard walled containers and Fig 4 illustrates the type of root

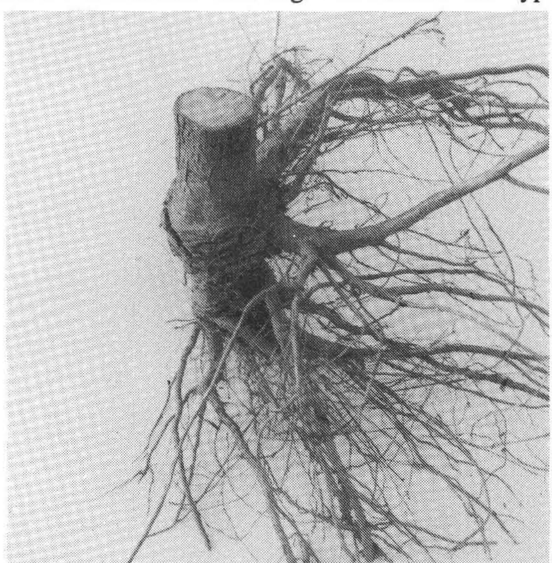

Fig 4 A common root form of lodgepole pine established as a tubed seedling. Note the absence of roots on one side of the stem due to impenetrability of the container wall.

system that a tubed seedling can develop. The "tap root" consists of the original tap root of the seedling and also the lateral roots which have been deflected downwards in a spiral towards the open end of the tube. Some of the laterals have emerged and radiated from the slit in the side of the tube (Low 1975). However, a sector opposite to the slit is without lateral support simply because the roots could not penetrate the wall of the container. Despite these shortcomings trees established in these containers have good juvenile stability.

Planting method

In Ireland the planting of lodgepole pine is largely confined to blanket peats and it is on these soils that present and future problems with the establishment of this species will mainly occur. The tough fibrous texture of these soils make it difficult to plant bare root stock without root distortion and the current method of slit planting on top of plough ribbons encourages L or J-shaped root systems. Transplant roots tend to be folded into the slit and when this is closed the plant possesses a bi-laterally compressed root system aligned in one direction, usually along the ribbon (Fig 3).

Lodgepole pine does not have the ability to produce adventitious roots from the root collar as does Sitka spruce. A strongly aligned root system will therefore result in early instability since the plant will not have a good radial distribution of lateral support roots and/or a tap root.

Cultivation technique

During the early establishment years instability appears to be caused mainly by poor quality plants and planting. As the crop develops rooting is confined mostly to the plough ribbons which often results in a strongly aligned root system, particularly on sites with a high watertable. Trees therefore do not have an even radial distribution of roots and support for the stem is strongest in the direction of cultivation. Consequently this can have a significant effect on the stem form of a crop particularly on a peat site.

Results from a direction of ploughing experiment (Hendrick and Pfeifer — In prep.) have shown that by aligning the ploughing direction into the prevailing wind it is possible to reduce the incidence of basal sweep. Ploughing at an angle or at right angles to this direction can increase sweep dramatically especially at the exposed edges of plantations.

Similarly, planting lodgepole pine on ground prepared by ripping can induce basal sweep particularly if the trees are planted in the rip channels. Few roots penetrate the walls of the channels but tend to run along the loosened soil in the direction of cultivation. This again results in a strongly aligned root system with little lateral support.

Genetic aspects of root development

The natural root form of lodgepole pine has evolved over millions of years in response to the environment in which the species colonised. Consequently, it is perhaps the most efficient structure for the absorption of water and nutrients while at the same time giving good support to the crown. Preliminary investigations revealed that both inland and south coastal ecotypes have the same basic root structure. However, differences in end of season root-shoot ratio do exist but this is a temporary phenomenon which reflects the extent to which the provenances are phenologically adapted to the length of the growing season in which they are grown. Provenances which produce small shoot dry matter in relation to total seasonal dry matter develop relatively large end of season root/shoot dry weight ratios and vice versa. Although these differences are temporary they do last through the autumn and winter months when wind damage is most likely (Cannell and Willett 1976). Inherent differences of 10-30% in root/shoot dry weight ratios between provenances have been reported (Lines 1971, Cannell and Willett 1976), which may make some contribution to differences in wind stability after planting. But morphological differences in shoot development and "sail area" are much greater and are therefore likely to have a more significant effect on stability. The vigorous denser crowned south coastal provenances are more prone to toppling as a result of root deformity since they place a greater strain on the stabilising root system than the less vigorous sparcely foliaged interior types.

Discussion and recommendations for future establishment practice

Present establishment techniques alter the natural arrangement of lodgepole pine root systems and both early and late instability are a consequence of departing from this basic structure. The reduction or elimination of instability in the south coastal ecotype will therefore be best achieved by ensuring that improved establishment techniques produce crops with a root structure similar to that of the natural seedling.

In the nursery, lining out is a major factor in altering seedling root forms and improvements in the production of nursery stock are required. The technique of conditioning transplants by box pruning developed in New Zealand for Monterey pine could perhaps be modified here for lodgepole pine. This would involve precision sowing of seed and employing a regime of undercutting, wrenching and vertical pruning on four sides of the seedling root system. Results with Monterey pine have shown that the tap root is preserved and a dense mass of lateral roots induced. The root system is robust and less likely to be badly damaged during planting. Careful packing in waxed cardboard boxes ensures that this root system is not damaged during transportation to the planting site (Chavasse 1978). While a similar regime could be envisaged for lodgepole pine for planting on mineral soils, the nature of the peat soil is such that even if this excellent root system could be achieved, distortion is still likely to occur during planting.

The problem of root distortion at planting can, however, be overcome by using some form of containers in which seedling roots are allowed to develop naturally and the root plug complete with growing medium is planted without disturbance (Burdett 1979). Dibbles and other tools have been developed which will open planting holes to the diameter of the root plug and allow the seedlings to be dropped in. Minimum root distortion will occur at this stage but it can occur within the containers themselves especially if the seedlings are left in these too long (Kinghorn 1978). However, recent developments such as those described by Burdett (1979) in which root morphogenesis can be controlled in hard walled containers offer real possibilities of overcoming the problem in this type of container.

Soft walled containers such as paperpots allow seedling roots to penetrate the walls of the pot but on peat soils the low level of biological activity does not allow rapid breakdown of the paper and roots have been observed to be confined mainly to the pots three years after planting. However, this could be overcome by simply removing the pot at planting. Alternatively peat plugs which consist of a cohesive mixture of sphagnum peat and cellulose fibre could perhaps be the simplest solution to container induced root distortion. A system using triangular shaped plugs has been devised (Erin Tree Starts) that allows air pruning of emerging laterals and this is currently being tested.

Direct seeding will produce plants with the natural root form but this establishment technique is more troublesome than planting. Young seedlings are subject to predation from many different agencies and the site must be made more fertile to ensure good growth. Early thinnings are also required to ensure an even distribution of plants at a desired spacing. Direct seeding may be suitable for certain sites but on exposed high elevation areas it is unlikely that it would give a crop with satisfactory stocking.

The present cultivation practice of producing continuous plough ribbons encourages root alignment and consequently instability. If this is to be avoided a change in cultivation practice will be required to encourage radial root spread. This might be achieved by the development of a plough which would break up the ribbon and produce isolated turves or mounds. If these can be planted with transplants or seedlings without root distortion then as the trees develop the roots will emerge radially from the mounds thus providing support for the tree in all directions. Other forms of cultivation that could be explored are bedding ploughs which form a low wide convex mound of cultivated soil rather than a high ribbon. Also the use of winged rippers on mineral sites will give greater soil shatter than the conventional tine thus allowing better root spread. The added advantage of using these alternative types of cultivation is that the extraction of timber will not be hindered by an uneven forest floor produced by conventional ploughing.

While this paper discussed instability in lodgepole pine the same basic arguments are applicable to other fast growing pines and species that do not have the ability to form adventitious roots at the root collar e.g. Bishop (*Pinus muricata* D. Don.) and Maritime pines (*P. pinaster* Aiton.) and Douglas fir (*Pseudotsuga* menziesii (Mirbel) Franco.) Greater attention to the establishment of these species is likely to improve crop stability and consequently stem form.

In the past, establishment practices have been judged mainly on survival and early rapid growth with lesser attention being given to the form and development of the tree root system. Greater emphasis should be placed on this aspect of establishment and its success is probably best judged by using the natural root form of the species as a standard.

REFERENCES

BURDETT, J. P. 1978. Control of root morphogenesis for improved mechanical stability in container-grown lodgepole pine. Can. J. For. 8: 483-485.

BURDETT, J. P. 1979. Juvenile instability in planted pines. Irish For. 36(1): 36-47.

CANNELL, M. G. R. and WILLETT, S. C. 1976. Shoot growth phenology, dry matter distribution and root/shoot ratios of provenances of *Populus trichocarpa, Picea sitchensis* and *Pinus contorta* growing in Scotland. Silvae Genetica 25: 49-59.

CHAVASSE, C. G. R. 1978. The root form and stability of planted trees, with special reference to nursery and establishment practice, pp. 54-64. In Proc. of root form of planted trees symposium. Victoria BC. BR. COL. M.N. For. and Can. For. Serv. joint Report No. 8.

HENDRICK, E. and PFEIFER, A. R. (In prep.). The effect of ploughing direction on the stem form of lodgepole pine (*Pinus contorta* Dougl. ex Loud).

KINGHORN, J. M. 1978. Minimising potential root problems through container design, pp. 311-321. *In* Proc. of root form of planted trees symposium. Victoria BC. BR. Col. Min. For. and Com. For. Serv. joint Report No. 8.

LINES, R. 1971. Provenances. Lodgepole pine. Studies of factors leading to basal bowing, pp. 39-40. *In* Rep. on For. Res. H.M.S.O. London.

LINES, R. and BOOTH, T. C. 1972. Investigation of basal sweep of lodgepole pine and shore pines in Great Britain. Forestry 45: 59-66.

LINES, R. 1980. Stability of *Pinus contorta* in relation to wind and snow, pp. 209-219. *In Pinus contorta* as an exotic species. Proc. of I.U.F.R.O. working party meeting on *Pinus contorta* provenances in Norway and Sweden. Swed. Univ. Agr. Sci. Rep. No. 30. Garpenberg, Sweden.

LOW, A. J. 1975. Production and use of tubed seedlings. Bull. For. Comm. 53. HMSO. London.

The Nursing of Sitka spruce 2. Nitrogen-fixing species

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SUMMARY

Three experiments covering the use of common broom, two species of lupin and two species of alder as aids in the establishment of Sitka spruce crops are described. One experiment was begun in 1961 and the others in 1964. Of the species tested common broom and tree lupin showed most promise. Broom when young is susceptible to destruction by hares, and tree lupin dies after about 5 years.

A combination of tree lupin and broom has resulted in a satisfactorily growing crop of Sitka spruce after 20 years. Establishment of tree lupin is improved by ground limestone and by intensive cultivation, but the long-term benefit of tree lupin alone to a tree crop has not been established.

It is suggested that further work is required to investigate the use of a shrubby or dwarf species of alder and also into the use of the native dwarf furze as nurses for Sitka spruce.

INTRODUCTION

The use of leguminous plants, such as clover, to supply nitrogen to associated agricultural crops, such as grass, has been practised for centuries, but it is only in the present century that their potential in forest practice has been examined.

The earliest investigations were carried out in Germany and the results are summarised by Baule and Fricker (1967). Substantial positive and long lasting effects of lupins on the growth of young crops were achieved. The yellow annual lupin *(Lupinus luteus* L.) is recommended for infertile sandy soils, and the perennial lupin *(L. polyphyllus* Lindl.) for other soils. Underplantings of perennial lupin to improve the growth of poor pine stands have also been successful. The need for adequate supplies of phosphorus, potassium, calcium and magnesium in order to achieve best results is also pointed out.

Investigations in Britain were reported in some detail by Nimmo and Weatherell (1962) who obtained promising results using broom *(Cytisus* spp.) although there were difficulties in interpreting their results because of a confounding of the effects of the broom with the effects of additional quantities of phosphorus fertiliser applied to encourage it.

More recent work in New Zealand has examined the contribution of tree lupin (*L. arboreus* Sims.), originally intended to provide shelter in the early stages of sand dune afforestation. Cadgil (1971) has estimated a maximum fixation rate of 240kg N per ha over the first 1½ years of lupin growth, with a subsequent sharp reduction. In this sequence the lupin crop is suppressed by the developing tree canopy but grows again from seed after the tree crop is thinned.

Work in Britain on mica wastes derived from china clay extraction has shown that naturally occurring colonies of tree lupin can accumulate nitrogen at about 185kg per ha per year over a period of 5 years (Palaniappan *et al.* 1979).

When forest research was begun in the Republic of Ireland in the late 1950s one of the problems tackled was the afforestation of the impoverished mineral soils of Old Red Sandstone origin in the southern counties. In addition to a known deficiency of phosphorous, many of these soils suffered from depletion of organic matter through the removal of shallow peat layers for domestic fuel in earlier times. One possible ameliorative measure appeared to be the use of nitrogen fixing nurses.

Three early experiments are reported in this paper. The first was established in Cappoquin forest in 1961. The two others, designed to follow up questions suggested by the early results in Cappoquin, were established in Rathluirc forest in 1964.

SITES AND METHODS

Cappoquin

Cappoquin State Forest, Boggaghduff. National grid reference S 0405, elevation 180m. The soil is a peaty podsolised gley derived from glacial drift comprised mainly of sandstone; present peat depth about 8-15cm. Slope 4° facing southwest. The natural vegetation was dominated by *Calluna vulgaris* Hull. and *Molinia caerulea* Moench. together with some *Erica tetralix* L. and *E. cinerea* L.

Rathluirc experiment 1

Rathluirc State Forest, Ballycoskery. National grid reference R 56 16, elevation 230m. The soil is a gley derived from glacial drift material of Old Red Sandstone origin, and the texture sandy with a high stone content. The site is flat and the natural vegetation was dominated by *Calluna vulgaris, Molinia caerulea* and *Tricophorum caespitosum* Hartm. (*Scirpus caespitosus* L.).

Rathluirc experiment 2

Rathluirc State Forest, Garrane. National grid reference R 58 17, elevation 265m. The soil is an ironpan podsol derived from glacial drift of Old Red Sandstone origin and of loamy sand texture. Slope is 4° facing north. The natural vegetation was dominated by *Calluna vulgaris* and *Molinia caerulea* with occasional *Tricophorum caespitosum* and *Narthecium ossifragum* Huds.

Establishment methods

In so far as possible the basal establishment treatments were the same as those in general local use, except where they were modified to take account of the other treatments, as in the use of basic slag rather than rock phosphate as a source of phosphorus in experiments where ground limestone was used, either as a basal treatment or as an experimental factor.

In Cappoquin the experiment site was completely ploughed with a Clark single mouldboard tine plough. Basic slag was applied after ploughing at the rate of 500kg, supplying about 35kg P, per ha.

Rathluirc experiment 1 was treated after planting with basic slag as at Cappoquin. As an added precaution copper sulphate was applied at the rate of 17kg per ha, broadcast in the plots completely ploughed, and spread along the ribbons in the spaced-ploughing plots. The Sitka spruce (*Picea sitchensis* (Bong.) Carr) was raised from seed of Queen Charlotte Islands, B.C., Canada, origin.

Rathluirc experiment 2 was completely ploughed as in Cappoquin, treated with 5.02 tonnes ground limestone per ha, half before and half after ploughing, and given basic slag as in Cappoquin.

EXPERIMENTAL TREATMENTS

Cappoquin

1. Ground limestone at 6026kg per ha, half before and half after ploughing.
2. Potassium-magnesium sulphate at 200kg per ha.
3. Common broom (*Cytisus scoparius* L. syn. *Sarothamnus scoparius* Wimm.) and tree lupin (*Lupinus arboreus* Sims.) seeded in early March 1961 at 10.1 and 3.4kg per ha respectively. Seed mixed before sowing broadcast.

4. All treatment combinations were replicated with each of the three species Sitka spruce (seed origin "western north America"), Scots pine (*Pinus sylvestris* L.) (seed origin Scotland), and lodgepole pine (*Pinus contorta* Dougl. ex Loud.) (seed origin inland Oregon, U.S.A.) but the results obtained with the pine species were generally negative and are not reported in detail.

The treatments were combined factorially giving 2 x 2 x 2 x 3 = 24 combinations, all replicated twice in randomised blocks. The plots were 335m^2 in area.

Rathluirc experiment 1

1. (a) Spaced ploughing. Single mouldboard Clark tine plough with furrows at 1.5m.
   (b) Complete ploughing. Complete ploughing with single mouldboard Clark tine plough.
2. Ground limestone applied at 5.02 tonnes per ha, half before and half after ploughing.
3. Tree lupin direct seeded at 3.4kg per ha in mid-May 1964. The seed was sown in bands about 15cm wide between lines of plants in complete ploughing plots, and in patches about 22cm square on ribbons midway between plants in spaced ploughing plots.

The experimental design was split plot. Ploughing treatments were applied to whole plots and these were replicated five times in randomised pairs. Each whole plot was divided into 4 square sub-plots, each 405m^2, which were randomly assigned to the four combinations of a 2 x 2 factorial of limestone and lupins.

Rathluirc experiment 2

1. Control. No auxiliary species.
2. Tree lupin seeded at 3.4kg per ha.
3. Herbaceous lupin *(L. luteus)* seeded at 3.4kg per ha.
4. Common broom seeded at 11.3kg per ha.
5. Alder. Grey alder (*Alnus incana* (L.) Moench.) and red alder (*Alnus rubra* Bong.), the latter used in two replications and planted four years later than the rest of the experiment.

The treatments were assigned as a 5 x 5 latin square with plots of 804m^2.

RESULTS

Cappoquin

Both broom and lupin germinated satisfactorily in the first year but the broom was selectively attacked and eaten back to ground level by hares (*Lepus timidus hibernicus* Bell). It grew normally when the site was protected by a fence during the second year. The establishment of lupin, both in stocking and vigour, was significantly improved by limestone (Table 1) but there was no effect of the potassium-magnesium sulphate, nor any effect of either of these treatments on the broom. In the spring of 1963 the lupins were observed to be bearing perennial walnut-sized root nodules with the internal tissue of the lobes showing a bright red colour indicating nitrogen fixation (C. L. Masterson, personal communication).

Table 1 Cappoquin. Effects of ground limestone on stocking and vigour of tree lupin in second year (July 1962).

	No. of plants per m^2	Mean of longest shoot per plant (cm)
Without limestone	0.98	41
With limestone	1.95	49
Significance	0.001	0.05

Small nodules were also seen on the broom. However, the lupins proved relatively short lived, for in the summer of 1965 they were generally moribund and by July 1966 they were all dead. The broom has continued to grow vigorously except where suppressed by the developing tree canopy.

After three growing seasons both mean height and foliar nitrogen content were improved independently by both the legumes and the limestone (Table 2). There was no effect of the potassium-magnesium sulphate. The effect of limestone on foliar N content had disappeared in 1965 while at that time foliar N was significantly increased from 1.50% to 1.84% by the legumes. About this time the overall height increment began to slow down, and in 1969 it averaged about 10cm irrespective of treatment, although the trees in the legume plots were clearly of a deeper green colour than those in the plots without legumes.

In the summer of 1971, at age 10-11 years, all plots were treated broadcast with 91kg P as ground rock phosphate, and 105kg K as potassium sulphate, per ha.

Table 2 Cappoquin. Effects of legumes (broom and lupin) and ground limestone on mean height (cm) and foliar nitrogen (% d.m.) of Sitka spruce after 3 years.

	Mean height	Foliar N
Without legumes	66	1.92
With legumes	77	2.17
Significance	0.01	0.01
Without limestone	67	1.93
With limestone	76	2.15
Significance	0.05	0.05

A year later visual observation suggested that a response was developing in the Sitka spruce in the legume plots (now pure broom) but not in those without legumes. This was confirmed by measurements which showed that legumes significantly increased height increment from 0.20 to 0.41m in 1973 and from 0.27 to 0.69m in 1974. (Table 3)

At age 17 (1977) the effect of the legumes was to increase mean height from 3.8 to 6.1m and basal area from 10.3 to 25.2m^2 per ha. The effect of ground limestone on both of these growth indicators was appreciable but failed to reach statistical significance. At this time also foliar N was significantly increased by legumes from 1.04 to 1.22% d.m.

At age 20, after thinning four of the eight legume plots, mean height stood at 5.2m in plots without legumes compared with 8.0m in plots with legumes. At this time also soil analysis indicated that the pH of

Table 3 Cappoquin. Effects of legumes (only broom surviving) on growth of Sitka spruce.

Age	13	14	17	17	20
Year	1973	1974	1977	1977	1980
Indicator	Ht. inc.	Ht. inc.	Ht.	B.A.	Ht.
Unit	m	m	m	m^2/ha	m
Without legumes	0.20	0.27	3.8	10.3	5.2
With legumes	0.41	0.69	6.1	25.2	8.0*
Significance	0.01	0.001	0.001	0.001	0.001

* After thinning

the top 15cm had been increased from a mean of 4.3 without limestone to a mean of 4.7 with limestone. The legume results are summarised in Table 3.

Rathluirc experiment 1

The lupin grew well from the start, and was noticeably more vigorous with ground limestone, especially with complete ploughing, but it established itself well with standard spaced furrow ploughing also. No quantitative assessment of lupin establishment here was carried out.

By the second summer the lupin had in places suppressed the indigenous vegetation, but at this time also some dying of the lupin was observed. By 1967 the lupin was described as "moribund, particularly in plots without limestone", and in August 1968 as "mostly dead". It was all dead in April 1970.

Assessments after 3 and 6 years (Table 4) showed that complete ploughing (compared with spaced furrow ploughing), lupins, and ground limestone all significantly, and independently, increased tree growth. Analysis of a small number of surface soil (0-15cm) samples in 1970 indicated that the limestone had caused a change in the pH (no limestone: pH4.3, 4.7; limestone: pH 5.2, 5.4, 5.9). Foliar nutrient levels were not assessed in the Rathluirc experiments.

Even with the positive effects recorded, it is clear from the data that the overall rate of growth was totally unacceptable for the

Table 4 Rathluirc experiment 1. Effects of ploughing method, lupins and ground limestone on mean height (m) of Sitka spruce.

Age	3	6	9	13
Complete ploughing	0.71	1.16	1.48	2.01
Spaced ploughing	0.61	1.07	1.24	1.55
Significance	0.05	0.05	0.05	0.001
Without lupin	0.61	1.00	1.19	1.53
With lupin	0.71	1.33	1.53	2.03
Significance	0.001	0.001	0.001	0.001
Without limestone	0.60	0.93	1.13	1.53
With limestone	0.73	1.35	1.59	2.03
Significance	0.001	0.001	0.001	0.001

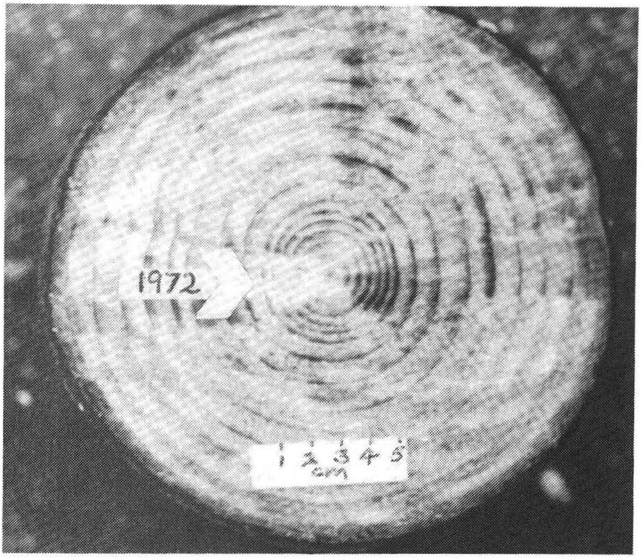

Fig 1 Cappoquin. Cross section of Sitka spruce from plot with legumes showing diameter growth response since 1972 to the PK treatment in 1971.

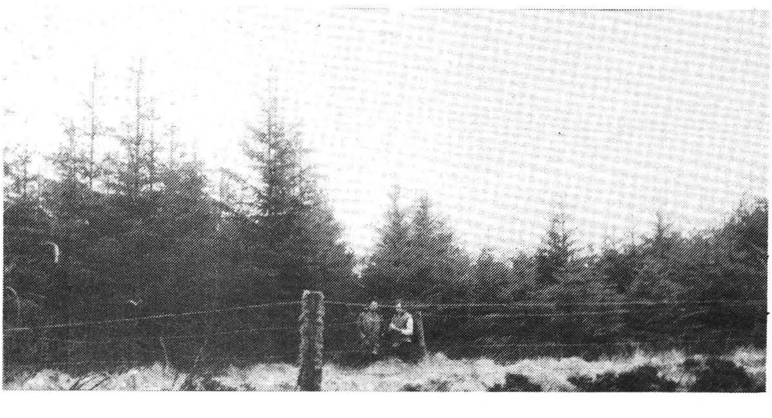

Fig 2 Cappoquin, Sitka spruce age 21. Legumes, left; no legumes, right.

purposes of economic forestry, and in February 1973, age 9 years, all plots were given a broadcast application of 91kg P as rock phosphate and 125kg K as potassium sulphate per ha.

Assessments of current height increment and mean height at age 17 are shown in Table 5. While the growth associated with complete ploughing is still significantly greater than that following spaced furrow ploughing, there is now a significant interaction, in both assessments, between lupins and ground limestone. Current height increment is significantly reduced by ground limestone in the absence of lupins, but is significantly increased both by lupins alone and, additively, by lupins and ground limestone together. Effects on mean height are similar, except that the negative effect of limestone alone on height increment is not reflected in a lower mean height at this stage.

Rathluirc experiment 2

Establishment of all legumes was sporadic and poor in this experiment, even though protectively fenced from the start. Alder establishment was also variable. In those patches where it was successful it has tended to outgrow the spruce and repeated cutting back of the alder has been necessary to prevent supression of the spruce. In later years dwarf furze (*Ulex gallii* Planch) has been spreading spontaneously over the site. After 17 years the mean height of the Sitka spruce is 3.50m, with no significant effects of any of the experimental treatments.

Table 5 Rathluirc experiment 1. Effects of ploughing method, lupin and ground limestone on current height increment and mean height (m) of Sitka spruce at age 17.

	Height increment		Mean height	
Complete ploughing	0.27		2.51	
Spaced ploughing	0.18		1.88	
Significance	0.05		0.05	
	Without limestone	With limestone	Without limestone	With limestone
Without lupin	0.20	0.10	1.72	1.76
With lupin	0.27	0.33	2.27	2.96
Least significant difference at 5%	0.06		0.15	

DISCUSSION

The experiment at Cappoquin was designed to test the efficacy, under local conditions, of three treatments — legumes, limestone, and potassium-magnesium — which had been found useful in continental Europe. These were tested under conditions of intensive cultivation, achieved by complete ploughing. Rathluirc experiment 1 was designed to examine further the cultivation and liming requirements of tree lupin, which at an early stage appeared to be more promising than broom. Rathluirc experiment 2 was designed to examine the separate effects of lupin and broom, together with another possible auxiliary crop, alder.

The presence of ground limestone led to improved establishment of tree lupin (Table 1). Legumes and ground limestone both resulted, independently, in improved early growth of Sitka spruce (Table 2). Although the data on mean height (Table 6) suggest that there may have been an indirect effect of the limestone on the spruce, through its improvement in lupin establishment (the effect of limestone is greater in the presence of legumes), the interaction does not reach statistical significance. The foliar N data (Table 6), where the combined effect of legumes and limestone is less than the sum of their separate effects, suggests an opposite trend, but the main effect of limestone on foliar N (Table 2) is adequate to explain its effect on tree growth.

There is not enough specific information, either in the data from this experiment, or in relevant literature, to offer a detailed explanation of the effect of limestone on nitrogen uptake and tree growth. In agricultural practice it was generally assumed in the past that the effect of liming arose from the mobilisation of nitrogen and other nutrients from soil organic matter, through increased biological activity, although there may also be direct effects on nutrient availability. (In modern practice, where mineral fertilisers are widely used, the effects of lime applications have been seriously questioned). The biological explanation would be consistent with the results of this experiment. A positive effect of limestone on early growth of Sitka spruce was obtained in another experiment on old red sandstone soil (O'Carroll, 1972). Similar effects have not been recorded on peat soils.

An overall growth stagnation at Cappoquin was corrected, at least in the legume plots by a topdressing of P and K after 10 years (Fig 1). Available data do not permit definite ascription of the improvement to either the P or the K component, but since foliar K at age 5 varied from 0.8 to 1.0%, and since there were no early effects of potassium-magnesium on tree growth, it is probable that the improvement was due to the P. This would suggest that an

Table 6 Cappoquin. Two-way tables showing mean height (cm) and foliar N (% d.m.) after three years with and without legumes and limestone.

	Without legumes		With legumes	
	Height	N	Height	N
Without limestone	0.62	1.78	0.71	2.09
With limestone	0.69	2.06	0.83	2.25

Note: In neither case was the interaction statistically significant. For main effects see Table 2.

application of 35kg P/ha as basic slag at planting time is inadequate to maintain Sitka spruce growth on this site.

Data on subsequent growth (Table 3) indicate a consistent superiority where legumes are present (Fig 2). Current height increment at 20 years indicates a growth rate equivalent to perhaps general yield class 18 or 20m^3 per ha (Hamilton and Christie, 1971), which would be acceptable in general forest management.

The overall sequence of events suggests satisfactory initial growth, improved by legumes and limestone, followed by the development of general P deficiency. When this was corrected a supply of N, here provided by legumes, became necessary to maintain growth.

Results in Rathluirc experiment 1 are generally consistent with the preceding hypothesis. Early growth is improved by limestone, by lupins, and by complete ploughing as compared with spaced ploughing. The effect of the ploughing may be ascribed to improved nutrient mobilisation under the influence of increased aeration. The response to the PK topdressing is developing more slowly than at Cappoquin, but this may be due to a site difference.

The significant reduction in height increment at age 17 by limestone in the absence of lupins (Table 5) is an effect not observed in Cappoquin. An explanation could be based on an assumption that increased mobilisation of soil nitrogen in the early years, under the influence of limestone, had led at this stage to the depletion of soil nitrogen to a level of deficiency greater than that which existed initially on this site.

The results in Rathluirc experiment 2 indicate that work on site classification needs to be undertaken before it will be possible with any degree of confidence to identify sites suitable for the use of nitrogen-fixing auxiliary crops.

Silvicultural implications

The results of these experiments support the hypothesis that the growth of Sitka spruce on Old Red Sandstone soils is limited by deficiencies of both phosphorus and nitrogen. Phosphorus deficiency can be corrected only by the application of mineral fertiliser, and this is relatively cheap and probably reasonably persistent with rock phosphate. Nitrogen can be either applied as mineral fertiliser, or supplied through the growth of auxiliary nitrogen-fixing plants. Mineral nitrogen fertilisers have increased rapidly in cost in recent years, and there is no reason to assume any reversal of that trend in future. The experiments show that both common broom and tree lupin may be useful as auxiliary crops. Both, however, appear to have disadvantages. Broom is susceptible to early destruction by hares. It is possible that if it were grown on a sufficiently extensive scale this destruction might be diluted to an acceptable level. Tree lupin, under the conditions of these experiments, is short lived — about 5 years — and it has yet to be established whether the quantity of nitrogen which could be fixed in that period could constitute a sufficient input for sustained growth. The indication for alder is that the species in present use in Ireland would be so aggressive as to suppress a nursed crop of Sitka spruce.

A shrubby or dwarf species of alder such as mountain or American green alder (*Alnus crispa* (Ait.) Pursh.) or Sitka alder (*A. sinuata* (Reg.) Rydb.) might be more promising. Until the necessary research has been carried out, attention may be directed to the proven value of Japanese larch (*Larix leptolepis* (Sieb. and Zucc.) Gordon) as a nurse for Sitka spruce (O'Carroll, 1978).

Another possibility is the use of dwarf furze, (*Ulex gallii* Planch.) which is native in the southern half of Ireland. Naturally occurring plants have been observed to bear root nodules, and many instances could be described where the presence of dwarf furze is associated with improved growth of Sitka spruce. It is admitted that such evidence is as yet wholly circumstantial, but more positive investigations are being carried out by Forest and Wildlife Service Research Branch.

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REFERENCES

BAULE, H. and C. FRICKER. 1967. Die Düngung von Waldbäumen. BLV Bayerischer Landwirtschaftsverlag Gmb H, München Basal Wien. (Transl. C. L. Whittles. 1970. The fertiliser treatment of forest trees. Munich).

CADGIL, R. L. 1971. The nutritional role of *Lupinus arboreus* in coastal sand dune forestry. 3. Nitrogen distribution in the ecosystem before tree planting. Plant and Soil 35: 113-126.

HAMILTON, G. J. and J. M. CHRISTIE. 1971. Forest management tables (metric) F. C. Booklet 34, London.

NIMMO, M. and J. WEATHERELL. 1962. Experiences with leguminous nurses in forestry. F. C. Rep. For. Res 1961, London, 127-147.

O'CARROLL, N. 1972. Crop establishment, in Forest Research Review 1964-70. Stationery Office, Dublin.

O'CARROLL, N. 1978. The nursing of Sitka spruce, 1. Japanese larch. Irish For. 35: 60-65.

PALANIAPPAN, V. M., R. H. MARRS and A. D. BRADSHAW. 1979. The effect of *Lupinus arboreus* on the nitrogen status of china clay wastes. J. Appl. Ecol. 16: 825-831.

An investigation of the effects of poor stem form and sawmill recovery on Coastal lodgepole pine

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INTRODUCTION

Coastal lodgepole pine LP(C) grown in the Republic of Ireland is frequently of very poor form. A small scale sawmill study was undertaken in order to answer several questions about the LP(C) material which will be produced over the next ten to fifteen years.

— How bad is the form and what are consequences in terms of sawmill recovery?
— Can sweep at the base be related to recovery?

Results indicated a loss of about 30% of the expected sawn wood return if the trees had been straight. Regression analysis indicated that there is a relationship between sweep at 1.3m and recovery.

An economic analysis revealed that at current prices and costs it is not profitable to sacrifice vigour for slower growing but straighter crops.

INTRODUCTION

In the conditions in which Coastal lodgepole pine (*Pinus contorta* Doug. Loud) is grown in Ireland, the more vigorous South Coastal provenances exhibit poor stem form. The reasons advanced for this are: fast growth rate, nursery practice, site preparation and planting methods used; all of which combine to produce instability, especially in exposed situations.

Will stands of crooked pine produce any sawlog material, assuming they reach suitable dimensions? Existing mature stands of good form are generally of slower growing provenances or were planted on sites not typical of the areas on which the tree is being planted today. As such, they cannot be considered suitable material from which to provide an answer.

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Very little information is available in the literature on the sawnwood recovery of trees exhibiting the degree of crookedness found in this country. In the United States, the lodgepole being harvested is mainly of good form (Benson 1973). Some sawmill studies of recovery from bowed logs (Dobie 1980, McDonald & Sutton 1970) do not relate results to the standing trees. In Britain, where some work has been done on the problem, reports indicate that the trees considered there were of considerably better form than those encountered in many Irish stands of lodgepole planted in the past 40 years (Moss 1971, Harding 1976).

One of the first attempts to quantify the problem in this country was made by Inventory Section of the Forest and Wildlife Service who conducted a survey of the degree of basal sweep in Coastal lodgepole pine planted before 1958. It was not known whether or not the measurement taken actually bore any relationship to the amount of sawable timber present in the tree. It could not be used, therefore, to estimate the potential sawn timber in a stand. The study described in this paper attempts to provide some answers to the following problems:

— Can recovery of sawn timber be related to basal sweep?
— If so, what sort of recovery can be expected from a typical pre- 1958 stand which will reach felling stage in the next decade or so?
— Could the assessment of sweep be improved to give a better estimate of return?
— What are the implications of the sawlog loss in terms of economics?
— Should straighter but slower growing provenances be planted?
— What is the likely effect of the loss on national sawlog production?

These questions are discussed in the light of the results from the actual conversion into sawn boards of sample trees from a stand of crooked South Coastal lodgepole pine.

MATERIAL

Twenty trees were selected from a stand of South Coastal lodgepole pine (LP(C)) in Foxford Forest. Details of the stand are presented in Table 1.

In order to obtain timber which would be representative in terms of size of that existing at the time of clearfelling, only trees with a diameter at 1.3m height (DBH) of 25cms or greater were selected. The trees were chosen at random and had a mean DBH of 28cms. This is approximately the same diameter as would be expected at clearfelling age in a stand of Yield Class (YC) 12, which is about the average YC for LP(C) in the country. The trees were more tapered than YC 12 final crop would be, having a mean height of 16m compared with 21m for the latter. However, there is no suitable material of greater dimensions available yet, as crops of this type are too young. While increased taper reduces absolute sawmill recovery, it does not effect the comparisons made in this study.

Table 1 Foxford Forest Lodgepole Pine

Species:	Lodgepole pine (Coastal)
Provenance:	South Coastal, mixed provenance, origin uncertain
Yield Class:	16. Age: 27
Mean DBH of selected trees:	28cms (Dominant trees)
Silvicultural History:	Pit planted on shallow peat. Unthinned but poorly stocked.

METHODS

As previously mentioned, Inventory Section of the Forest and Wildlife Service have conducted a survey of the degree of basal sweep in Coastal lodgepole pine planted before 1958. A frame (Fig 1) is used to measure the angle, which a line from the base of the tree to the centre of the tree at 1.3m above ground forms with the vertical. On the basis of this angle, the trees are classified as being of type A, B or C (Fig 1). The trees used in this study were grouped in the same way and the proportions falling in each class corresponded almost exactly with the proportions obtained nationally by the inventory survey (Table 2).

After the trees had been selected and assessed for basal sweep they were felled. The tops were cut off at 7cm diameter overbark. Two vertical rods were nailed to each tree as it lay on the ground, one at the base and another at the 7cm point. The rods passed directly over the pith and extended about 1m above the bark at both ends. A string was drawn taut between the tops of the rods. The process is illustrated in Fig 2. The distance from the string to the surface of the tree was measured in two planes at right angles to one another, at various points along the stem. The overbark diameter at these points along the tree was also measured. This allowed a three-dimensional model of the tree to be constructed. Distortions were inevitably caused by the tree pressing against the ground;

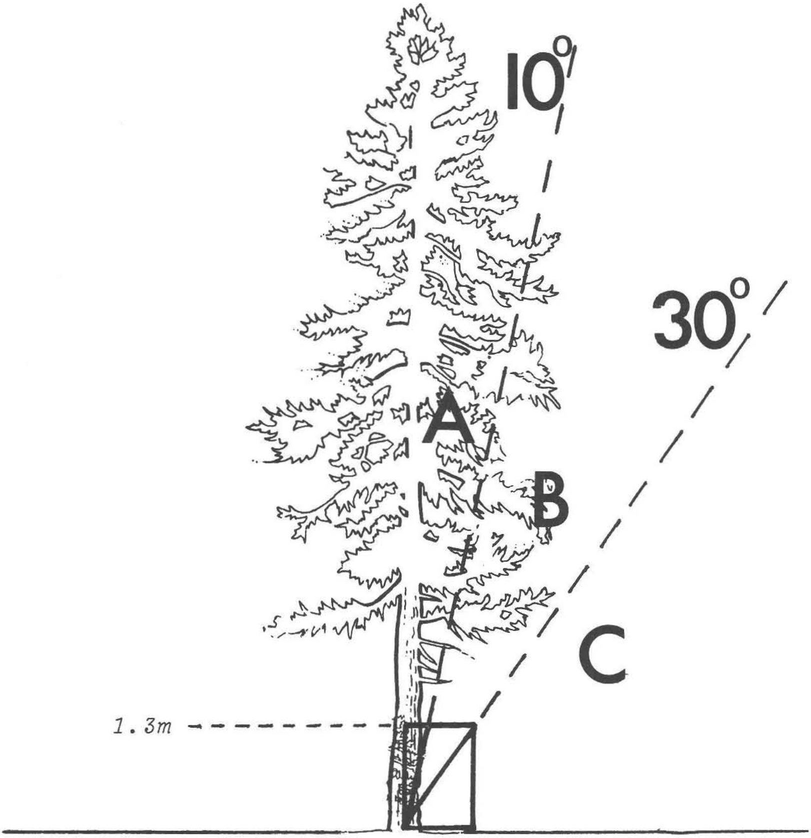


Fig 1 The protractors used by Inventory Section of the FWS for assessing basal sweep. The frame is held with its bottom left hand corner at the base of the tree in the plane of greatest sweep. Depending on where the centre of the stem at 1.3m height cuts the bar of the frame the tree is classified as A (0°-10°), B (10°-30°) or C (»30°).

however, these were not very severe as the area was mainly flat. When felled, the stem tends to align itself with its most bowed axis parallel to the ground so the main distortion occurs in the plane of least crookedness, and is probably slight.

Table 2 %Trees falling into basal sweep categories

	Category		
	A	B	C
Inventory National Survey	59	36	6
Foxford Sample Trees	50	45	5

The twenty trees were divided at random into 2 separate lots of 10 each for sawing. An experienced sawmiller was asked to section the stems in the forest using two different criteria:

Lot 1) To obtain the maximum recovery of sawn wood from each tree to a minimum of 14cm overbark diameter and subject to a minimum length of 1.2m (4 ft).

Lot 2) As above, but with a minimum length of 2.4m (8 ft).

The sections greater than the specified minimum length were then sawn into boards of various cross-sectional dimensions and the total volume recovered in boards to the specified lengths was calculated.

Using the stem profiles of the original trees and making suitable allowances for bark thickness and for loss in the form of sawdust, a theoretical maximum recovery of boards of lengths of 2.4m (8 ft) or greater was computed. This theoretical maximum was taken to be that which would be obtained if the trees were perfectly straight, perfectly circular in cross-section and perfectly sawn to obtain maximum recovery using a cant sawing with slab recovery technique. (This was the sawing method actually used on the test logs). The theoretical maximum was then reduced by 5% to obtain a "practical maximum", that is expected recovery in practice if the trees were straight and sawn correctly (Montague 1971). The actual volume recovered in boards of greater than 2.4m (8 ft) in length was compared with the calculated "theoretical practical maximum", and the difference regarded as the loss due to poor stem form.

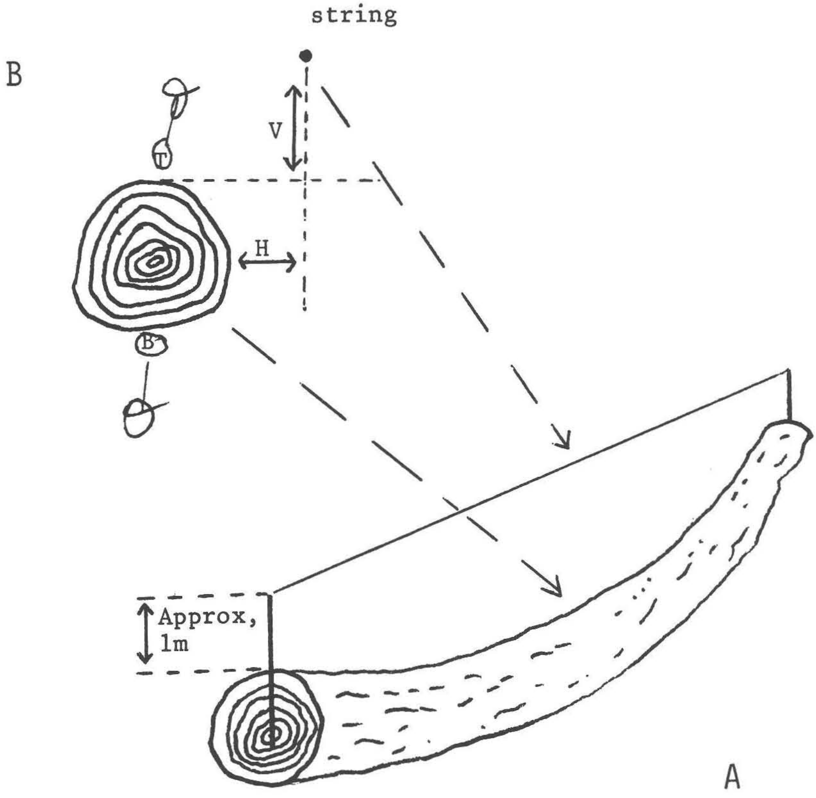


Fig 2 Measurement of tree shape (on ground).

A Rods attached to tree at base and 7cm point.
String drawn taut between the rods.

B Section through log and string near mid-point.
V is the vertical distance from string to level of upper surface of log.
H is the shortest horizontal distance from the string to the log surface.

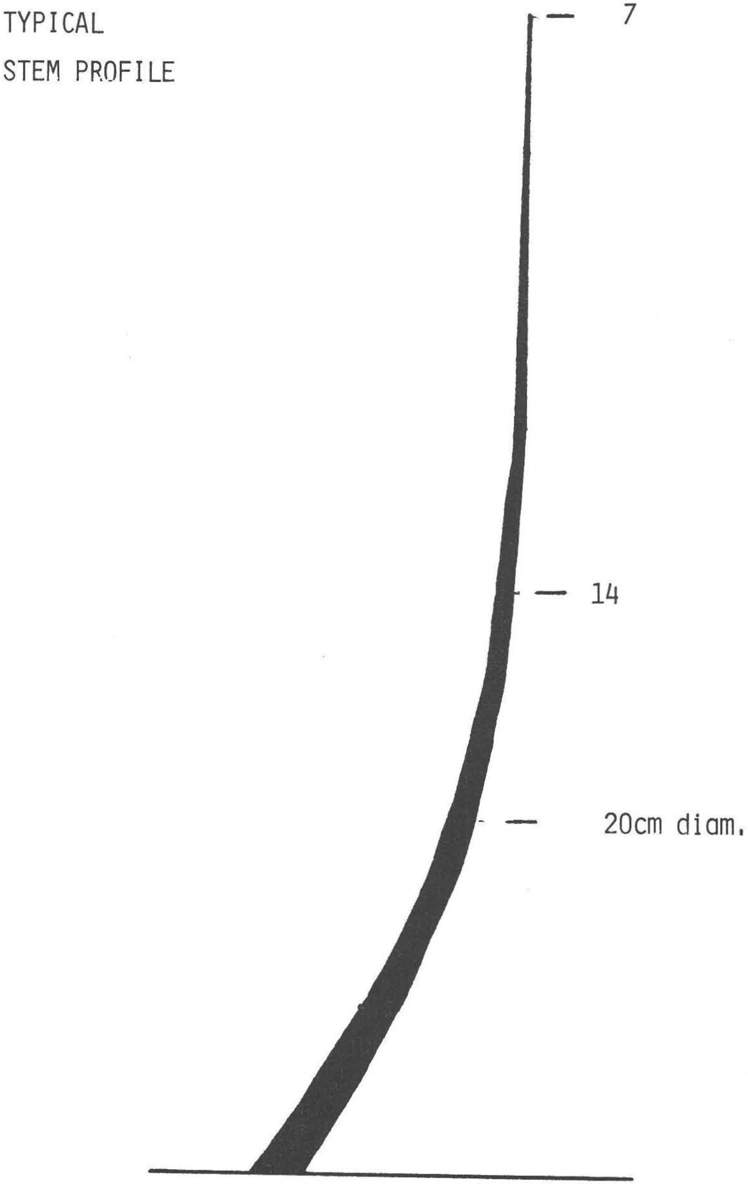


Fig 3 When viewed at right angles to the direction of maximum deviation from the vertical all stems exhibited this basic shape. Severity of the bow varied, but in all cases it continued at least to the 14cms diameter overbark point.

Recovery

The actual volume of sawn timber recovered in lengths of 2.4m (8 ft) or greater from the twenty trees amounted to 72% of the "theoretical practical maximum". That is 72% of the calculated return if the trees had been straight. There was, however, a considerable difference between the result from the trees sectioned to a minimum length of 1.2m (4 ft) and those cut to 2.4m (8 ft), as shown in the recovery figures in Table 3.

Tree Form

The method of assessment of tree shape which was used allowed two profiles of each tree to be drawn at right angles to one another. One of these profiles occurred in the plane of maximum bow of the tree, which in every case was the horizontal plane as the log lay on the ground. The second plane was at right angles to the first. Examination of the profiles revealed that nearly all the trees had the same basic shape, (Fig 3), only the degree of the distortion varied between stems. Unlike trees examined in surveys of basal sweep in Britain (Moss 1971, Harding 1976), the sweep in the Foxford trees was not confined to the lower section of the tree but continued right up to the timber height, forming one large bow. The distortion was however, most severe at the butt.

In almost all cases the displacement of the stem from the vertical was much more severe in one of the planes. This was, as expected, roughly in the direction of the prevailing wind, which is south-westerly. When the trees were assessed for basal sweep while standing it was found that in 85% of the trees the direction of greatest sweep to 1.3m height was due East. The profiles revealed that the direction of maximum displacement of the stem further up the tree was nearly always in a North-Easterly direction. In fact the trees all exhibited a corkscrew shape to a greater or lesser extent. There were successive displacements of the stem in excess of its diameter at intervals up along it in a spiral pattern (Fig 4). (Fig 5 shows a typical young plantation of crooked lodgepole pine in County Wicklow).

One of the objectives of the study was to estimate the relationship between sawmill recovery and some measure of stem form in order to help classify stands by their sawlog potential. Many possible measures of stem form and size were taken (Table 4). Recovery was expressed as the percentage of the theoretical. The correlation coefficients indicate a significant relationship between recovery and degree of sweep at 1.3m.

Table 3

Volumes in m^3 underbark Top diameters in cms underbark Percentages in brackets are % of standing UB volume		Tree sectioned to minimum lengths of:	
	Overall	Lot 1 1.2m (4 ft)	Lot 2 2.4m (8 ft)
Standing vol. to 14cm:	6.999	3.729	3.270
Vol. left in forest (m^3):		0.258 (7%)	1.361 (42%)
Vol. into sawmill (m^3):		3.470 (93%)	1.910 (58%)
Mean top diam. of logs≥ 1.2m:		18.8cms	
Mean length of logs≥ 1.2m:		2.45m	
Total vol. of boards recovered »1.2m in length:		1.916 (51%)	0.971 (30%)
Mean top diam. of logs »2.4m:	20.6cms	19.9cms	21.1cms
Mean length of logs »2.4m:		3.21m	2.78m
Total vol. of boards recovered »2.4m in length:	2.352 (34%)	1.381 (37%)	0.971(30%)
Total vol. of boards recovered »2.4m expressed as a percentage of standing vol. 14 overbark:	29%	32%	26%
Mean length of boards recovered »2.4m:		3.07m	2.74m
Theoretical 'practical' max. recovery:	3.246 (46%)	1.666 (45%)	1.580 (48%)
Actual recovery as % of above:	72	83	61

The 'Theoretical Practical maximum recovery' incorporates a loss in the form of sawdust of 15% of the underbark volume. It includes another 5% to allow for the non-circular logs and imperfect sawing which will be encountered in practice.

Lots 1 and 2 were sawn to *minimum* lengths of 1.2m (4 ft) and 2.4m (8 ft) respectively, no maximum was specified. Lot 1 produced more sawn timber in boards greater than 8ft long than did Lot 2, illustrating the subjective nature of the sectioning process.

Stepwise regression was used to scan the variables in order to find how best to predict the sawlog recovery. The only significant independent variable was the degree of sweep at 1.3m. The sample size is quite small however and the results should therefore be treated with caution. Some of the independent variables are correlated, but as these variables do not contribute significantly to the regression it does not affect the analysis.

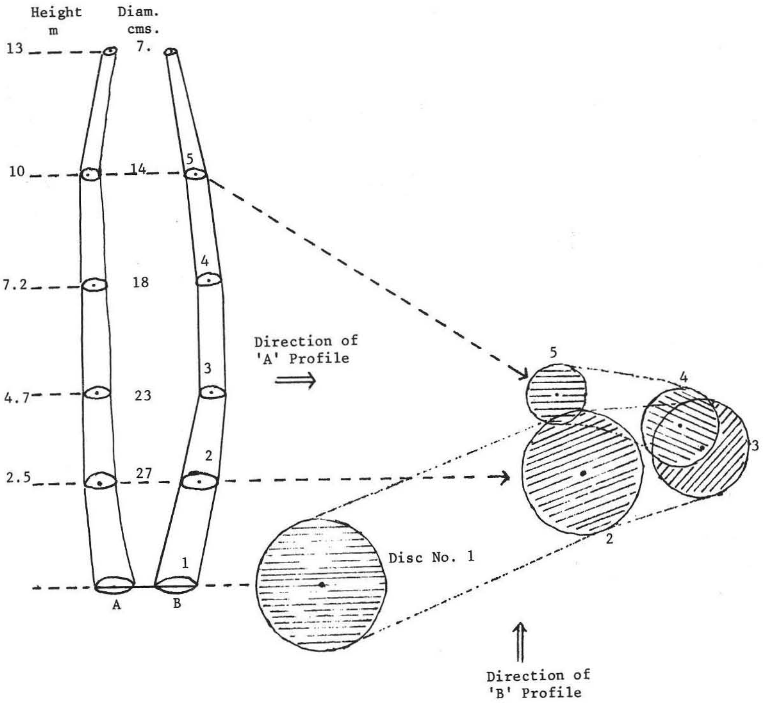


Fig 4 Diagram of Typical Stem Shape based on one of the trees from the study. On the right, above, is a plan view of discs taken at intervals up along the stem, as they would be viewed from above if it were in an upright position. On the left are two stem profiles showing how the tree would appear if viewed from directions A and B, as indicated. Discs are numbered to indicate their place in the stem profiles.

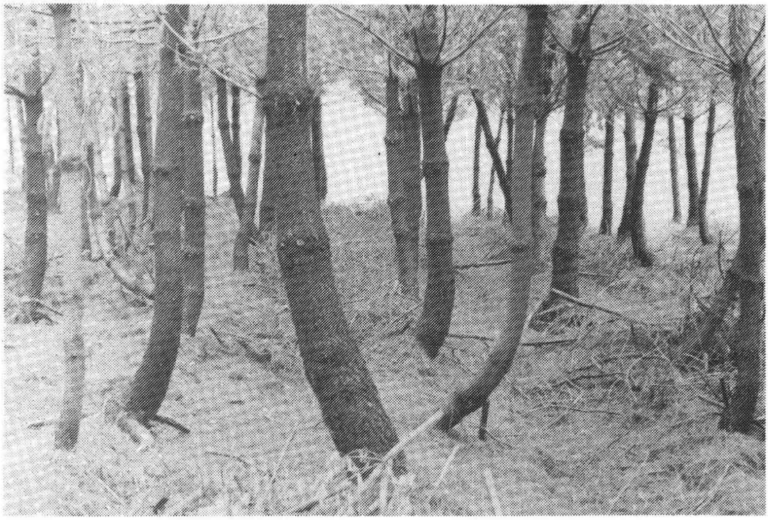


Fig 5 A young stand of crooked Coastal lodgepole pine.

Discussion of Results

The two lots of trees sectioned in the forest were very similar in terms of DBH, taper and stem crookedness, yet produced significantly different volumes of boards recovered in lengths of 2.4m (8 ft) or greater (Table 3). The reasons were apparently the different criteria for sectioning used, combined with the subjectivity involved in this operation. Had the stem profiles of the trees been examined before they were sectioned, and the optimum cuts calculated, results which were both more efficient and consistent could have been achieved. Firmer relationships could have been established between recovery and the various parameters of stem form. In practice, however, such a process would be much too cumbersome and costly for any timber harvester to consider. Its use in this study would have led to unrealistically high returns from the type of material under consideration. The most likely procedure for dealing with crooked stems in practice is that the chainsawman would simply section the tree rapidly on a purely visual basis, as was done in this case. The selected sections would be gathered into the sawmill and the crooked portions left behind, perhaps to be sold as firewood as they would not be acceptable for use in pulpmills. Making the assumption that the sawmiller would accept lengths as short as 1.2m for palletwood, the amount of material left behind in this study (from the trees sectioned to 1.2m minimum length, (Table 3)) was 7% of the standing volume.

Table 4

A. Relationship between recovery and measures of stem form (All twenty trees included in this analysis)

Variable	Correlation Coefficient	Significance level	Order of entry into stepwise regression	Proportion of sums of squares reduced by inclusion of variable
Degree of sweep at 1.3m (Basal sweep)	-0.51568	5%	1	0.266
Degree of sweep at 2.0m	-0.39084	NS	6	0.026
Degree of sweep at 3.0m	-0.35667	NS	9	0.001
Maximum deviation (cm) in the worst profile	0.09812	NS	4	0.017
Mean of the deviations (cm) in the worst profile	0.08877	NS	3	0.086
Sum of the 2 largest deviations in the worst profile	0.08214	NS	8	0.001
Taper (mm/m)	-0.06513	NS	7	0.007
Sum of 2 largest deviations in each of 2 profiles at right angles	-0.04924	NS	2	0.050
Diameter at breast height	-0.00861	NS	5	0.024

B. Regression equation for % recovery (Arcsin transformation) versus degree of sweep at 1.3 metres

		Std. Error of regression coeff.	T. Value
Intercept	61.003		
Regression Coefficient	-37.363	14.63	2.55

'Degree of sweep' refers to the distance in metres from the centre of the base of the tree to a perpendicular dropped from the centre of the stem at 1.3m, measured along the ground.

'% Recovery refers to the actual recovery in lengths of 2.4m (8 ft) or greater expressed as a percentage of theoretical recovery.

The subjectivity of the sectioning process was demonstrated by the results from the sawing. Lot 1 was sawn to produce the maximum volume of boards subject to a minimum length of 1.2m (4 ft). No maximum length was specified. Lot 2 was to produce the maximum volume of sawn boards subject to a minimum length of 2.4m (8 ft). For analysis purposes boards of only 1.2m length could not be considered as having "sawlog" value. So it was decided to accept only sawnwood greater than 2.4m (8 ft) as representing sawlog recovery. Lot 1 actually produced a greater volume in lengths of 2.4m (8 ft) and greater than did Lot 2 (Table 3).

Some of the 30% of the sawlog volume estimated lost due to crookedness was included in the timber left behind in the forest and some of it was recovered in shorter lengths as palletwood.As the trees in Lot 2 were not sawn down to palletwood sizes assumptions about the amount of material not suitable for this purpose must be based on Lot 1.

Averaging for the two lots the amount of sawn timber recovered in minimum lengths of 2.4m, it can be roughly stated that the loss of sawn timber due to bad stem form is about 30%, that about two-thirds of that can be considered as usable for palletwood and the remainder is suitable for firewood.

In regard to the shape of the trees the two points most clearly emerging were firstly that the sweep was not confined to the lower sections of the tree but continued up to timber height and secondly that most of the trees were of corkscrew shape. There is a poor relationship between recovery and the shape of the stem above 3m. This is largely because almost 50% of the estimated return from the trees occurs below this point. Measurements of stem form above 3m do not seem to hold much promise of improving on basal sweep as a potential estimator of sawn timber yields. The correlation between angle of sweep at 1.3m and recovery is significant (Table 4) but not strong enough to give a reliable estimate if small lots of timber were involved, and could with confidence be used only as a very rough indicator for forecasting purposes. However, it does appear to show promise as a potential indicator of sawmill returns. It could probably be improved if used in conjunction with one or more other measurements from the bottom 3m section.

A more extensive study would be required if a useful relationship were to be established, e.g. for sales purposes. Nevertheless, the correlation is strong enough to allow reasonable confidence that as the trees used here coincide in terms of ABC grouping with the Inventory National Survey, they may also be representative in terms of sawmill return. The major reservation to making this assumption is caused by the nature of the survey. It included stands of all ages, not just at clearfell time. Where thinning is practiced the average stem form would be expected to improve, thus the survey may overestimate the degree of sweep at felling time. Knowledge on any change in sweep over time of the individual tree is also lacking, but it must certainly get worse rather than improve. The net effect of these factors is unknown.

Some Economic Implications

If the losses in sawlog caused by stem crookedness are sufficiently severe then it might become more profitable to grow straighter but less vigorous provenances or perhaps a different species altogether. In a recent paper comparing the profitability of Sitka spruce and lodgepole pine under different sets of conditions, Carey and Griffin (1981) made allowances for loss of sawlog volume in lodgepole based on the results of this project. They concluded that in certain circumstances, such as on blanket bog and on Old Red Sandstone sites with no furze present, lodgepole pine was still a viable alternative option to Sitka spruce despite the loss of sawlog. To determine whether or not it would be justifiable on economic grounds to plant slower growing but better formed trees, such as might be achieved with more Northerly provenances, I have calculated the returns in terms of Net Discounted Revenue (NDR) for a range of Yield Classes of Coastal lodgepole pine.

A list of the assumptions used in the calculations is presented in Table 5. The volume figures are based on the Forest and Wildlife Service Yield tables for the species. It is assumed that selection thinnings only will be carried out, and that these will be done with a view to improving the overall stem form of the crop by removing the worst trees. The proportion of recoverable timber in a log decreases as the degree of sweep increases; this trend becomes more pronounced with smaller top diameters (McDonald and Sutton 1971, Dobie 1980). Therefore the sawlog element in thinnings has been assumed to be reduced by 40%. This is only a rough estimation and may well be overly optimistic.

The sawlog content of the stand at clearfelling is reduced by only 30%, on the basis of the results of this study. It is possible that tree selection at thinning could improve this figure and as such this may be a conservative estimate of the return. In the case of both thinnings and clearfellings 10% of the boxwood is assigned a pulp value only. This is loosely based on the results from the sawing of Lot 1, where 7% of the total standing volume was left in the forest.

All the remaining portion of the stand still considered as sawlog (i.e. 70% of expected clearfelling volume) is reduced in value by 10%. This is to compensate for the reduced lengths available to the

Table 5 Assumptions for Net Discounted Revenue Analysis

Straight Stems: (straight Lodgepole provenance).

1. 'Normal' management, based on the LP(C) Yield Tables from the Forest and Wildlife Service (1976).
2. Costs and revenues are those of March 1981.
   The price for sawlog was approximately £21/m^3 and that of pulp £1.20/m^3.

Crooked Stems: (Typical South Coastal).

1. Management as above. Selection thinning is assumed with straighter stems being favoured.
2. Costs as above.
3. Revenues:
   A) For thinnings, 40% of the sawlog element in the trees reduced to boxwood value. 10% of the boxwood element reduced to pulp value. The remaining sawlog element reduced by 10% in value.
   B) For clearfellings, as above except that only 30% of the sawlog element was reduced to boxwood value.
   This gave an adjusted price for the sawlog element in the timber of £14.30/m^3 in thinnings and £15.30 in clearfellings. Calculations of assortments were based on tables in British Forestry Commission Booklet No. 39.
4. 'Sawlog' is taken to be the proportion of a stand of timber occurring in logs of at least 3m in length with top diameters of 20cms.
   'Boxwood' or 'Palletwood' is defined as above but with a top diameter of 14cms and minus the sawlog element.
   'Pulp' is the remaining volume up to the 7cm mark of the trees in the stand.

sawmiller from the crooked stems and also to compensate for the increased handling costs involved in the sectioning process. It is a very arbitrary figure. There is no information available on what sawmillers are likely to pay for material of sawlog dimensions but mean log lengths of about 3m. Attempts to extract longer lengths would result in great losses in overall recovery.

The results of the NDR analysis (Fig 6) indicate that even if the trees could be grown straight it would not be profitable to drop more than one yield class in doing so. With decreasing yield class or increasing interest rate the benefit gained from better form diminishes. For example, at the 2% interest rate, YC 10 'straight' provenance is better than YC 12 South Coastal but not as good as YC 14, South Coastal. At the 4% rate however, YC 10 'straight' provenance is no longer more profitable than YC 12 of the more vigorous but crooked trees.

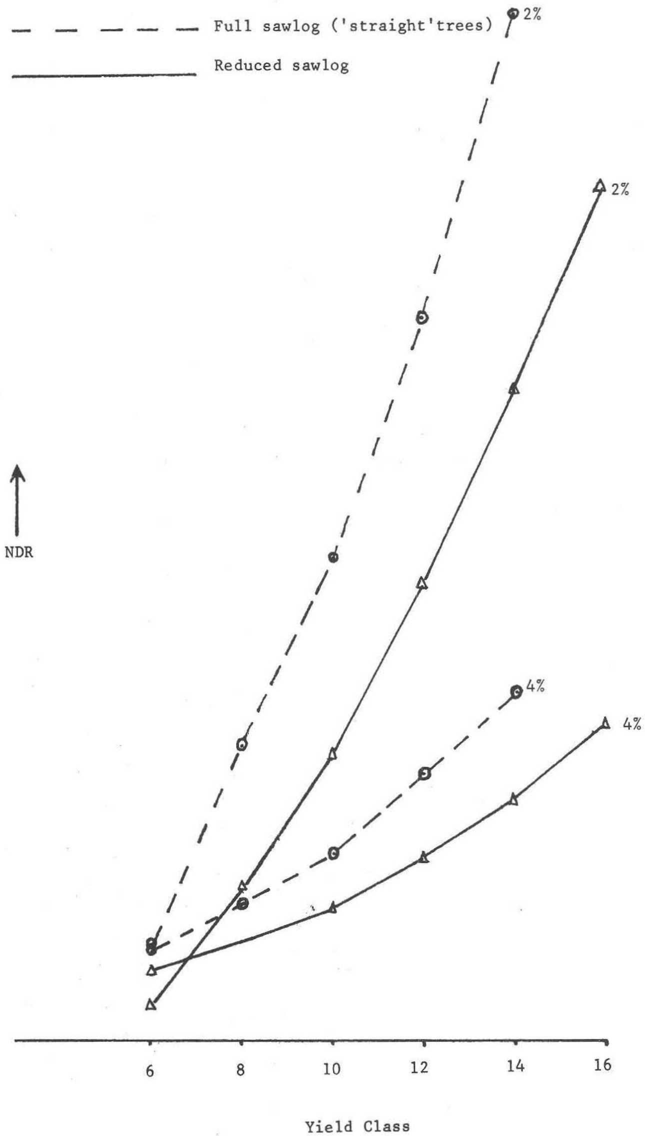


Fig 6 Net Discounted Revenues at 2% and 4% for 'normal' and 'reduced' sawlog assumptions over a range of yield classes.

CONCLUSIONS

Coastal lodgepole pine at present accounts for about 6% of the total volume to 14cms top diameter produced by the FWS. This figure is not forecast to rise during the coming decade. The losses of sawlog due to the poor form of these crops, as indicated by this study, would thus amount to less than 2% of the anticipated national sawlog production during the next ten years. The situation may become more serious afterwards as it appears that the stem form of LP(C) crops planted since 1958 is worse than that of the older crops, due to changes in provenance, site types and silvicultural practices. Without some sampling, on a national basis, of the degree of sweep present in these stands it would be impossible to make a reliable estimate of sawnwood returns from them.

If the degree of sweep in new plantings of South Coastal lodgepole pine could be limited to that present in the pre-1958 stands, then it would remain a more profitable proposition than planting less vigorous provenances. It would also, according to Carey and Griffin (1981), remain an alternative to Sitka spruce on certain sites.

ACKNOWLEDGEMENTS

Special thanks are due to Mr. M. Forde for his advice and assistance in the field stage of this project. Mr. M. Maye of Cong Sawmill sectioned the trees and Mr. D. O'Brien suggested the project and assisted in the analysis.

REFERENCES

ANON, 1976. Revised Yield Tables for Coastal lodgepole pine, Research Comm. No. 16, Research Branch, Forest and Wildlife Service.

CAREY, M. L. and E. Griffin, 1981. Sitka spruce or lodgepole pine? Irish For. 38(2): 61-77.

DOBIE, J. 1975. Lumber Recovery practices in British Columbia Coastal Sawmills. Environment Canada, Forestry Directorate Western Forest Products Laboratory Information Report VP-X-151.

DOBIE, J. 1980. Lumber yields from sweepy lodgepole pine. For. Chron. 56(2): 66-67.

HAMILTON, G. J. 1975. Forest mensuration handbook. For. Comm. London Booklet No. 39.

HARDING, T. 1976. Joint Research Programme or Home-grown timber. Forest Research 1976: 67-68.

McDONALD, D. S. and W. R. J. Sutton, 1970. The importance of Sweep in Sawlogs — a theoretical consideration. New Zealand Forest Research Institute Symposium No. 12, Volume 2: papers.

MONTAGUE, D. E. 1971. Band and Circular sawmills for softwoods. Dept. of the Environment Forest Products Research Bulletin No. 55. H.M.S.O.

MOSS, A. 1971. An investigation of Basal Sweep of lodgepole and Shore Pines in Great Britain. Forestry 44: 43-65.

OBITUARY

Tadg Crowley (1938-1982)

The sudden death of Tadg Crowley at his home in Adare on April 22nd 1982, came as a deep shock to his many friends inside and outside the Forest and Wildlife Service. This great loss to his family is shared particularly by his colleagues who entered Kinnitty Forestry School with him in 1957. On leaving Shelton Abbey three years later we had come to respect Tadg for his sincerity, loyalty and leadership. Every task he undertook was approached with energy, determination and tenacity, while he applied a vigorous mind to all aspects of silvicultural study.

As an Assistant Forester, Tadg was appointed to Lough Talt under Barney Brady in 1960; very briefly to Ballinlough under Willie Coffey in 1962; to Ballygar under Harry Silke in 1962; and Roscrea under Garry Kennedy in 1965. With the experience he gained under these able foresters he was appointed Forester-in-Charge to Kinelea in 1967. He served at Toormakeady from 1970 to 1978 when he transferred to Adare.

At Adare Forest with its extensive amenity park at Currah Chase he had ample outlets for his managerial skills and eager research. Over the last four years he had applied himself with his usual energy to many improvements and extensions to facilities at that beautiful place. As a committed member of the Society of Irish Foresters, Tadg had presided over the annual Forest Walk at Currah Chase, bringing the fruits of his experience and the study of a wide silvicultural literature to an ever increasing number of the public.

Parallel with his forestry interests, Tadg never put aside his great love for the Irish language and associated cultural activities. Gaining scholarships to Irish Summer School in Ballingeary from his native Bantry, he became a fluent Irish speaker early on, and wherever he was stationed he soon made contact with others who loved to exchange ideas through Irish. In Adare his involvement in these cultural affairs was acknowledged at his funeral in a dignified and moving manner by local musicians and dancers.

The guard of honour of Forester colleagues from church door to graveside gave eloquent expression to the feelings of loss and sadness at his untimely departure. To his wife Kathleen, and his young family we extend sincere sympathy. Ar Dheis Dé go raibh a Anam.

Seamus Crowley

Book Reviews

STATE FORESTRY FOR THE AXE

Robert Miller.
Hobart Paper 91, Institute of Economic Affairs, London, 1981. Price in U.K. £1.50.

After the Second World War, an intellectual concensus developed that State intervention on a substantial scale was necessary and desirable to assure prosperity and political stability in the democracies. The success of the Marshall Plan, the consequent near-miraculous economic and political revival of West Germany and Japan and the impressive post-War performance of the Scandinavian countries under socialist regimes, all encouraged this belief. However, during the past decade, inflation, unemployment, government deficits, levels of crime, drug addiction and family breakdown have been such as to diminish confidence in existing policies. The view that government should be more selective and parsimonious in its interventions in economic and social life has gained ground; among the major Western countries, this perspective has achieved political expression in the U.S., the United Kingdom and Australia.

One of the intellectual strands supporting this political philosophy argues that government intervention in commercial affairs should only be undertaken when it can be demonstrated that markets in the area in question are failing significantly. A variety of tests can be administered so as to assay the extent (if any) of such failure in particular circumstances.

The volume under review is in this tradition. The author examines State forestry in Britain. He takes in turn each of the arguments typically used to justify government intervention — a social rate of time preference which is lower than the market-determined rate, strategic and balance of payment considerations, amenity and recreation values, generation of employment in rural areas — and concludes that on none of these grounds can state investment be justified. For example, with regard to recreation and amenity, the author decides that forests, far from being a net contributor in these respects, instead "impose costs . . . reducing water resources, damaging the natural resources of the countryside, and harbouring pests"; a stockpile of ready-cut, imported timber would be cheaper than maintaining a large reserve of standing forest as a means of providing security in the event of an emergency.

This study is not wholly relevant to our situation in Ireland: to the limited extent that the rationale for State investment has been debated here, the tendency has been to argue that such investment can yield returns commensurate with commercial returns at the margin elsewhere in the economy; the market fails because of cultural attitudes and land-tenure considerations. This paper is also somewhat unbalanced in terms of the eagerness with which arguments against state forestry are embraced and counter-arguments are dismissed. In this respect it is an interesting counterpoise to the University of Reading study, *Strategy for the U.K. Forest Industry* (reviewed in *Irish Forestry* Vol. 38(2): 101-102), which was equally partisan in favour of additional state forestry investment.

Nevertheless, "State Forestry for the Axe" is an interesting and stimulating contribution. It does provide a methodology which should be helpful in analysing "privatisation". It is very modestly priced at £1.50 sterling, and provides plenty of food for thought for those with an interest in Irish forest policy.

Frank J. Convery

THE TREES OF BRITAIN AND NORTHERN EUROPE

Alan Mitchell and John Wilkinson
Collins, London. UK£3.95 (paperback ISBN 0 00 219035 4), UK£6.95 (hardback ISBN 0 00 219037 0).

This "Complete Pocket Tree Guide" contains illustrations and descriptions of the more commonly encountered trees, native and introduced, of the British Isles and northern Europe, although clearly it is intended mainly for users in Great Britain and Ireland. Over 600 species, varieties and cultivars are illustrated in about 1,500 coloured drawings, and there are 40 black-and-white winter silhouettes of common deciduous trees. A series of keys is provided, written in simple English without complicated botanical terminology. The illustrations fill the pages alongside the descriptive paragraphs, so that each page is colourful. Each tree is described briefly and there are notes on native habitats, behaviour in cultivation and special characters which aid identification. The illustrations, which range from habits to details of shoots, flowers and fruits, are generally adequate without being minutely exact.

This is a less technical work than Mitchell's earlier *A field guide to the Trees of Britain and Northern Europe* (Collins, 1974), which covered almost the same subject. The new volume is a virtual precis of the "Field Guide" which was not as colourful nor as profusely illustrated. The "Field Guide" contained more detailed descriptions which are botanically precise. This new book, therefore, is not intended for botanists or dendrologists seeking a scientific text, (the "Field Guide" serves that role better) rather it is a book to be used by those generally interested in trees especially people who want to identify specimens growing in Irish arboreta and gardens.

Ireland has only a handful of native trees and all are covered in this volume apart from controversial species like the endemic *Sorbus hibernica* (Irish whitebeam). What is lacking in our native woodlands is amply compensated for in our plantations. At a guess there may be over 1,000 species and many more varieties and cultivars growing in the great gardens in Ireland. Alas these are all too infrequently labelled, so this volume can be recommended as a useful book to be kept in the car and carried in one's pocket when visiting gardens or parks.

Indeed, a novel and amusing feature of the book is the final section which gives dimensions (height and trunk girth) of trees in the British Isles. The ones selected for quotation from Mitchell's vast accumulation of such data, are record specimens. It is interesting that Kilmacurragh tops the Irish list with 11 specimens which are either the tallest or have the greatest trunk girth in the British Isles. Powerscourt comes second with 10, followed by Mount Usher (7) and Glasnevin (6). Headfort, Gosford Castle and Castlewellan each have 2, and ten other gardens have 1 apiece. Surprises abound! Most of Glasnevin's records are pines although the Botanic Gardens are said to have a poor environment for conifers. Eccles Hotel, Glengarriff, has the tallest *Eucalyptus globulus* in the British Isles, at 46 metres — is this the tallest tree in Ireland?

This attractive little book should appeal to natural historians, gardeners and foresters. It does not provide comprehensive botanical descriptions but there are many other books which can be consulted if precise identifications are required. It is well printed, although the review copy (a paperback) had loose pages and the paperback version may not stand up to too much wear-and-tear. One serious error occurs on p.255 where the Chusan palm and the Canary palm illustrations are all incorrectly assigned.

E. Charles Nelson

MAN AND THE MEDITERRANEAN FOREST

A history of resource depletion
Thirgood J. V. 1981. Academic Press, London. 193pp. Price UK£12.00.

Is it possible for a book of roughly eighty thousand words to cover the story of man and his part in the depletion of the Mediterranean forest resource? Professor Thirgood makes a bold attempt but can only hope to give a broad outline of the subject. He deals with an area that contained the centres of many cultures which have contributed largely to the development of modern civilisation. Egyptian, Greek, Pheonician, Roman, Venecian and many others have been sustained by the Mediterranean lands and resources. After thousands of years of exploitation, overtaxed ecosystems are the legacy.

It is hard to visualise the original Mediterranean environment because of the past influences of Man and his livestock. For this reason, a definition of the region on the basis of vegetation types is difficult and the author suggests that a more realistic classification is through climatic/land use zonation. The reader is referred to a Food and Agriculture Organisation document for details.

If, as the author suggests, there are difficulties in visualising the original environment, it is even harder to quantify the area covered by forest or its composition through time. The literature of antiquity is employed as one source of reference but it is impossible to extract from it comprehensive quantative data, mainly because writers of old dealt with the forest indirectly. It is often hard to give weight to their comments; for example, in the section dealing with the Lebanon, there are reports of timber shortages followed by periods of timber extractions. Did the forest recover in the mean time or were more inacessible areas opened up? Botanists, historians, archaeologists and geographers help us to evaluate the written record; but some form of mathematical modelling techniques, based on assumptions, is perhaps the only way we shall ever be able to answer these questions. Without quantifiable data on the forest resource, I think the subtitle (a history of resource depletion) overstates the contents; however, a lucid analysis is given of the responsible agents of depletion.

The book discusses man in history rather than pre-history. It is divided into four parts, the first three deal with the overall Mediterranean basin, the Levant and Cyprus in that order. There is a certain bias towards the Central and Eastern Mediterranean but much of the discussion, limited to specific areas, applies to the entire basin. It is apparent that environmental damage has been caused largely by mismanagement associated with Man and his grazing animals, especially the free-range goat. Grazing animals have been part of the Mediterranean landscape for thousands of years but their dominance is linked to the post Classical Arab invasions. The case study-Cyprus, illustrates how the situation may be redressed and it is interesting to see, through the author's eyes, ecosystems recover under proper management.

The fourth part entitled 'the zone of tension' discusses the Mediterranean of today, restates the problems of the basin and possible solutions. It is a concise statement of the conflict the forester or land manager faces in many areas of the world: technically there are answers to problems but there is social resistance to change. Those interested in or involved with third world agro-silviculture should find this instructive.

The book is, in general, easy to read although in places a chronological order of events is not adhered to and this makes the text somewhat hard to follow. The volume is aimed, not only at those who have first hand experience of the Mediterranean zone, but at the beginner too. It succeeds in this respect and there are over 230 references cited, mostly in English, which is ample material for anyone wishing to pursue the study. Foresters should find it fascinating reading, though I imagine it would be of interest to other professionals like archaeologists, historians, biblical scholars and social scientists.

R. M. Keogh

Society Activities

ANNUAL GENERAL MEETING 1982

COUNCIL REPORT FOR 1981

Symposium:
The theme of the 1981 symposium was 'Lodgepole pine, what is its future?' held at Belfield in April, over 200 members attended. Although at the end of the day there were no clearcut answers, encouraging things were heard about the timber, if only it would grow straight. Organisation of the 1982 symposium, which will deal with harvesting, began during the year. Choosing a subject is always a difficult task and Council invites suggestions of topics for future symposia.

Indoor Meeting:
Mr. Niall O Muiregheasa and Dr. Gerhardt Gallagher gave a talk on 'Forestry in Japan' at the R.D.S. in November. Both attended the Seventeenth Congress of the International Union of Forestry Research Organisations held at Kyoto in September.

Field Days:
Two very well attended field days were held in Clare in September and in Wicklow in October. At the Clare meeting the morning was spent discussing the nutrition of Lodgepole pine and Sitka spruce at Ennis forest. The afternoon was spent at Mr. Robert Tottenham's Mount Callan plantations. This included a visit to the renowned stand of Sitka spruce growing at Yield Class 34. Here discussion turned to grading rules for such fast grown timber. The concensus of opinion was that grading rules need to be critically examined. Woodfab Containers were hosts for the morning of the Wicklow field day. Here a new pallet line has been installed which included two profile chippers. Aughrim State forest nursery was the venue for the afternoon and modern approaches to nursery work were fully discussed.

Annual Study Tour:
The counties of Fermanagh, Leitrim and Sligo were the venue for the Study Tour held in May. Over 80 members attended what was a very successful tour (see *Irish Forestry*, Vol. 38(1)).

Guided Forest Walks:
Walks were well attended at 38 centres on the 13th September. Organisation of the walks is becoming increasingly time consuming as they expand in number and interest. Council is examining the organisation of the walks to find ways of sharing the work-load involved.

The Society thanks the following for help with meetings during the year:
Mr. Robert Tottenham, Mount Callan, Co. Clare; Woodfab Containers of Aughrim; both Forest Services; Mr. Liam Quinn who organised the Forest Walks; and all those who acted as field leaders and speakers.

Annual General Meeting:
The 39th Annual General Meeting was held at the R.D.S. on the 9th April, 1981. The minutes are in Irish Forestry Vol. 38, No. 1.

Society Publications:
Irish Forestry Vol. 38 (1 & 2) was published. The final draft of the revised edition of 'The Forests of Ireland' has been sent to an interested publisher. Publication is planned for later this year.

Examinations:
All three candidates for the Foresters Certificate Examination were successful. One candidate achieved an Honours Mark and the other two passed with Distinction. The Preliminary Certificate Examination was taken successfully by twelve candidates.

A review of the Examinations Syllabus is in progress. It is hoped to have the review completed in time for 1983 Examinations.

Elections:
Three posts of Technical Councillor and one post of Associate Councillor for the period 1982-1984 were filled by election. Each of the remaining posts had one candidate only and subject to confirmation at the Annual General Meeting will be filled without election. Members are reminded that they are entitled to nominate candidates for election to Council and are urged to do so for the 1982 elections.

Membership:
Technical 517; Associate 107; Student 33; Total 657.

New members elected in 1981
Technical 23; Associate 9; Student 20; Total 52.

Eight members resigned during the year.

Attendance at Council Meetings:
Six Council Meetings were held during the year. Attendance at Council Meetings was as follows:

J. Connelly, J. Fennessy, E. Hendrick, J. O'Driscoll — 6 meetings. J. Brosnan, C. Farmer, E. P. Farrell, J. J. Gardiner, E. Joyce, J. Prior — 5 meetings. J. Dillon, L. Furlong, J. C. L. Phillips — 4 meetings. P. J. Glennon, P. McArdle — 3 meetings.

Signed: EUGENE HENDRICK,
5th March, 1982. *Hon. Secretary.*

MINUTES OF THE 40th ANNUAL GENERAL MEETING
Thursday, 1st April, 1982,
Agricultural Building, University College, Belfield, Dublin 4.

Attendance:
The outgoing President Mr. O'Driscoll took the chair. Present were: N. O'Carroll, T. Farrell, L. Furlong, P. M. Joyce, M. Sheridan, L. Quinn, C. S. Kilpatrick, T. McEvoy, J. C. L. Phillips, J. M. Sanderson, L. P. O'Flanagan, B. Wright, C. J. Boyle, J. J. Maher, J. P. Connelly, J. Dillon, M. MacSúirtáin, M. Carey, J. Gardiner, G. Cunningham, P. Carlin, C. Farmer, J. Mackin, P. J. Glennon, K. J. Hutchinson, V. O'Connor, T. Booth and J. Fennessy.

Apologies: E. Hendrick and J. Prior.

Secretary's Business:

In the absence of the Hon. Secretary Mr. John Fennessy performed his duties. The minutes of the 39th Annual General Meeting were read and signed. Dr. O'Carroll stated the full text of the "Forests of Ireland" was with the publisher. On the question of aiding the cost of publication of the book Mr. O'Driscoll informed the meeting that the Forest and Wildlife Service had agreed to donate a sum towards the cost. The Council Report for 1981 was then read. It was pointed out that Mount Callan Tree Farms were not acknowledged for hosting part of the Society's field day in Clare. It was agreed that this would be included in the Council Report when it was published in Irish Forestry. The adaption of the 1981 Council Report was proposed by Dr. P. Joyce and seconded by Mr. J. Dillon.

Treasurer's Business

The Treasurer clarified some points in the Abstract of Accounts. Following discussion at the last A.G.M. he had investigated the advantages of investing Society funds in a commercial bank account. As a result he had recommended to Council to invest in this type of account. This was agreed and acted upon. There had been many difficulties with the sterling area account and regrettably it was closed. Expenditure on stationery and printing was high because the cost of printing the supplement to Irish Forestry. There were 400 fully paid-up members from a total of about 650. Double payment of subscriptions was still a problem. The point was made from the floor that this should be taken up with the banks concerned. Postage costs had been reduced through the introduction of stick-on labels and by the reduction of post-outs. The finance committee was examining way of increasing revenues; through increasing membership and the possibility of sponsorship. Members who are not paid up by end of March lose the benefit of membership. The cost of printing the journal was about £2,000 per issue. The size had been reduced to keep costs down. Adoption of the 1981 Abstract of Accounts was proposed by J. Connelly and seconded by J. Gardiner.

Confirmation of Elections:

The meeting confirmed the 1981 Council election as follows: President J. C. L. Phillips, Vice-President J. O'Driscoll, Hon. Secretary E. Hendrick, Hon. Treasurer J. Brosnan, Editor E. P. Farrell, Business Editor J. Fennessy, Hon. Auditor W. H. Jack, Technical Councillors P. Crowe, E. Joyce, J. Prior, Associate Councillor L. Furlong.

The outgoing President Mr. O'Driscoll paid thanks to the members of the outgoing Council for their work during the year. The incoming President Mr. Phillips then took the chair. He paid tribute to Mr. O'Driscoll for his hard work on behalf of the Society.

Other Business:

It was suggested that a provincial venue should be sought for the 1983 symposium. It as agreed that this would be considered by the incoming meetings committee of Council. Mr. McEvoy on retirement from the Forest and Wildlife Service had kindly initiated a fund for young technical members. Discussion followed on the way the fund should be administered. Mr. McEvoy stated that he would leave this up to Council but hoped that it would aid young technical members in the future. It was agreed that a letter should be sent by the Society to the Institute of Foresters of Great Britain and Northern Ireland congratulating them on being presented with a Royal charter. The meeting finished at 10 p.m.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1981

1980	*RECEIPTS*		*1981*
786.75	*To Balance from Last Account*		4,837.72
	To Subscriptions Received		
	Technical 1981	1,823.37	
	Technical 1980	85.29	
	Associate 1981	314.72	
	Associate 1980	7.00	
	Student 1981	34.00	
	Student 1980	—	
	Other Arrears	33.00	
	Advance Payments	213.55	
2,629.46			2,510.93
	To Interest on Investments		
	Dublin Corporation Stock 9¾%	20.09	
	Savings Account	76.80	
	Educational Building Society	100.08	
	Lombard & Ulster	125.19	
545.01			322.16
	To Journal		
	Sales	325.58	
1,496.54	Advertising	1,149.42	1,475.00
2,235.00	*To Forest Walks*		2,725.00
100.00	*To Examination Fees*		80.00
	To Donations	5.04	
9.02	*To Gains on Sterling Transfers*	25.00	30.04
12,801.78			**11,980.85**

1980	*PAYMENTS*		*1981*
35.28	*By Stationery and Printing*		—
3,244.60	*By Printing of Journals*		5,419.00
767.22	*By Postage*		824.89
101.52	*By Expenses re Meetings:*		125.60
61.00	*By Bank Charges*		25.83
822.96	*By Secretarial Expenses*		1,054.08
504.48	*By Value Added Tax*		791.85
71.80	*By Examination Expenses*		105.86
	By Honoraria:		
	Secretary	30.00	
	Treasurer	30.00	
	Editor	30.00	
	Business Editor	30.00	
120.00			120.00
2,235.20	*By Forest Walks*		2,725.00
	By Balance:		
	Current Accounts	609.98	
	Savings	77.68	
	Educational Building Society	101.08	
4,837.72			788.74
12,801.78			**11,980.85**

I have examined the above accounts, have compared it with vouchers, and certify same to be correct, the balance to credit being £788.74 which is held in current and savings accounts at the Ulster Bank, and in the Educational Building Society. There is also a holding of £206.19, in the Dublin Corporation 9¾% 1981-83 Stock and £100.00 in Prize Bonds.

Dated: February 24th, 1982 *Signed: W. H. Jack, Hon. Auditor*

40th ANNUAL STUDY TOUR, 1982 — KILKENNY AREA

Tuesday 25th May — Rossmore Forest.

Eamonn Flanagan, Divisional Inspector, George Mccarthy, District Inspector, W. Aherne, Forester-in-Charge, F. Comiskey, Forester.

Harvesting Thinnings: Rossmore forest is situated on the Castlecomer plateau at an elevation ranging from 300-350M. The main soil types are gleys derived from coal measure shales and sandstones and peaty podsols derived from carbon shales. In 1978 a P58, Y.C. 20 crop of Norway spruce was line thinned removing every 6th line with chevrons. Now, it is being line thinned again, taking the centre line and doing some selection on the remainder. Extraction is by Mini-Bruunett. A similar Sitka spruce stand was line thinned at first thinning and now is being line thinned in the opposite direction. To use the Mini-Bruunett it is essential to line thin. This is a high risk windblow area and the wisdom of heavy line thinnings was questioned. The quality of the S.S. crop did not appear to be good. All of this material is sold to Woodfab. 10% of produce is sawlog size and 60% is palletwood. It would not be economical to sort the sawlog. The prices paid are £15/m^3 for palletwood and £11.80 for pulpwood.

Soil Cultivation: Eugene Hendrick, Research Branch.

This experiment was established in 1977 to compare SMB ploughing, DMB ploughing and ripping for the establishment and growth of S.S. on a peaty gley soil. The necessity for herbicide application and the planting position relative to the ribbons and rip lines were included as sub-treatments. Growth differences are small as yet. Ripping would be the preferred treatment, if it gives satisfactory growth. The application of herbicide (glyphosate) seems to have had little effect upon growth.

Oakpark Research Centre: Mr. P. J. O'Hare, Dr. M. Neenan, Mr. F. O'Farrell, Dr. M. Ribiero, Mr. H. W. Kehoe.

Aspects of the research programme discussed at this centre included, Biomass experimentation, the Passive Solar Farmhouse, the breeding of perennial ryegrass, white clover and the breeding of potatoes. In the biomass species trial only the willows and some poplar clones are growing well. The traditional coppice species, Spanish Chestnut, has not performed well on this site. Regrowth of Alder following coppicing has been very poor.

The Passive Solar Farmhouse is designed to make maximum use of solar energy without he use of expensive solar panels. This is achieved by glazing the southside of the house, by underfloor, attic and wall insulation and by providing a double wall on the north side of the house. These modifications added 7% to the construction costs but have significantly increased winter temperatures within the house.

Wednesday May 26th— Mullinavat Forest.

M. O'Connell, Forester-in-Charge, E. Slattery, Forester.

This forest is some 1415 hectares in extent with 68 kilometers of roads. The principal soil type is peaty gley.

Sitka spruce Gene Bank: J. O'Driscoll, Research Branch.

This gene bank was planted with material remaining following the establishment of the IUFRO provenance trials. There are 72 provenances. The objective is to conserve gene resources and to use this gene pool as a source of breeding material. It is clear even at this early age, that there is an increase in height growth the further south the seed source. All provenances flush at about the same time but the more southerly provenances have a longer growing season and thus tend to be damaged by early autumn frosts.

Land Acquisition — P. Kelleher (Acquisition).

Since June 1980, the amount which can be paid for land suitable for afforestation has increased substantially. The top price is £500 per ha for grass rush sites in enclave situations. The lowest price is about £50 per ha. At the present time there is a considerable amount of good quality land on offer to the Forest and Wildlife Service but there is no money available to buy land. Only land of strategic importance is being acquired and even this can only be recommended for acquisition on the basis of savings in other areas, such as, roading, fencing and fire protection. Some participants felt that there is nothing wrong with the policy and that perhaps it is time to concentrate on doing a good job with the forest estate already established.

Harvesting Windblown Sitka spruce.

A P60, yield class 26 crop was marked for a first thinning in 1976. At that time average pole size was $0.05m^3$. It was line thinned in 1980/81 when the average pole size was $0.12m^3$. In the following winter 70% of the crop was blown but with little or no breakage.

Harvesting is now being carried out by a sub-contractor at a cost of £9/m^3. Extraction is my a Mini-Bruunett at a cost of £1.45/m^3. The material has been purchased by Woodfab. The sub-contractor uses five men — one chain saw and four axes. He maintains that the use of chain saws which cost approx. £50/week is too expensive for this kind of work. Output from this gang is in the region of 100-200 tonnes/week. The main question now is that of replanting. Apart from a few hollows the areas does not require an intensive drainage system. These hollows will be tapped using a JCB and planting will be through the brash at a spacing of 2.4m X 2.4m. The question of subsequent treatment was debated and unresolved.

p66/67 Sitka spruce.

The soil was a peaty gley. This site carried a first rotation crop of Y.C. 14 Lodgepole pine which was windblown. It was subsequently notch planted with S.S. following windrowing of the brash with a blade. There was vigorous regrowth of heather and gorse. Plants were dipped, but spraying to control weevils was necessary. The efficiency of dipping and the timing of spraying for weevil control were mentioned as being critical. The crop is now growing very well but many leaders on the Sitka are distorted. This appears to be common on very vigorous crops of Sitka. Opinion was that these will straighten out.

P55 Lodgepole pine.

There are approximately 40 hectares of Lulu Island Lodgepole growing on a peaty gley site. It was planted in 1955 and the yield class is 6-8, 2625 stems/ha. It has been line thinned but is growing very poorly. It is quite difficult to decide how to treat these crops. The options appear to be: (a) apply fertiliser; since the crop has had no fertiliser in recent years it might respond to G.R.P. application. (b) fell and replant the area with coastal Lodgepole or Sitka.

Local management prefer the first option and hope to carry the crop to pallet wood-small sawlog size.

Thursday May 27th — Durrow Forest and Abbeyleix Estate.

M. J. Fahey, Senior Inspector, M. Alyward, Forester.

Many of the properties of Durrow Forest are remnants of old estates. The soils are of high fertility and many broadleaved species have been planted. Some areas were planted with a mixture of conifers-hardwoods. The first stand visited was planted in 1949 with an oak-beech mixture. Some natural regeneration contributed other species such as ash, hazel and elm. There are now 4000 stems per ha and there has been no treatment to date. It was agreed that the area needed some treatment but there was considerable diversity of opinion as to what to do. One suggestion was to introduce conifers after a clearing. This was generally rejected on the grounds that we have few areas on which we can grow hardwoods and that we should be planting hardwoods where we can. It was suggested it was now too late to do anything, that the present crop should be cleared and the area replanted with oak — 'to start correctly'. The market for oak in the country is very feeble because we do not have enough oak to create a stable market. At the same time veneer quality is being exported to France.

An adjacent area had been cleared to leave 1400 of the best stems per hectare. These were mainly oak and beech. Average pole size was $0.048m^3$. Individual trees appeared to be of poor quality and the stand was yield class 6. Some foresters remarked on the amount of scrub on the ground which would be valued at £10/m^3 standing in other parts of the country. Some doubts were expressed about the quality of the crop and if it was worth retaining. The question as to the genetic quality of beech mast collected in the country was raised and it was generally agreed that an effort should be made to secure good quality hardwood mast.

The next hardwood stand visited was a mixture of oak, beech and ash. It was P36 and had 1000 stems/ha. Average pole size was $0.21m^3$ and the objective was to thin to 450 stems/ha with a rotation age of 150 years. The ash was hurley quality and will gradually be removed. This stand was originally of similar quality to the previous one. This stant will be lightly thinned every 3 years from now on and good quality stems will be high pruned. This is a very expensive management system.

Abbeyleix Sawmills — Joe O'Brien (Manager).

This sawmill is independent of the estate. The mainline has a bandrack headrig. Policy in the mill is to concentrate on a high quality dried and finished product rather than a very efficient conversion. This policy is adopted in the absence of very efficient machinery.

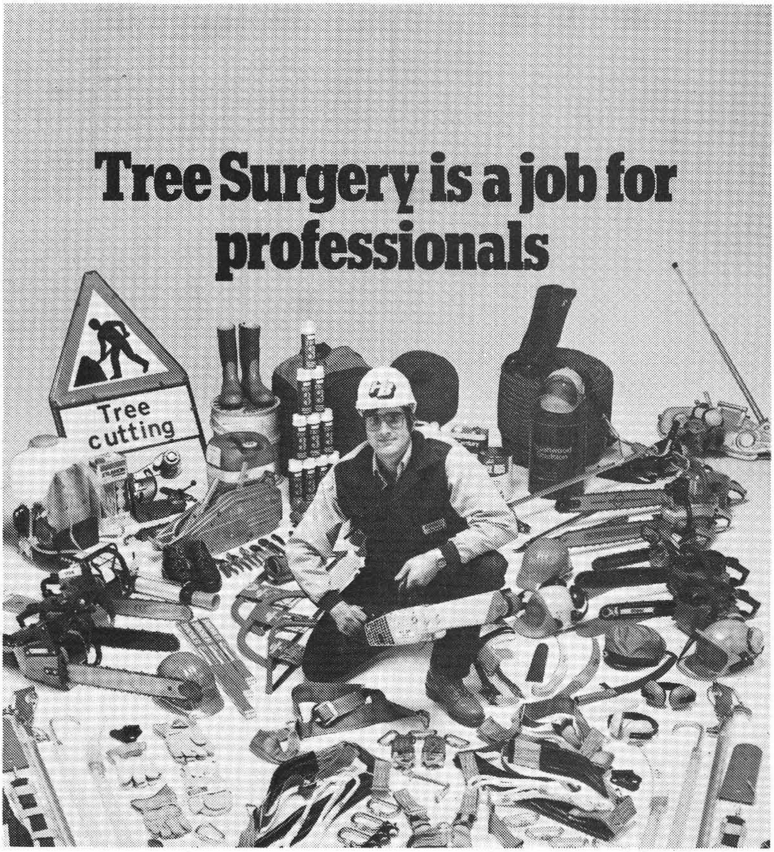
The timber drying kilns are fired by burning sawmill waste such as sawdust. Drying time for home grown timber ranges from 3-4 days for ½" material to 20 days for 3" material. Imported hardwood are also dried under contract to importers. The average cost of drying is about £10-12/m^3. All lumber is dried to 20% moisture content. Slabs in the yard have a moisture content of 55-60% (O.D.W.) and can at present be sold to the E.S.B.

Abbeyleix Estate.

The party led by Mr. Joe O'Brien and Mr. George McCarthy spent a pleasant afternoon on the grounds of the estate. This amble through the estate took in the collection of Japanese maples, Bluebell hill and the pleasant gardens.

List of Participants.

E. Collen, L. Collen, M. Conway, T. Cormican, J. Crowley, M. Cosgrave, Myles Cosgrave, J. Dillon, J. Fennessy, L. Furlong, D. Gallagher, J. Hanley, G. Hipwell, R. Keogh, E. Larkin, P. J. Lyons, D. Mangan, Tony Mannion, B. Morrissey, Ml. McElroy, M. O Neachtain, J. Phillips, K. Quinlan, J. Tottenham, R. Tottenham, H. van der Wel, G. Beirne, T. Boland, I. Booth, P. Breathneach, R. Browne, J. Carmody, J. Cleary, B. Comiskey, T. Considine, K. Cremin, P. Doody, J. Dooley, J. Doyle, P. Drea, P. J. Corbett, M. Duggan, C. Fahy, A. Finnerty, Ml. Fahy, J. Gardiner, G. Harney, G. Hayes, J. Healy, E. Johnston, P. Kelleher, J. Kilbride, J. Maguire, D. McCarthy, P. McAuliffe, Ml. O'Brien, P. J. O'Brien, Ml. O'Connell, V. O'Connor, C. O'Donovan, T. O'Regan, J. O'Riordan, C. O'Shea, J. O'Sullivan, Ml. Ryan, R. Sweetnam.


Tree Surgery is a job for professionals
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