IRISH FORESTRY

JOURNAL OF THE SOCIETY OF IRISH FORESTERS

Volume 46 No. 1, 1989

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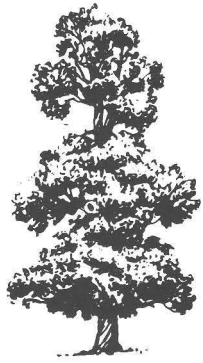

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Volume 46, No. 1, 1989

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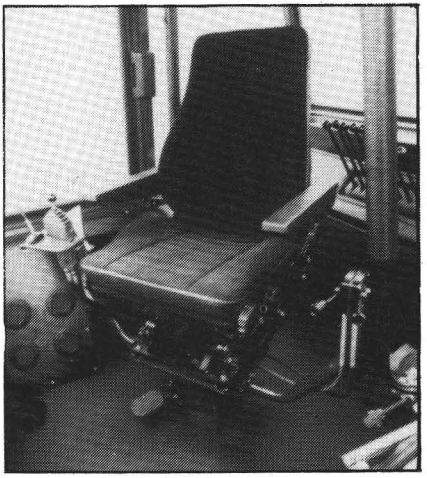

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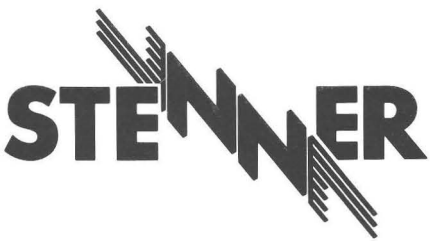

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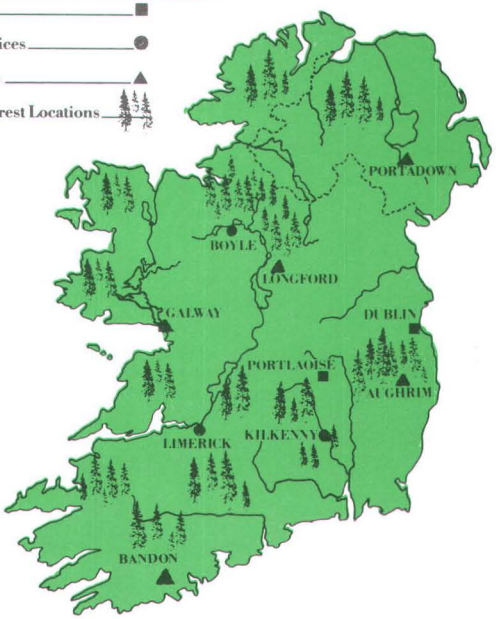

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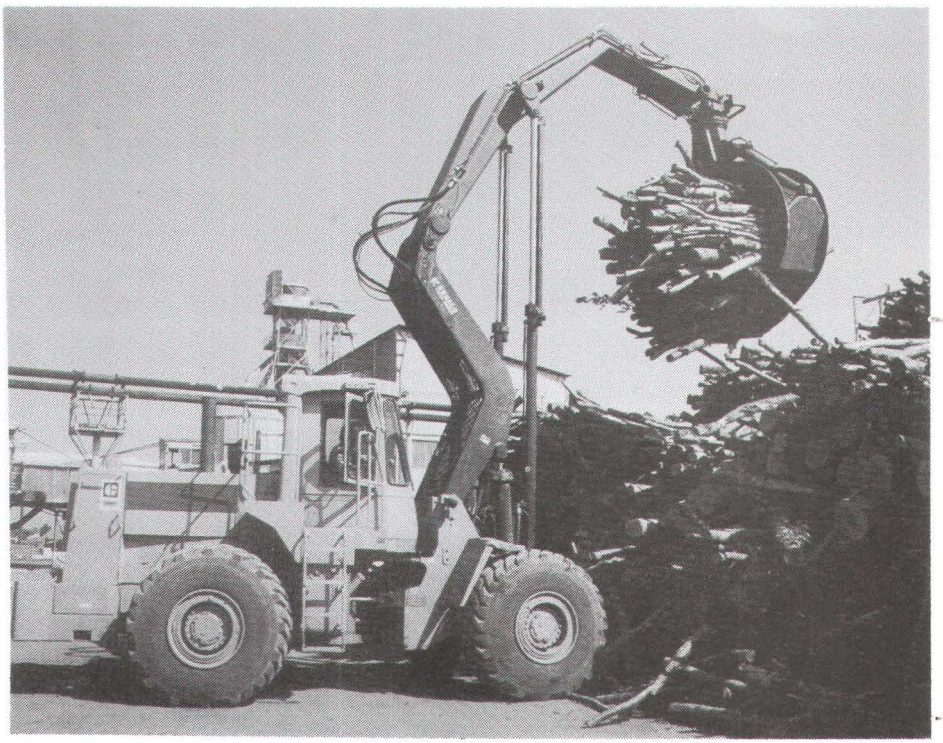

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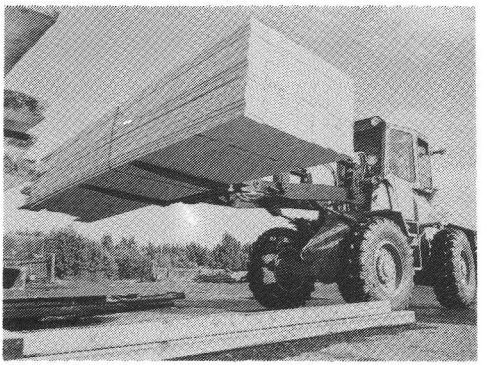

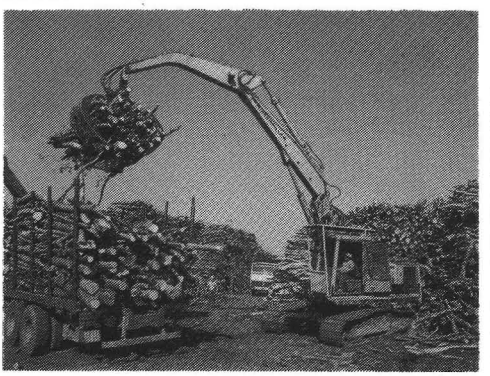

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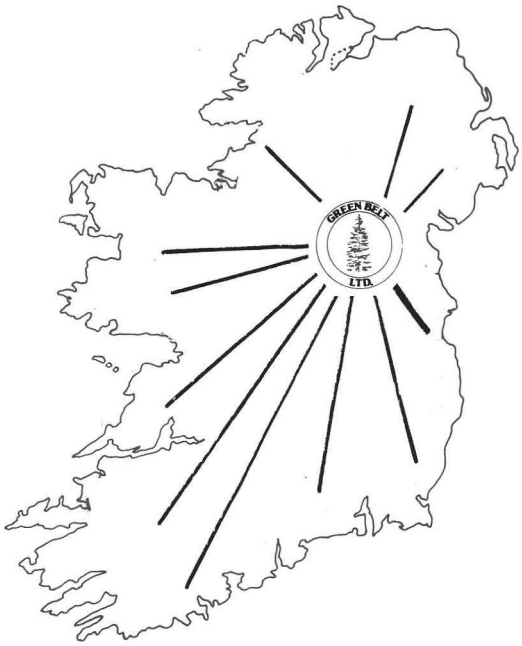

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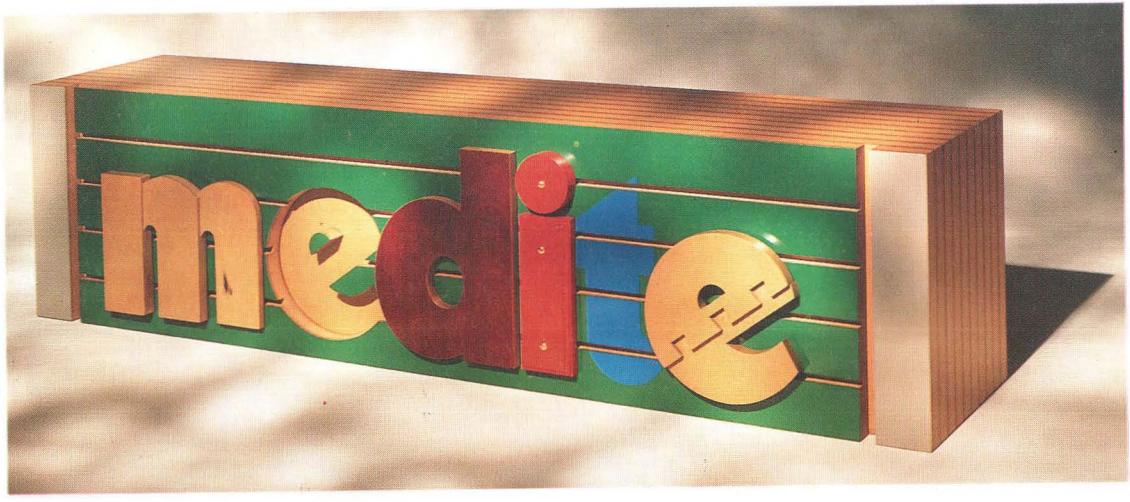

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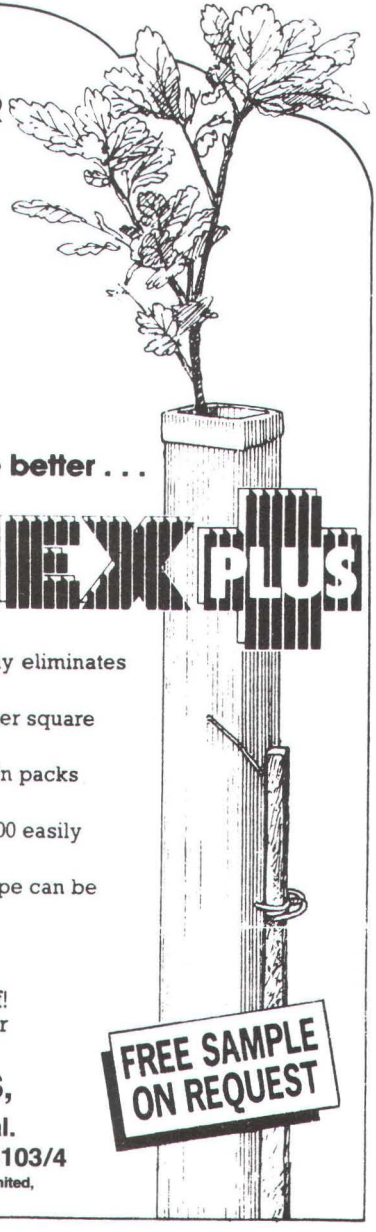

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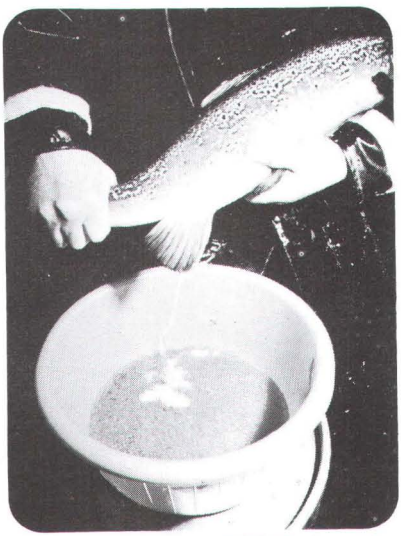

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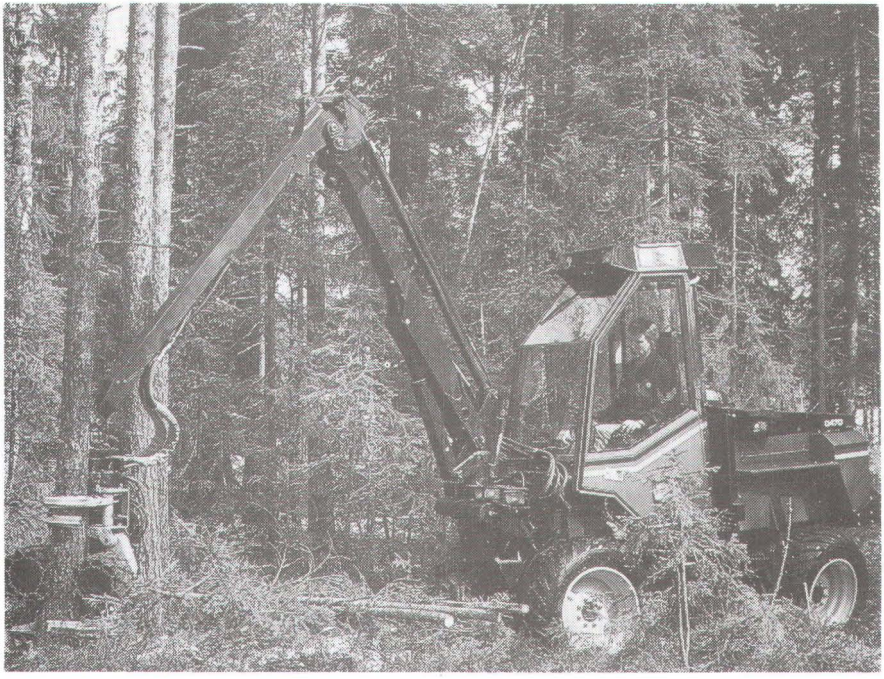

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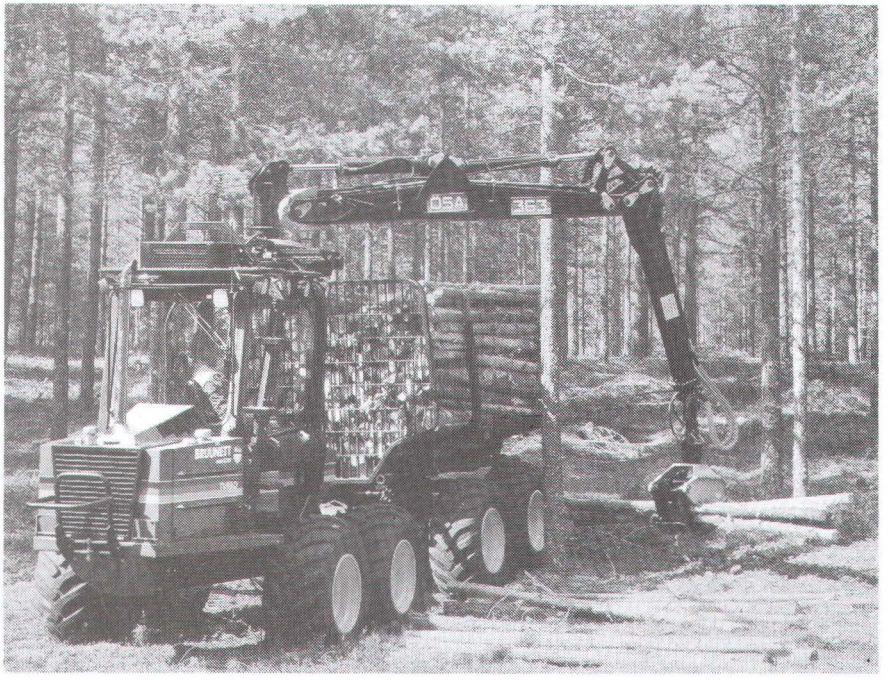

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Foreword

I consider this edition of the journal a very significant one because it coincides with an exciting and historic milestone in Irish Forestry.

On January 1, 1989 Coillte Teoranta was established. This new state-sponsored company faces great challenges but concurrently there are great opportunities out there to be explored and exploited.

I am confident, however, that the staff of the new company will respond in a positive and effective way to these challenges. In this context, they can be assured of my commitment and, that of the Government, to ensure an environment exists whereby a positive and successful approach can be adopted to develop Ireland's forestry potential.

The Society of Irish Foresters, since its foundation in 1942, has played an important part in the history of forestry in Ireland.

Through its meetings and study tours it has been a force in the education and development of the management team which brought the forests to their present productive condition.

The dedication of its members, and of its officers, is a wholesome indicator of the commitment to forestry which has come to be regarded as normal.

In conclusion I wish all of you every success.

Michael Smith, T.D.

The Effect of Cultivation Method on the Growth and Root Anchorage of Sitka Spruce

Eugene Hendrick

Coillte Teoranta, Research Branch, Bray, Co. Wicklow.

Summary

Tree pulling, using a hand winch, showed that 14 to 16 year old Sitka spruce trees, established on surface-water gley soils following mole drainage, had an average maximum turning moment almost double that of trees established on DMB plough ribbons. Root excavations showed that this was due to improved rooting depth and spread in the mole draining treatment. Mole draining gave better diameter growth than ploughing on drumlin slopes; on inter-drumlin flats it resulted in poorer growth.

Introduction

Surface-water gleys are the most productive forest soils in Ireland. In south Co. Leitrim, for example, the mean Yield Class of Sitka spruce is 24 cubic metres ha/year. These soils reach their greatest extent in the drumlin belt of the north midlands. Most of the land below 180 metres elevation in counties Cavan, Leitrim and Monaghan is comprised of drumlins.

In Ireland the great majority of gleys are surface-water gleys. These have high combined silt and clay contents (often exceeding 80%). This results in a predominance of small pores which restrict drainability, as these hold water at high tensions. There is, in addition, an annual surplus of rainfall over evapotranspiration in the drumlin region which leads to high water tables and surface run-off. Ground water gleys occur along valley bottoms, where they are caused by springs and upward seepage of groundwater but these are necessarily limited in extent.

All gleys present problems for agriculture. Tillage is rarely practised due to the heavy nature of the soil and grazing is generally limited to the period May to September owing to soft ground conditions and the danger of poaching. In addition, the steep slopes of many drumlins (often exceeding 12°) makes forage harvesting difficult and expensive. These factors, combined with the small average farm size, have resulted in a movement from the land in the drumlin counties, with holdings often being sold for forestry development.

Large scale forestry development began in this region in the late 1950s. Ploughing was the cultivation method used, although some early private plantations, such as at Drumheirney in Co. Leitrim, were successfully established using hand mounding. From an early stage, however, it was realised that ploughing might lead to extraction difficulties during thinning. It was also observed that when crops were windthrown that the supporting roots were largely confined to the plough ribbon and their spread was severely restricted on the side of the plough furrow.

A research programme was initiated in 1971 to examine a range of site preparation treatments, with the objective of improving root spread and depth and ultimately of making crops more windfirm. This programme was extended to include root excavations and more recently, tree pulling to determine root anchorage, on which this paper reports.

Methods

1. *Field experiments*

A large number of drainage/cultivation trials was established on surface-water gleys between 1971 and 1980. Three of these are described: Ballyfarnon 1/71, Cuilcagh 2/73 and Scotstown 1/74 (planted in 1971, '73 and '74 respectively). All are located within the drumlin region (Figure 1). Six treatments were included in each trial. Two of the treatments were variations in planting position and as these did not result in any appreciable growth differences they are omitted from discussion. Descriptions of the other four treatments are given in Figure 2. Each experiment has three randomised blocks; two of the blocks in each case are located on the drumlin slope, the third on the inter-drumlin flat. This has implications for the performance of some of the treatments which are discussed below. The slopes of the drumlins in question vary from 7° to 12°. In each case Sitka spruce 2+1 transplants were planted on top of the ribbon or into the mole slit at an espacement of 2m×2m.

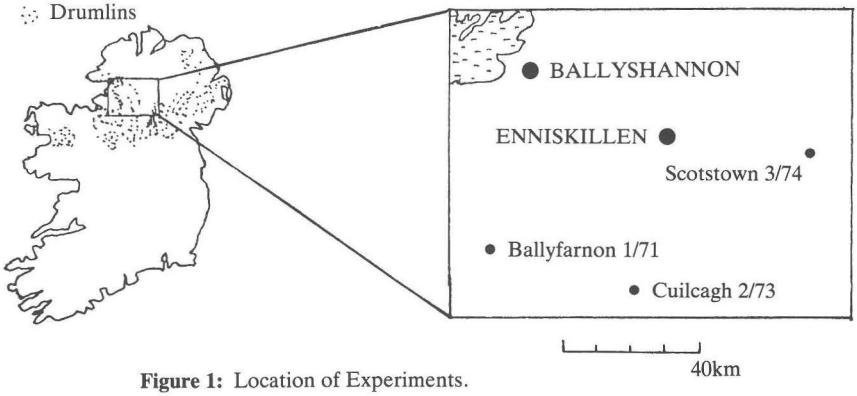

Figure 1: Location of Experiments.

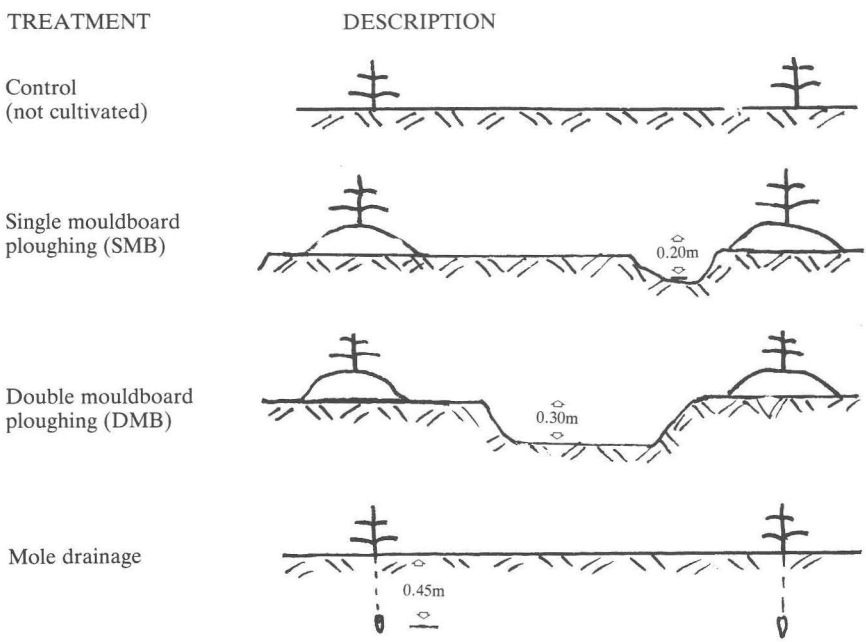

Figure 2: Site Preparation Treatments.

2. *Root excavations*

All of the root excavations were carried out at Ballyfarnon in 1985 following a 1 in 3 line thinning. Two stumps were chosen at random in each block in the DMB and mole treatments. The soil was first removed to a depth of 300-400mm around the main structural roots. These were then cut at 800mm from the centre of the stump which was then winched vertically from the ground using a block and chain tackle mounted on a horizontal beam supported at either end. The root systems were described and photographed.

Table 1: Number of trees pulled by experiment and treatment.

EXPERIMENT	TREATMENT	
	MOLE	DMB
Ballyfarnon 1/71	5	5
Cuilcagh 2/73	9	9
Scotstown 1/74	7	7
Total	21	21

3. *Tree pulling*

Tree pulling was carried out at the three experiments, Ballyfarnon in May 1987 and at Cuilcagh and Scotstown in June 1988 (Table 1). The mean diameter breast height (dbh) of the DMB treatment was first determined in each block. Two trees per block of the mean dbh size were then chosen for pulling in both the DMB and mole draining treatments. Each tree was cut at about 4m above ground level to avoid having its crown caught up in adjoining trees during pulling. A point of attachment for a nylon sling was marked on the tree, usually below the top-most remaining whorl to keep the sling from slipping off the stem. The vertical distance to ground level was measured. The sling was hooked to a wire rope and fed through a hand winch which was attached to an anchor tree, chosen at the same elevation as the object tree and about 20m distant from it. Trees were pulled at right angles to the direction of ploughing and away from the plough furrow. A load cell was placed between the winch and the anchor tree to measure the pulling force (F) on the object tree. The force was recorded at predetermined 10 second intervals using a single channel data logger and printer (Figure 3). Using the distance (D) of the anchor tree to the object tree and the height of attachment (H) of the sling the horizontal pulling force on each stem was derived as:

$$F(h) = F \cos \frac{(H)}{(D)}$$

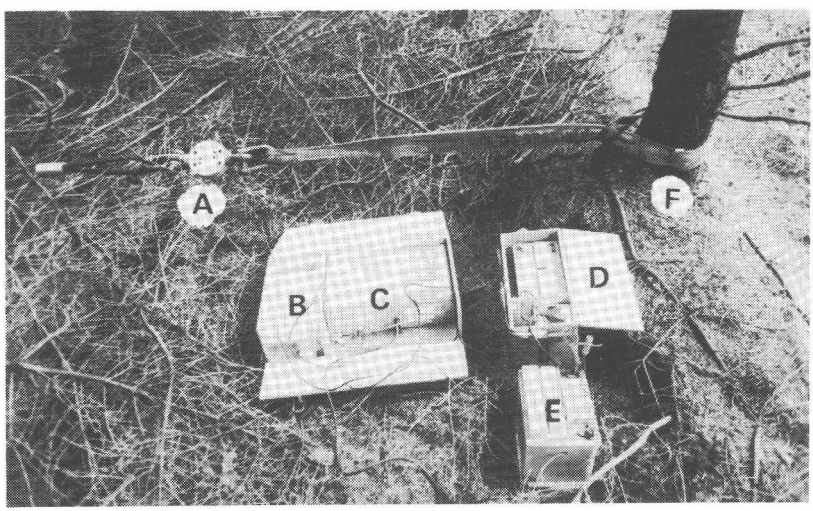

Figure 3: Equipment used to measure pulling force, A: Load Cell, B: Printer, C: Data Logger, D: Battery, E: Back-up Battery, F: Sling attached to anchor tree.

Trees were gradually winched over until either the tree was uprooted or the stem broke. The maximum force recorded during the pulling was then used to calculate the maximum turning moment for each tree.

Results

1. *Growth*

Basal area was assessed in all three experiments at the end of 1987. At Cuilcagh and Scotstown there was little difference between SMB, DMB and mole treatments but all three were significantly (P=0.05) better than the control; at Ballyfarnon the differences were not significant (Table 2).

Table 2: Effect of site preparation treatment on basal area production.

Treatment	SITE			Mean
	Ballyfarnon 1/71	Cuilcagh 2/73 m^2/ha end 1987	Scotstown 1/74	
Control	35.46	13.92	30.33	25.57
SMB	37.57	29.98	48.90	38.82
DMB	38.93	29.11	42.05	36.70
Mole	38.36	31.00	46.52	38.62

Mole draining gave better growth than DMB on the drumlin slopes but poorer growth on the inter-drumlin flats (Table 3).

Table 3: Effect of location on growth differences between moling and ploughing.

SITE	Inter-drumlin flat 1 block	R	Drumlin slope 2 blocks	
Ballyfarnon 1/71	-0.11		0.14	0.05
Cuilcagh 2/73	-0.18		0.34	0.22
Scotstown 1/74	-0.10		0.55	-0.07
Mean	-0.13		0.21	

$$R = \frac{\text{mole draining plot basal area - DMB plot basal area}}{\text{DMB plot basal area}}$$

Student's t (slope v flat)=3.02 (significant at P=0.05 level)

2. *Rooting*

There were consistent visual differences in both root spread and depth. Root spread in the DMB treatment was largely confined to the plough ribbon and the inter furrow flat. In the mole draining treatment roots grew

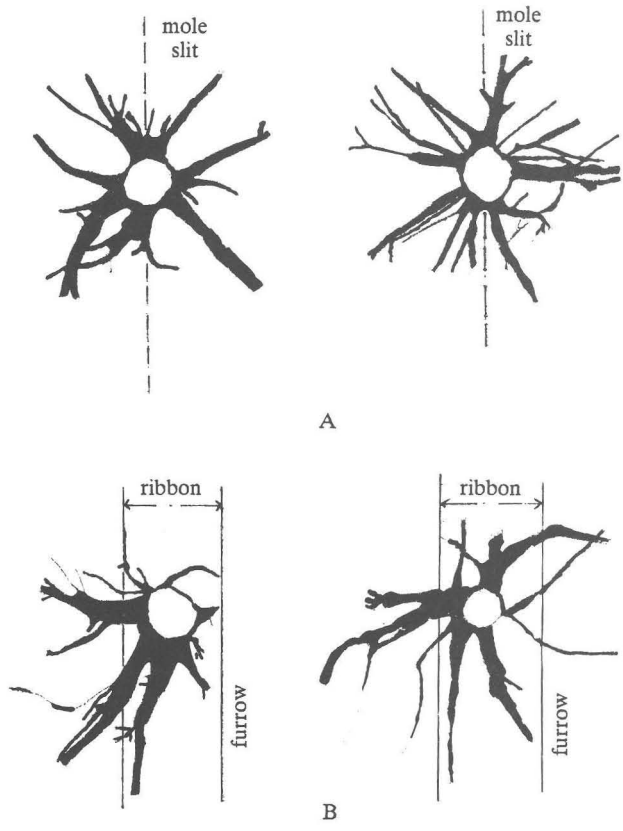

Figure 4: Typical root patterns shown in plan for A – Mole Draining and B – Double Mouldboard Ploughing.

in all directions and the root system therefore had a more symmetrical shape in plan (Figure 4). Roots grew down to the level of the mole and in a 10-15cm wide band along the mole slit. In the DMB treatment roots grew down to the level of the bottom of the furrow and no deeper.

3. *Tree Pulling*

All trees pulled in the DMB treatment at the three sites were successfully uprooted by pulling. At Cuilcagh, however, the stems of four of the eight trees in the mole draining treatment snapped near ground level. This also occurred in one of the mole draining treatment trees at Scotstown (Figure 5). The force on the stems in both the DMB and mole draining treatment increased steadily for about 100 seconds pulling (the strain rate was

about 0.02 to 0.03m s^{-1}). Thereafter the force either remained static or slowly declined in the DMB trees but increased steadily in most of the mole draining trees until uprooting or stem breakage occurred (Figure 6). At all three sites the maximum turning moment in the mole draining was significantly greater than in the double mouldboard treatment (P=0.001) (Table 4).

Table 4: Maximum turning moments of Sitka spruce in DMB and mole draining treatments.

Site	Maximum turning moment (kNm)	
	Mole	DMB
Ballyfarnon 1/71	18.5	10.0
Cuilcagh 2/73	21.9	11.5
Scotstown 1/74	17.1	12.0
Mean	19.5	11.3

Figure 5: Stem snap near ground level in mole draining treatment at Scotstown.

The maximum turning moments obtained are similar to those obtained by Blackburn *et al.* (1988) for Sitka spruce growing on ploughed peaty gley in south Scotland. Using their equation relating dbh to turning moment (maximum turning moment (kNm)=0.0016 dbh^3+2.61) predicted and measured turning moments can be compared for trees in the present study (Table 5).

Table 5: Measured and predicted turning moments for Sitka spruce

Site	Treatment	DBH cm	Maximum Turning Moment kNm	
			Measured	Predicted*
Ballyfarnon 1/71	DMB	16.0	10.0	9.2
	Mole	16.0	18.5	9.2
Cuilcagh 2/73	DMB	14.5	11.5	7.5
	Mole	14.5	21.9	7.5
Scotstown 1/74	DMB	16.4	12.0	8.0
	Mole	16.4	17.1	8.0

* Using Blackburn *et al.* equation.

The Blackburn *et al.* equation was statistically valid for the DMB treatment at Ballyfarnon and Scotstown. It underestimated the maximum turning moments, however, for the DMB treatment at Cuilcagh and for the mole draining treatment at all sites. Trees in the mole draining treatment had a different relationship between maximum turning moment and dbh. There was an almost linear increase in force with increasing strain until uprooting or stem breakage occurred (Figure 6).

Discussion and Conclusions

Mole draining resulted in deeper and more symmetrical rooting than DMB ploughing and this was reflected in the doubling of maximum turning moments measured. Trees in the DMB treatment had their maximum turning moment accurately predicted by the Blackburn *et al.* equation, except for those at Cuilcagh. Turning moments estimated by static pulling tests are useful for comparison between treatments but do not, however, simulate the effect of windloading. Windloading is a dynamic process which results in high instantaneous bending moments. Milne (personal communication, 1989) estimates that an $18ms^{-1}$ (65km/hour) wind imparts a turning moment of up to 30kNm at the bottom of a 15m tall Sitka spruce tree of 15cm dbh.

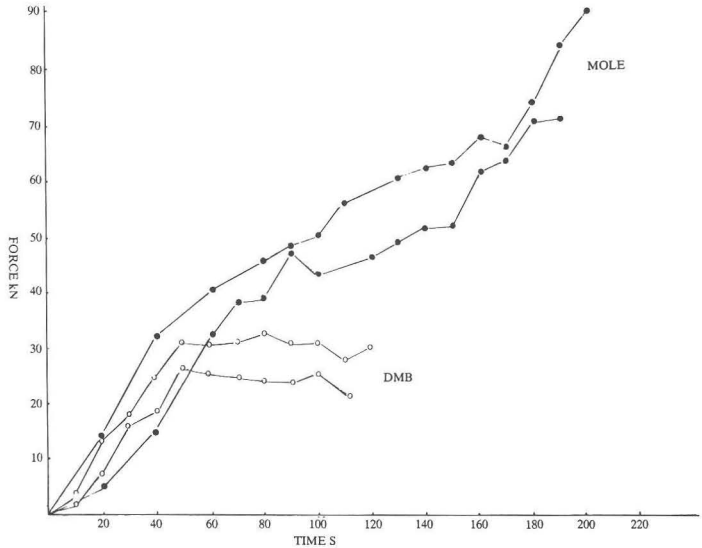

Figure 6: Plot of Force against Time for two DMB and two mole draining trees at Cuilcagh 2/73. All trees 14.5cm dbh. Both trees in the mole draining treatment snapped near ground level.

The constant loading and unloading of soil from winter gales can be simulated under laboratory conditions. In a study of soil from Ballyfarnon 1/71, Rodgers *et al.* (1988) found that cyclic loading, such as is encountered under root plates, reduced soil shear strength by half. Observations lend support to this finding as windthrown trees on gleys frequently have little root breakage and roots appear to have been torn from the soil and are often damaged only at their extremities, probably as a result of rocking. The measurement of forces imparted to soil under root plates is the objective of a study under way at present.

Recommended Practice

Mole draining works best on fine textured gley soils where the clay content exceeds 45% and the sand content is less than 20% (Nicholson, 1972). At Ballyfarnon, however, the soil failed to meet both criteria but the moles are still discharging water 18 years after installation. Observations suggest that soils with clay contents from 30% to 50% are suitable for moling. The minimum gradient for moling is 4%, at lower values small depressions and large stones lead to ponding of water. The optimum depth is 400 to 450mm. Collector drains to collect the water running in the moles are essential and should be 100 to 150mm deeper than the moles.

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Pruning Conifers in Ireland

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Summary

The case for pruning of conifers in Ireland is discussed and the financial implications considered. Pruning Tables produced for the major conifer species in Irish forests are described.

Introduction

The pruning of forest trees is an established practice in many countries to improve the quality of timber. In Ireland, pruning was carried out extensively in the 1950s and 60s, but has almost ceased in recent times, due mainly to its high cost with no guarantee that any cash benefit will accrue.

Recently, the view has been expressed by members of the timber trade, the Institute of Industrial Research and Standards (now Eolas) and members of the Forest Service (FS) that the quality of timber from Irish forests could be greatly enhanced by the re-introduction of pruning.

This paper summarises the findings of a Forest Service working party on pruning whose report was produced internally in 1985.

Historical Perspective

Pruning lapsed as a silvicultural practice in State forests in the early 1970s as a result of an increased awareness of the need for cost control. Prior to this all stems in a stand were low pruned or brashed (branches removed from the bottom 2m of stem), which resulted in a high cost being charged against the rotation at an early age, thus requiring a significant increase in price to justify the cost of the operation.

The timing of pruning was frequently late, resulting in the removal of dead branches, which often resulted in a cosmetic operation rather than an improvement in timber quality. Even where pruning was carried out early, the lack of a thorough recording system meant that the amount of clear timber to be expected in any stand was not known. In these circumstances, often no substantial differential in price between pruned and unpruned stands was obtained.

Reasons for Pruning

The presence of knots in sawn wood is a recognised strength-reducing factor in timber used for structural (load bearing) purposes. Currently, about 76% of sawlog dimension timber produced in Ireland has a structural end-use. In grading rules for joinery timber, knots are regarded as undesirable for a variety of reasons. However, in some instances, such as panelling, the presence of some knots may be beneficial.

In conifers, the central core of a log is composed of juvenile wood which has many undesirable properties. There is evidence that the removal of live branches (green pruning) reduces the size of this core. A pruned log may be regarded as two cylinders; the inner knotty core and an outer shell of clearwood. The smaller the inner cylinder and the larger the outer one the more clearwood available. Using the normal technique of sawing parallel to the axis of the tree, most of the conversion loss occurs in the removal of slabs from the outer shell of clearwood. Thus the wood produced by the tree in the years after pruning will be removed as conversion waste, unless the outer cylinder is reasonably thick. These points are illustrated in Fig. 1.

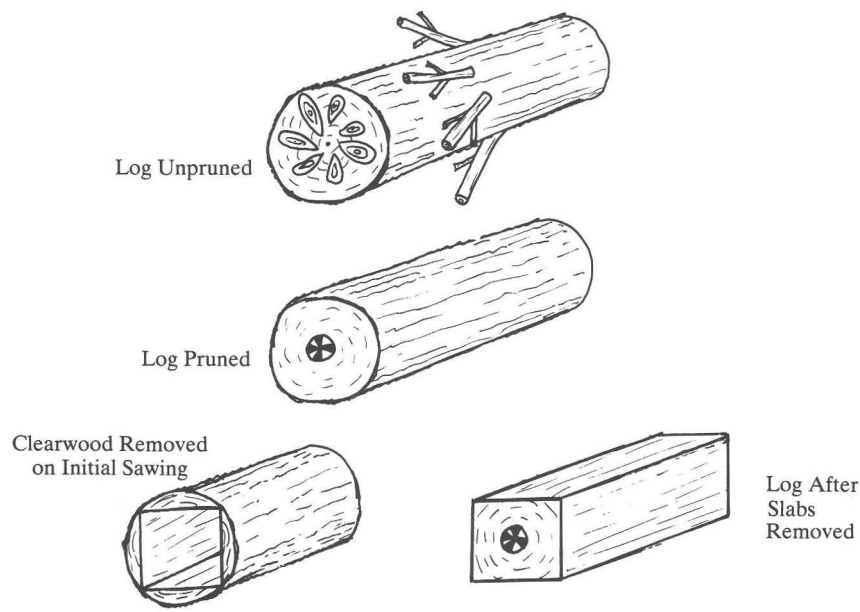

Figure 1: Effects of pruning on knottiness in round and sawn timber.

The greater the ratio of diameter at felling to the knotty core the more clearwood available on sawing. As larger diameter logs produce less percentage conversion waste, for any given clearwood to knotty core ratio,

the bigger the diameter at sawing the greater the amount of clear wood. It can be seen, therefore, that in modern plantation forests where diameter at clearfelling tends to be smaller than in old growth stands, it is essential to prune early and keep the core narrow if worthwhile quantities of clearwood are to be produced.

Pruning for Structural Timber

Increasingly, timber used for structural purposes must be graded. There are numerous grading systems and most developed countries have their own, geared to meet the needs of their particular circumstances. In Ireland the system applied to home grown softwoods when grading is required is Irish Standard Recommendation, SR11 (Anon. 1988). The use of timber graded to this recommendation is overseen by the Timber Grading Bureau of Ireland. Grading is divided between visual and machine stress grading. Two of the major features of Irish conifers which can be influenced by silviculture and in turn influence grade are: knottiness, measured in terms of knot area ratio (KAR) and rate of growth (ROG) i.e. ring width. In machine grading the separate influences of these factors are not easy to isolate. This is because a force is applied to a plank, the response is measured and a grade is assigned. The response is determined by all the properties of the plank which affect its strength. In visual grading, however, all the strength-affecting elements are assessed separately according to a set of rules andd thus the effect of knots on grade can be directly determined.

Using visual grading, the importance of pruning is clearly illustrated by a series of grading studies undertaken by the Forest Service as shown in Table 1.

Table 1: Visual Stress Grading Results. (Graded on KAR only)

Material	Treatment	% planks per grade		
		SS	GS	Reject
Sitka spruce (Fitzsimons 1980)	Pruned	28	57	15
	Unpruned	3	47	50
Lodgepole pine (Coastal) (Phillips 1978)	Pruned	90	0	10
	Unpruned	86	5	9

SS=special structural. GS=general structural (Anon. 1973).

Pruning for Joinery Timber

Joinery grades are all visual and excessive knottiness is the most common reason for rejection. This is of particular importance in Ireland in relation to lodgepole pine. There are 60,000 ha of coastal provenances from Washington and Oregon (LPC) planted in this country, most of them at initial densities of 2,500 stems/ha. As is shown in Table 1 knots are potentially a serious problem. The difficulties posed by poor stem form have been considered elsewhere (Fitzsimons 1982); they are the subject of current research and will not be discussed here. Tests carried out in the 1960s on home-grown LPC have shown it to be an excellent joinery timber, similar in many respects to Scots pine (Dunleavy et. al. 1969).

Given the wide spacing of most plantings since the early 1960s, pruning appears to offer the chance of converting much of this material from palletwood to joinery timber.

When is Pruning Justified?

After allowing for the occlusion of the branch stubs the layers of timber added annually to the pruned portion of the tree will be clearwood. In a straight log, once formation of the clearwood starts, some improvement in sawn wood quality can be expected. As can be seen from Fig. 1, however, if the only clear timber left after slabbing is in the corner of the squared-off log, the improvement would be very slight indeed, and not likely to fetch a premium to repay pruning costs.

In commercial forestry practice, the amount of clearwood required is that which will obtain an increase in price sufficient to repay the compounded costs of the pruning. A variety of factors will affect the calculation of what size the shell of clearwood must be to enable such a premium to be paid. These factors are summarised under the two interrelated headings of utilisation and financial considerations.

(i) *Utilisation*

Before embarking on a pruning programme the objectives, in terms of the kind of produce, must be clearly defined. Six species are considered in this context. They are:

Sitka spruce
Norway spruce
Coastal lodgepole pine
Douglas fir
Scots pine
Japanese/hybrid larch

Sitka spruce

Because of the fast growth rate of this species there were fears that Sitka spruce, in certain circumstances, would not produce structural timber.

However, the results of recent studies in Ireland indicate that growth rate may not be as serious a degrading factor as was previously thought (Picardo 1986). Some of these studies have indicated that knottiness does have a significant effect on reducing strength, even under the silvicultural regimes employed i the past. The effect of knots in causing degrade is greatly increased when spacings wider than 2m were examined.

Sitka spruce can be used for structural purposes. It dries quickly but, because of rapid growth rate, very mild schedules have to be used when kiln drying to avoid distortion. While spruce is not as strong as pines, larches or Douglas fir, it has greater strength/weight ratio, this making it ideal for structural timber providing its KAR is acceptable.

Norway spruce

Norway spruce is a general purpose timber and in the past its small knots have not been considered a severe drawback to quality. Under modern silvicultural practices it is doubtful if this would apply to Irish grown Norway spruce. It has similar properties to Sitka spruce, is slightly less strong, but it may be used in low grade joinery. No grading studies have been carried out in this country in order to establish the effect of knottiness on timber quality. However, it is likely that results similar to those found for Sitka spruce would apply.

Lodgepole pine

As a structural timber, on achieving the grade, lodgepole pine is considerably stronger than spruce. It is particularly suitable for joinery purposes, and with appropriate silvicultural practice, is considered superior to Scots pine (Evertsen 1987). It finishes better, has much less obvious heartwood, and has a lesser difference between the properties of early and late wood, than Scots pine.

Grading studies have indicated serious degrade due to knots. This is the species where pruning is most essential, if the timber is to have any chance of becoming a high-value product. Due to its short rotation, compounded pruning costs are moderate. The potential benefit is the movement of the end-product from palletwood to first class joinery timber.

Scots pine

Pruning will benefit this species for reasons similar to those given for lodgepole pine (coastal). Its established place as a high-class joinery timber makes this pine suitable for pruning, specifically to produce clear timber. However, slow growth of Scots pine relative to many other species, will increase the real cost of pruning.

In many countries it is the first choice for transmission poles. Pruning for this purpose may not always be necessary, though in Ireland Scots

pine is not rarely used for transmission poles due to previous breakages at knot clusters.

Douglas fir

Douglas fir is an excellent structural timber, and can also be used for joinery, providing knots are eliminated. Consignments of home grown Douglas fir tested by Eolas have been severely degraded for structural uses due to knots, such material was also unsuitable for joinery. Larch and Douglas fir have the greatest strengths of the species considered here.

In summary, the production of structural timber of the highest grade will be the aim with Sitka spruce, while with pines it will be the production of joinery timber. The other species will be pruned with a view to supplying either market. For both types of product the pruning strategy will be the same – the removal of branches as early as possible without reducing increment and the production of the maximum amount of clearwood.

There are products where a different pruning schedule might be emphasised, for example, certain types of joinery (as previously mentioned) or transmission poles. It can be safely assumed that sufficient timber with live knots will always be available for the former so pruning for such a limited outlet will not be considered here. In the case of transmission poles, in some countries a late pruning is carried out to provide a knot-free skin. In Ireland such measures are not required for the transmission pole market, however if an export trade developed they might be considered. For the purposes of this discussion it can be assumed that nearly all pruning will have as its aim the production of maximum amounts of knot-free timber for joinery and structural end-uses. Thus the pruning strategy in both cases will be similar, except that for joinery, shorter log lengths are acceptable.

(ii) *Financial Considerations*

Based on growth and yield research for the six species, estimates can be made of tree diameters at clearfelling for numerous combinations of growth rates and silvicultural practices. Similarly, pruning research indicates the smallest diameters at which branches can be removed without significantly affecting the growth of the pruned trees (Gallagher 1875). Combining the two, the time taken to produce varying amounts of clearwood can be calculated. Before deciding to prune, however, it is necessary to decide whether any given proportion of knot-free wood will pay for the pruning required for its production.

At present, most timber in this country is sold standing or in lots segregated only by size. There is no reason, however, why pruned stands could not be segregated into pruned logs and unpruned logs. Whether segregated or not, the price obtained for the stand must cover the cost of pruning, compounded at a selected interest rate, at time of felling.

While the cost of pruning can be directly measured there is surprisingly little definite information on the exact relationship between improvement in quality (and therefore value) and the amount of clearwood. Both the relationship and the amount of information vary with species. To further complicate matters the techniques and efficiency of different sawmills will have a bearing on the relationship and the results will be different depending on whether joinery or structural timber is being produced.

To illustrate this, a cubic metre of LPC upgraded by pruning from palletwood to joinery timber would increase it's value by a greater factor than the same volume of Sitka spruce in which the outturn of top grade boards rises from 60% to 80%. There is, however, no information to quantify this.

The approach taken in this investigation has been to (a) examine the literature available to decide on the amount of clearwood required to attract a premium and (b) based on discussions with wood processors and experts from Eolas estimate the premium likely to be achieved by the various species considered, given that amount of clearwood.

How much Clearwood is Required?

There is no definitive answer to this question. From the literature available, it appears that 10cm of clearwood is the minimum necessary to attract a premium (Henman 1963, Fenton 1976, Walderidsson 1981). Any less than this is unlikely to produce a significant improvement in the sawn timber, though as mentioned previously, the value of any given amount of clearwood will vary with species, end-use and sawing technique. Size of tree will also have a bearing; the larger the tree the greater the volume of clearwood produced.

Some foresters are convinced that the removal of branches a few years before felling, attracts higher prices due to the improved appearance of the trees; however, this cannot be verified.

Given the differences of opinion in the literature and also among sawmillers and lack of conclusive information, it was decided that pruning should be carried out in a manner which would produce trees at clearfelling with a diameter at breast height (DBH) of 2.5 times the diameter at time of pruning. All sources consulted indicated that this would produce sufficient clearwood to attract a premium for the six species as they are commonly managed in Ireland. In terms of pruning height, it was considered that a clear butt section of 5m should be produced for all species except LPC, where a 3m section was considered useful and attainable. Two factors restricted the recommended pruning to the butt section; the greatly increased costs involved and reduced clearwood produced with higher pruning. To achieve a 5m pruned section, pruning to 6m is recommended and to achieve a 3m section, pruning to 4m. This is to allow for loss of length during harvesting.

Accepting the 2.5:1 ratio as the target for clearwood production a series of tables were constructed to indicate how this might be achieved.

The financial aspects were then examined. Rather than attempt to predict the premiums attainable for all the species concerned the approach taken was to indicate the percentage increase in price required (based on current prices for unpruned material) to repay the compounded costs of pruning at time of felling.

The Pruning Tables

The tables were constructed in order to estimate the ages at which the pruning operations would have to be carried out in order to obtain the 2.5:1 clearwood to knotty core ratio. They are also used in the economic analysis. For each yield class and species, a range of five ages of first-stage pruning is given and the ratio of the DBH of the 500 largest trees per hectare at pruning to the mean DBH at clearfelling is given. This ratio is used as an estimate of the clearwood to knotty core relationship of the final crop trees. All tables assume 2,500 stems/hectare initial stocking, and that no thinning will be carried out prior to pruning for any of the five first-stage ages given. They are based on Forestry Commission, UK yield models (Edwards & Christie 1981) with the exception of the LPC table which is based on Irish data (Anon. 1976). The age of second stage is calculated mainly from Forestry Commission information. It is the estimated age at which the full 6m can be pruned without removing more than 40% of the live crown and assumes normal thinning practice, except that some allowance is made, based on observations in early thinned stands, of the likely effect of early thinning on crown development.

The tables produced are based on a maximum of two 'lifts', or pruning operations. Further lifts were not considered as being logistically or financially practical. The aim is to reach the target height as early as possible without removing more than 40% of the live crown in any operation. A series of pruning experiments conducted by the Forest Service Research Branch indicates that this is the maximum that can be pruned without seriously reducing tree growth in some species (Gallagher 1975).

The timing of the second lift allows for the fact that the initial pruning artifically reduces the live crown. A further 40% of the crown obviously cannot be removed a year after the first lift.

Tables 2 and 3 are examples produced for Scots pine, similar tables are available for the other 5 species. They cover only the range of yield classes for which a ratio of at least 2:1, final diameter to knotty core (DBH:KC) ratio can be achieved by the age of maximum mean annual increment (MMAI).

In the tables 'Normal' first thinning age refers to Forestry Commission recommended age.

The 'Reqd. Rotation' indicates the age to which the crop would need to be grown to give the 2.5:1 ratio, using conventional silvicultural practices.

Table 2: Example of Pruning Table including crop statistics.

SCOTS PINE

First Lift Before or at Thinning (3m)				Second Lift Post Thinning	Clearfell				Ratio	Reqd. Rotation (Yrs)	'Normal' 1st Thinning Age
YC	Age	Mean DBH	Top DBH	Max. Age	Age	Mean DBH	No. Stems	Total Vol(m^3)			
14	17	12	16	25	66	49	230	475	3.1	53	21
	18	13	17						2.9		
	19	13	17						2.9		
	20	14	18						2.7		
	21	14	18						2.7		
12	20	12	16	29	69	46	260	429	2.9	59	23
	21	12	16						2.9		
	22	13	17						2.7		
	23	13	17						2.7		
	24	14	18						2.6		
10	23	12	16	33	73	41	310	388	2.6	70	25
	24	12	16						2.6		
	25	13	17						2.4		
	26	13	17						2.4		
	27	14	18						2.3		
8	28	12	16	39	77	35	380	336	2.2	90	29
	29	12	16						2.2		
	30	13	17						2.1		
	31	13	17						2.1		
	32	13	17						2.1		

Table 3: Example of Pruning Table for field use (with footnotes)

Applied to Unthinned Stands or Stands at Time of First Thinning

Species	YC	Earliest Age of Pruning	Max. Height of Pruning at this Age	Latest Age of Pruning	Second Lift Age
Scots pine	14	17	3m	23	25
	12	20	3m	25	29
	10	23	3m	24	33
Norway spruce	22	17	4m	21	21
	20	18	4m	23	23
	18	19	4m	24	24
	16	20	4m	25	26
	14	22	4m	26	28
	12	24	4m	27	31

1. 400 stems per hectare should be pruned.
2. No yield classes lower than given in these tables should be considered.
3. There is flexibility as indicated in time of first lift. However, second lift to 6m should never deviate by more than one year either side of the age indicated in the tables.
4. If even one growing season elapses between thinning and pruning these tables will be invalid and DBH assessments to establish ratios must be taken.
5. If stand is understocked, or if initial spacing is outside the range 1.9m-2.1m (2,800-2,400 stems/ha) these tables will be invalid and DBH assessments to establish ratios must again be taken.

Financial Return

Tables 4 and 5 show, by species and yield class, the premiums required to repay, at an interest rate of 4%, the compounded costs of pruning as recommended in the Pruning Tables. The base price on which the premium is calculated is the average price for sales from State forests over a ten year period; the costs are based on Forest Service costings data. Figures are given only where a 2.5:1 ratio of felling DBH:knotty core can be achieved by MMAI using 'normal' silvicultural management.

Pruning in Practice

In situations of normal Irish stand management, that is, 2,500 stems/ha initial stocking and thinning to marginal intensity thereafter, the Pruning Tables will indicate pruning times and heights. Some other factors to consider are:

(i) Selection of Stands

The stands to be pruned will be primarily those on good sites. They must

be capable of producing trees of sufficient diameter and thus clearwood in a short enough time to repay pruning costs. The sites must be stable to allow the pruned trees to reach the target dimensions. This is a very important consideration and will exclude many Sitka spruce and LPC stands which might otherwise be suitable. Stands where access problems are likely to preclude the necessary thinning operations should not be pruned and isolated stands in areas where the bulk of the forest is not going to be pruned should be carefully considered before a decision is made.

Table 4: Premium Required/m^3 at MMAI after Pruning as Recommended in Pruning Tables

Expressed as a Percent of Base Timber Price*

No. Stems Pruned 600

	YIELD CLASS								
Species	24	22	20	18	16	14	12	10	8
Scots pine						16	18	20	
Norway spruce		10	11	12	14	15	17		
Larch						12			
Sitka spruce	7	8	8	9	10				
Douglas fir	8	9	10	11	12				
Lodgepole pine (coastal)				6	7	7			

Assumptions:

All species 4m first lift at earliest age in tables.
Second lift 2m at recommended age.
*Ten year average for State Forest sales, unpruned.

Table 5: Premium Required/m^3 at MMAI after Pruning as Recommended in Pruning Tables

Expressed as a Percent of Base Timber Price*

No. Stems Pruned 400

Species	YIELD CLASS								
	24	22	20	18	16	14	12	10	8
Scots pine						11	12	14	
Norway spruce		7	7	8	9	10	11		
Larch						8			
Sitka spruce	5	5	6	6	7				
Douglas fir	6	6	6	7	8				
Lodgepole pine (coastal)				4	5	5			

Assumptions:
All species 4m first lift at earliest age in tables.
Second lift 2m at recommended age.
*Ten year average for State Forest sales, unpruned.

Where many stands are suitable but resources for pruning are scarce, priority should be given to species in the following order:

1. LPC and Scots pine.
2. Larch and Douglas fir.
3. Norway spruce.
4. Sitka spruce.

This ranking is based on the estimated improvement in value attainable. It is rather tentative and may be subject to change in the light of further information. For example, widely spaced Sitka spruce (2.2m or greater) should

be given priority over larch and Douglas fir as there are indications that, if unpruned, it may produce low yields of high grade structural timber.

(ii) *Selection of Trees*

(a) Number of Trees

This should not exceed the number expected to reach the diameter required, except to provide a small reserve against accidental loss. As thinning cycles and intensities will always vary in practice it is not possible to recommend precise numbers applicable to all species and conditions. For this reason a figure of 400 stems/ha is regarded as a reasonable overall figure for all species and yield classes to allow for attrition of pruned stems, where the rotation is age of MMAI. The single exception is LPC where 600 stems/ha should be pruned. This is because the number of trees at clearfelling is greater than with other species due to the shorter rotations applied for LPC in Ireland.

(b) Type of Tree

These must be the largest and most vigorous of the dominants in the stand, unless they are unsuitable. Reasons for rejection include crokedness, forking, leaning, heavy swelling at whorls and branch bases, severe spiral grain, damage or signs of disease (Henman 1963). Coarse branching is not a good reason for rejecting a tree. Any dominants not pruned must be removed in early thinnings least they interfere with the growth of the pruned trees. It is vital to remember that there is no point in pruning a tree which will subsequently be suppressed.

(iii) *Season of the Year*

There is no clear evidence of disease or insect damage in this country from pruning in any season.

(iv) *Thinning of Pruned Stands*

Thinning should be to marginal intensity, favouring the pruned stems and removing in particular competing unpruned dominants or 'wolves'.

(v) *Pruning not in accordance with the Pruning Tables*

Many stnds will not conform to the management systems implied in the Pruning Tables. In most situations where future management can be controlled, yield models are available to estimate tree size in the future. Thus the age at which the 2.5:1 ratio will be achieved can be predicted with reasonable assurance, even if diameter at pruning exceeds the Pruning Table values. However, it should be remembered that if greater diameter is required this may involve greater terminal heights and the question of stand stability must not be overlooked. The ratio itself is only a guide. However, if pruning is done outside the strictures of the Tables the figures for premiums required to recoup the investment presented in Tables 4 and 5 may not apply.

(vi) *Records*

Pruning operations should be recorded in such a way as to allow the purchaser to have an accurate assessment of the amount of clear timber in the stand at felling.

The earlier the pruning the more clearwood will be available and the greater the value of the record. Pruning in state forests in Ireland lapsed in large measure due to the fact that timber buyers could not accurately gauge the amount of clearwood in pruned stands which had frequently received late or cosmetic pruning. Thus premiums for pruned lots were small, in turn leading the grower to conclude that pruning did not pay.

The working party considered that accurate recording of pruning details is vital to maximise the return from pruning.

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Variation in Timber Strength of Fast Grown Unthinned Sitka Spruce in Northern Ireland

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Summary

Timber from six unthinned stands of Sitka spruce (*Picea sitchensis* (Bong.) Carr.), of general yield classes ranging from 20 to 24 m^3/ha/year, and established at spacings of 1·5-2·0 metres, was machine stress graded to determine the amount of timber sawn to structural sizes that attained BS 5268 Strength Classes (SC) 3 and 4. The stands were derived from seed from at least two North American sources. Although there were some differences between stands related to provenance, none was statistically significant. Within the range of conditions tested, yields of SC4 structural timber obtained varied between 24% and 57% of battens tested, the differences being primarily related to local yield class. Yields obtained of SC3 timber ranged from 36% to 69% of battens tested, and between 3% and 9% of battens did not meet the machine grading requirements of SC3 or SC4.

Introduction

This study was initiated in order to supplement results obtained from tests on timber from a Sitka spruce spacing experiment at Loughermore, Co. Londonderry, conducted during 1984 by the Building Research Establishment and the Forestry Commission (Hands, pers. comm). The tests showed that timber from all spacings sampled was weak in comparsion with that tested from spacing experiments in Britain. Previous tests on timber grown in Northern Ireland had shown that it was of comparable strength to that specified in BS 5268 for British grown Sitka spruce (Taylor, 1982).

The stand at Loughermore, planted in 1956, was of higher than average growth rate (GYC 22), whereas timber previously tested had come from older, slower growing stands that had been thinned. Records indicate that the stand at Loughermore originated from seed purchased in 1953 from a merchant based on Vancouver Island.

The aims of this study were to determine whether the results obtained from Loughermore are atypical, and relate to peculiarities of site and provenance, or whether they are representative of all Sitka spruce timber derived from high yield class unthinned plantations. It should be acknowledged that

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Table 1: Sample Plot Measurments

Site	Top Height (m)	General Yield Class (m^3/ha/yr)	Basal Area (m^2ha)	Standing Volume to tdob (m^3/ha) 7cm	14cm	Stocking (Stems/ha) Initial	Current	Top Height Form Factor	Mean Volume (m^3) Plot	TST	Local Yield Class (m^3/ha/yr)
Ballintempo	18·6	20	58·6	502	301	4565	2775	0·46	0·18	0·29	24
Springwell	18·8	22	51·2	425	262	3019	2475	0·44	0·17	0·31	22
Tully (A)	21·0	24	57·1	487	331	3019	2225	0·41	0·22	0·37	24
Washington/ Oregon Mean	19·5	22	55·6	477	320	3534	2492	0·44	0·19	0·32	23
Tully (B)	17·3	20	56·2	369	237	3673	2525	0·38	0·15	0·24	18
Conagher	21·3	24	75·7	618	438	3858	2925	0·38	0·21	0·35	26
Loughermore	19·1	22	79·1	657	556	2403	2041	0·43	0·32	0·37	28
Vancover Island Mean	19·2	22	70·3	540	398	3311	2497	0·40	0·22	0·32	24
Overall Mean	19·3	22	63·0	511	346	3423	2494	0·42	0·20	0·32	24

the majority of Sitka spruce plantations in Northern Ireland are not thinned owing to risk of windthrow (Phillips, 1980).

This paper presents results obtained from testing of timber from Loughermore forest and five other stands, two of which, at Conagher and Tully forests, were grown from the same seed lot as at Loughermore, the remaining three, at Ballintempo, Springwell and Tully forests, being grown from seed obtained from an Oregon based merchant. The implications of the results for silviculture and management of Sitka spruce on fertile sites susceptible to windthrow are discussed briefly.

The work was carried out by the Department of Building, University of Ulster. The timber was processed and tested at Ballycassidy Sawmills, Enniskillen, Co. Fermanagh (Gawn, 1986).

Selection of Stands

Stands were identified for possible testing on the basis of seed lot number, planting year and top height. Visual inspection showed that some stands, including that at Loughermore, were characterised by generally poor stem form and heavy branching. In the others, stem form was better and branching finer. It was not possible to ascribe seed lot numbers to all the stands falling into the latter category because records had been lost. However they fulfilled the main criteria for testing, being of high growth rate and of a different seed origin to that at Loughermore, and were most probably of Washington or Oregon provenance.

Selection of Sample Trees for Testing

In each selected stand, plots of 0·04 ha were marked out, avoiding edges and patches of windthrow, and the diameter at breast height (dbh) of all trees within was measured. Fifteen timber sample trees (tst's) and five volume sample trees (vst's) were systematically selected from across the dbh range, constraints being that tst's would represent stems of dbh greater than 18cm and vst's greater than 18cm and less than 7cm. Forked stems were to be rejected, but this did not prove necessary. Timber sample trees and vst's were felled and measured; measurements were used to derive standing volume to 7cm and 14cm top diameter overbark (tdob), form factor and local yield class. Top height was taken as the mean height of the four largest dbh stems per plot.

Conversion and Machine Stress Grading

Timber sample trees were cross cut in order to yield the maximum number of sawlogs of 14cm or greater top diameter underbark (tdub); these were graded according to Forestry Commission/Home Timber Merchants Association rules, and additionally to the Biological Grading System proposed by the Forestry Commission and Building Research Establishment (FC/HTMA, 1983). This applies the same criteria except that restrictions

Table 2: Sawlog Characteristics and Batten Properties

Site	%Structural Timber/ Volume 14cm tdob/ha	% Select Grade Logs	Mean Knot Size (mm)	% Juvenile Core	No. of Battens	% SC3 Battens	% SC4 Battens	Mean Ring Width (mm)	Oven Dry Density (kg/m³)
Ballintempo	19·5	73·3	19·6	58·1	44	36·4	56·8	7·16	386
Springwell	24·5	46·5	19·5	52·6	56	48·2	42·9	7·66	399
Tully (A)	23·6	46·9	23·2	53·7	78	46·1	51·3	7·99	387
Washington/ Oregon Mean	22·5	55·6	20·8	54·8	178	43·6	50·3	7·60	391
Tully (B)	23·1	7·7	27·9	57·1	47	38·3	57·4	7·10	414
Conagher	21·1	33·3	19·5	52·6	55	58·2	36·4	7·99	411
Loughermore	32·9	45·7	18·9	63·3	80	69·0	24·0	*	399
Vancover Island Mean	25·7	28·9	22·1	57·7	182	55·2	39·3	7·54	408
Overall Mean	24·1	42·2	21·4	56·2	60	49·4	44·8	7·58	399

* Missing value

on top diameter are removed. Mean knot size was determined from whorls falling on either side of the mid length point of each sawlog. Sample discs were taken from the base of all sawlogs prior to measurement for determination of oven dry density; percentage juvenile core was assessed from the diameter to the 12th ring of second log discs. On conversion the yield of structural timber for strength testing was maximised by varying the depth of battens, with an optimum width of 44mm, between 75, 100, 125 and 150mm; processing to standard 100 × 50mm battens would have resulted in lower yields and excessive waste. Battens were then kiln dried down to an equilibrium moisture content of 16-18%, and planed down to size prior to stress grading. A Cook Bolinder stress grader was used, with separate runs for each strength class (Home Grown Timber Research Committee, 1984; Building Research Establishment, 1973 & 1984). Mean ring width of each batten over four ring widths was measured when stress grading had been carried out. A total of 360 battens suitable for stress grading was obtained following drying. The number obtained for each site varied from 44 to 80. Battens were stress graded without regard to visual grading.

Results

Plot measurement and results from timber testing for all five sites sampled are shown in Tables 1 and 2, together with plot measurements and timber testing results for the closest spacing at Loughermore (by courtsey of the Forestry Commission and Princes Risborough Laboratories). A partial correlation matrix of results is given in Table 3.

Table 3: Partial Correlation Matrix of Results

		% Structural Timber 1	**% SC4 Battens 2**
% Structural timber	1	–	
% SC4 battens	2	-0·75	–
Local yield class	3	0·43	-0·76
Mean tst volume	4	0·45	-0·69
Initial stocking	5	-0·88*	0·65
% Juvenile core	6	0·65	-0·34
% Select grade logs	7	-0·10	-0·03
Oven dry density	8	0·06	-0·19
Mean ring width†	9	-0·29	-0·76
Mean knot size	10	-0·20	0·62

† Excluding Loughermore

* Significant at p = 0·05

Differences related to seed origin are not significant, although the wide variation in local yield classes observed between stands of the same provenance was not anticipated when they were selected. Results from log grading under the biological grading system are also shown; since top diameter restrictions are removed, straightness is the most significant reason for downgrading.

On average, 44.8% of battens attained SC4, compared to 24% from the closest spacing at the Loughermore site. Six percent (range 3% – 9%) of battens failed to meet the machine grading requirements of SC3 or SC4, the remainder being of SC3. There was no discernible trend between provenances or sites in the percentage of battens rejected, although a considerable proportion of the SC4 and SC3 battens obtained would be rejected on visual grading, owing to the presence of wane.

Discussion

The results from the tests described demonstrate that the low yield of SC4 timber from Loughermore is not likely to be representative of all unthinned Sitka spruce of equivalent age (28 yr) and GYC 22, planted at spacings equivalent to 1·5-2·0m. They also demonstrate the variation in timber strength occurring between apparently similar stands.

The average yield of SC4 timber obtained is low compared to published results from tests performed in timber from unthinned stands in Britain, which were considerably older and of lower yield classes (Brazier and Hands, 1985; Hands, 1985). However it is important to note that only a small pecentage of battens failed to meet the requirements of SC4 or SC3; the major limitation of the stands tested is the low yield of structural timber obtained on conversion. The results show that the yield of structural timber is related to factors influencing or affected by average tree size. However the absence of any strong correlation (except for the negative correlation with initial stocking) suggests that relationships are obscured by the small size of the majority of sawlogs obtained.

While there are broad differences between sites in terms of the yield of SC4 battens the results obtained indicate that, in order to effectively evaluate the significance of factors influencing timber strength, it would be necessary to sample a wider range of site conditions and to ensure that more battens (80-120) are obtained for machine stress grading from each location. The absence of any significant correlation between timber strength and mean knot size, the percentage juvenile core or oven dry density also may be an effect of comparatively close spacing in all stands. Multiple regression shows that within the range of conditions tested, timber strength is predominately related to initial stocking and local yield class; the relation is described by the equation:

$$\% \text{ SC4 timber} = 73{\cdot}6 - 2{\cdot}37 \times \text{local yield class} + 0{\cdot}00797 \times \text{Initial stocking}$$

($r = 0{\cdot}88$, significant at $p = 0{\cdot}05$).

This implies that, at an inital spacing of 2·0 metres and typical yield classes, no more than 60% of structural timber from unthinned Sitka spruce stands of equivalent height is likely to be SC4. The yield of SC4 timber is most probably limited by the high percentage of juvenile wood in all the samples, a consequence of the relative immaturity of the stands from which timber was tested.

Currently 56% of the underbark cross sectional area of sawlogs in the stands sampled is assessed as juvenile core, at an average top height of 19·3m and average tree size of 0·21m^3. Using published yield models (Edwards and Christie, 1981) and calculated factors to account for differences in standing volume and stocking to predict changes in crop structure, the indications are that at a top height of 24·3m, juvenile core material is reduced to 32% of mean cross sectional area, equivalent to 4-5% for every metre gained in top height. Consequently, if the high proportion of juvenile material in stands tested is a significant factor contributing to low yields of SC4 material, silvicultural practices promoting stability, and thereby allowing longer rotations, are of great importance (Brazier, 1986; Senft, 1986).

Since the yield of structural material is related to average tree size it can be influenced by thinning. Moreover, any selective thinning operation which seeks to remove crooked or deformed stems will patently have an effect in terms of improving timber quality throughout the stand (Hands, 1985). Thinning will also lead to the formation of more wood with mature characteristics relative to juvenile wood in sawlogs, albeit with wider ring widths compared to mature wood in sawlogs from unthinned stands. It would therefore be inappropriate to consider the effects of thinning on timber strength in isolation from factors already discussed.

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Operations Research in Forestry

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Summary

The applications of Operations Research techniques in forestry and forest industries are numerous. The most widely used mathematical models are: linear programming, integer programming, goal programming, dynamic programming, network analysis, and computer simulation. The demand for improved efficiency, combined with multiple-use requirements, and the availability of computers, will result in a continuing increase of the use of Operations Research in natural resource managerial decision-making.

Introduction

Operations Research (OR) is the development and application of scientific optimization techniques for the management of organizations or systems. From early on, natural resource management has been recognized as an area extremely suitable for the implementation of OR. Five factors, which are common to most management problems in forestry, make it possible to use a wide range of OR solution procedures which have been developed to assist in managerial decision making.[14] These five factors are: a complex environment; one or more specific objectives; doubt about the best course of action; decisions constrained by limited resources; and the possibility to quantify the problems.

Each OR solution technique involves the construction of a mathematical model.[24] This is a set of mathematical statements that collectively describe the workings of an organization or system. Mathematical programming, a sub-discipline of OR, involves the use of these mathematical models to solve managerial decision making problems.[56] The specific model used in each case depends on the nature of the problem, and can be deterministic or probabilistic; analytical or numerical; linear or non-linear. This article describes a number of mathematical programming techniques and their application in forestry. It has to be emphasised that OR procedures should be used as an aid to decision making, not as a replacement of the decision maker.

Linear Programming (LP)

Soon after the development of the LP technique by George Dantzig during World War II, applications were developed in the area of forest management. These range from harvest scheduling[25,29] and stand management[17] to transport planning[42] and planning of production in pulp and saw mills.[55]

The name implies the use of a linear model, both in objective function and constraints. A further four conditions have to be satisfied in order to be able to use LP: proportionality, additivity, non-negativity, and continuity.[31] Without discussing these conditions any further, experience has shown that these requirements do not restrict the use of the procedure, and it has become the most widely used method of all OR techniques. The basic model consists of an objective function and a set of constraints. The objective function can be either a maximization (profits, stumpage prices, timber volumes, etc.) or a minimization (costs, earth movement, time, etc.) and expresses the alternative courses of action. The constraints express the limitations on resources, such as land, labour, machines and capital. Additional constraints can be used to include such diverse conditions as equal annual cut volumes and the restriction of machine operations on certain terrain types.

Linear programming models can be constructed at any scale or precision, because computers have made it possible to solve very large problems quickly. The most important restriction on size and complexity is the capability of the modeler to visualize the complex interactions embedded in the models.

One important aspect of LP is that it not only gives an optimal solution to the model, but at the same time a wide range of sensitivity analysis information is provided. In many cases the actual solution is of less importance than the information on the influence of changes in costs and profits and the availability of limited resources on the optimal strategy.

Integer Programming (IP)

One of the conditions on using the LP model is the continuity of the variables, which means that any positive value is allowed. In certain cases, however, it is necessary to restrict the values of all or some of the variables to positive integers. In these cases the LP technique cannot be used and special IP solution procedures have to be employed.[26]

Examples of integer variables are the number of trucks scheduled for a haulage operation, the number of fellers in a clearfell, and the number of machines available. A special type of integer variable is the 0-1 variable.[15] For instance, a stand can be scheduled for clearfell in a certain year or it may be retained. The 0-1 variable in the optimal solution will either have a value of 0 (retained) or 1 (scheduled). Similarly, a machine can be bought or not, a sawmill constructed or not, etc. Zero-one variables are also used

for the inclusion of spatial and chronological restrictions in models.[34,57] For instance, a stand cannot be replanted unless it has been clearfelled, or a road has to be built before harvesting can start.[52]

Because of the complexity of the solution methods for IP models, LP techniques are often used, followed by a rounding-off of the integer variables. In some cases this can lead to satisfactory results, but often, especially in the presence of 0-1 variables, this will result in sub-optimal or meaningless solutions.

Goal Programming (GP)

Many decision problems in natural resource management have multiple objectives. Most public forests, for example are managed for multiple uses, such as timber production, wildlife, and outdoor recreation. A restriction of LP models is the condition that only one objective function is allowed. If the multiple objectives are in conflict with each other, one objective function cannot be formulated. In that case, GP might be the answer. GP minimizes the deviations from multiple goals, subject to constraints. This requires that both objectives and desired goal levels can be quantified, and in addition, the decision maker has to be able to rank the objectives in order of their preference. These requirements have limited the use of GP. At the same time, many applications have been developed in forest management, especially in multiple-use contexts. Examples are management of small private woodlands,[51] land use planning,[1] Christmas tree production,[22] and outdoor recreation planning.[16] The increasing demands of society on the use of forests for purposes other than timber production,[28] and the question of afforestation of large areas in sensitive landscapes make GP a technique which will become more attractive in the future.

Dynamic Programming (DP)

Certain types of decision problems involve making a sequence of interrelated decisions in such a way that overall effectiveness is maximized. Many of these problems can be solved using LP, but in some cases the resulting models are very complex and DP techniques can mean a significant simplification. No standard mathematical formulation exists that applies to all DP problems, nor is there a standard solution procedure. Because of this, DP has not been used very widely, but a few good applications have been developed in forestry. The best known model issued for the optimal crosscutting of stems.[18,43] A decision made at the butt end of the stem (e.g. to cut off a 3 or 4 metre log) is obviously going to influence the possibilities further along the stem. In cases where there are many possible assortments, the optimal crosscutting of stems can mean significantly increased profits as compared with sub-optimal solutions.[20] Other applications of DP are in the area of stand management,[5] pest management,[39] forest road location,[12] and forest fire detection.[41]

Network Analysis (NA)

The group of network analysis models consists of a large variety of techniques. The network can be a geometric network, such as a road system or a flow pattern in a saw mill, or an abstract network pertaining to the order of events or the flow of information within a project. Almost all NA problems can be solved using LP or IP techniques, but because of their relative simple structure, special procedures have been developed which solve the problems more efficiently.

The best known of the NA techniques are the transportation model and the shortest path model, which are used for the analysis of geometric networks, and the Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT) which are used for project scheduling. The transportation problem is concerned with transporting goods or services from multiple supply centres to multiple demand centres in an optimal manner. Examples of situations where the transportation model can be used are: the minimization of earthwork transportation during forest road construction;[3] the transportation of timber to processing locations and the distribution of finished products to customers;[9,44,45] the movement of logging equipment from sites where harvesting has been completed to new sites; and the supply of seedlings from nurseries to planting sites.[14]

The shortest path problem deals with finding a route between two points in a network which is minimized with respect to distance, cost, time or some other appropriate quantity. Examples of the use of the shortest path model in forestry are: scheduling of logging trucks;[6] the planning of forest transportation networks;[38,47] and the analysis of forest fire behaviour.[30]

In addition to the transportation and the shortest path models, a large group of other techniques exist, such as the minimum spanning tree model, the maximum flow model, and a collection of procedures known as locational models, dealing with the optimal location of facilities in a network. Examples are: the location of a logging camp to serve a group of logging sites; the location of a garage to serve the roads within a network; and the location of a road network to serve a forest area.[37]

Both CPM and PERT deal with the scheduling of projects, where the objective is to minimize the total duration.[58] The major distinction between the two is that CPM is a deterministic model whereas PERT is probabilistic in nature. Both models are based on the fact that certain operations have to be completed before others can start. Examples of applications in forestry are planning and control of harvesting operations,[40] timber sale preparation,[11] forest road construction,[46] and sawmill modernization.[32]

Computer Simulation

Simulation is frequently described as the process of duplicating the essence of a system without attaining the reality of that system.[19] The construction of a simulation model can take three forms: physical, symbolic,

and mathematical. Computer simulation deals with a mathematical model describing the system in terms of mathematical equations.

The main disadvantage of simulation is that unlike other OR techniques, it does not provide optimal solutions directly. Simulation is a trial-and-error (heuristic) approach to problem solving. It is an appropriate analytical approach where it is not feasible to experiment with the actual system, or when the complexity of the system prevents the use of other analytical techniques. Infeasibility can arise because of costs, risk of disrupting the system, unavailability of the system for experimentation, or non-existence of such a system. Examples of the use of simulation in forestry include: forest machinery and systems design;[8,33,59] harvesting and transportation systems analysis[13,21,23,54]; sawmill design and layout;[4] and policy evaluation.[49]

The use of simulation has a number of additional advantages. The detailed observation of the system required to construct the model can lead to improved understanding of the system, and might even remove the need for a simulation model. Also the use of simulation is a teaching device for developing skills in analysis and decision making.

Implementation

For all of the techniques discussed above, the use of computers is essential. Small problems can be solved by hand, but the application of OR procedures to real-world problems requires large amounts of computational capacity. During the last two decades a large collection of OR routines has been developed, both for mainframe and micro computers. This includes specialized packages for natural resource management and forestry, such as Timber RAM[35] and LOGPLAN[36]. But for many applications general OR packages such as LINDO[50] and SAS/OR[10] for mainframe, and QSB[7] for micro, are more than adequate.

Recent developments involve the combination and integration of OR techniques and management information systems. For instance, a combination of network analysis and LP makes it possible to integrate road location and transport scheduling with harvest planning.[27] The integration of OR models in Geographic Information Systems makes the spatial and descriptive data bases directly available to the mathematical programming models. Research in this area focuses on forest road location[37] and harvest scheduling[2,48]

These new developments provide the decision maker in the field of forest management with the necessary tools, given the continuing demand for improved efficiency, combined with the increased implementation of multiple-use policies in natural resource management.

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Notes

FOREST HEALTH SURVEYS IN IRELAND: 1987 AND 1988 RESULTS

M. Keane, R. McCarthy and J. Hogan

Research Branch, Coillte Teoranta, Sidmonton Place, Bray, Co. Wicklow.

Summary

Results of the 1987 and 1988 forest health surveys indicate that defoliation and discolouration are evident in Irish forests. Damage is generally attributed to insect or disease attack, nutrient deficiency or climatic stress. These results contribute to the annual EC forest health survey.

Introduction

Since the early 1980s, many European countries have been carrying out surveys of forest health. The initial impetus for many of these surveys was to evaluate the effects of atmospheric pollution on the health and vigour of forests. Such surveys have evolved over time and now measure the effects on forests of many damaging agents, e.g. insects, disease and adverse weather conditions.

All Member States of the EC are now obliged to carry out these surveys and results from Ireland have contributed to the EC reports on forest health in 1987 and 1988.

Methods

The survey is based on assessments of trees at locations selected using a 16 x 16 km grid. Co-ordinates of the intersection points of the grid were supplied by the EC and assessment plots selected only where the intersections occur within forest areas of greater than 1 ha. The official EC grid was not available to us in 1987 and results presented here for that year are based on different trees than those assessed in 1988 (Figure 1). Different assessment procedures were also used. Results, therefore, are not comparable between 1987 and 1988. From 1988, results will be directly comparable from year to year. A total of 22 plots was established in each year and individual trees (20-25 per plot) assessed for defoliation (5 classes) and discolouration (4 classes). Assessments made on each tree were the same as those carried out in other Member States: results, therefore, can be compared between the countries involved.

Results

Species assessed were Norway (*Picea abies*) and Sitka spruce (*Picea sitchensis*) (1987 and 1988) and lodgepole pine (*Pinus contorta*) (1988 only). Because the 1988 results will act as the base-line data for future surveys, only these data are shown here in any detail (Figures 2 and 3). The 1987 and 1988 results for all species are, however, given for completeness (Tables 1 and 2).

Norway spruce showed lower levels of defoliation than Sitka in both the 1987 and 1988 surveys. Lodgepole pine was found to have more defoliation than either of the spruces and had over 7

Figure 1: Location of forest health survey plots for 1987 (▲) and 1988 (●).

DEFOLIATION CLASS	ALL SPECIES COMBINED 1987	1988
0 : 0 - 10%	95.9	69.9
1 : 11 - 25%	4.1	25.3
2 : 26 - 60%	-	4.5
3 : > 60%	-	0.3
4 : Dead	-	-

TABLE 1.

Percentage distribution of defoliation class. Direct comparisons between years (1987 and 1988) are not possible for reasons outlined in text.

per cent of trees moderately or severely defoliated (classes 2 and 3, Figure 2).

In the 1988 discolouration assessments (Figure 3), Norway spruce had only slight yellowing (3.2 per cent). Sitka spruce and lodgepole pine, however, showed 23.4 and 53.7 per cent respectively of trees falling into the slightly and moderately discoloured categories (classes 1 and 2).

Possible Causes of Observed Damage

Although individual trees were assessed for defoliation and discolouration, it is difficult to attribute either of these two factors specifically to the effects of atmospheric pollution.

In the spruces, most of the defoliation was attributed to climatic stress (mainly exposure to wind) or attacks by the green spruce aphid (*Elatobium abietinum*). Only edge trees were surveyed in this genus, and the defoliation levels assessed may be an overestimate of the situation within stands.

In lodgepole pine, almost all of the needle loss was attributed to feeding by the European pine sawfly (*Neodiprion sertifer*).

Discolouration in the spruces was generally slight and was caused mostly by green spruce aphid attack and/or nutrient deficiencies. This latter factor was also the cause of most of the discolouration in lodgepole pine. Yellowing of the shoot tips was evident on some lodgepole pine trees and was caused by the fungus *Ramichloridium pini*.

Wide genetic variation in crowns, in terms of quantity of branching, was observed, but not evaluated in this survey. The variation occurred irrespective of defoliation, and appears substantial in some cases, especially for lodgepole pine.

DISCOLOURATION CLASS	ALL SPECIES COMBINED 1987	1988
0 : 0 - 10%	97.8	68.6
1 : 11 - 25%	1.7	30.5
2 : 26 - 60%	0.5	0.9
3 : > 60%	-	-

TABLE 2.

Percentage distribution of discolouration class. Direct comparisons between years (1987 and 1988) are not possible for reasons outlined in text.

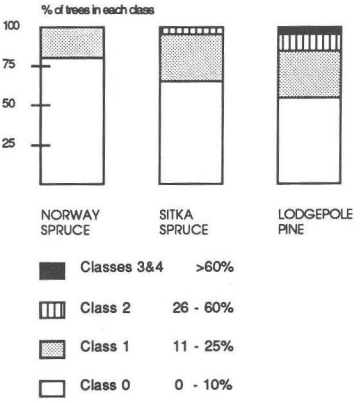


FIGURE 2. Percentage distribution of defoliation class by species (1988)

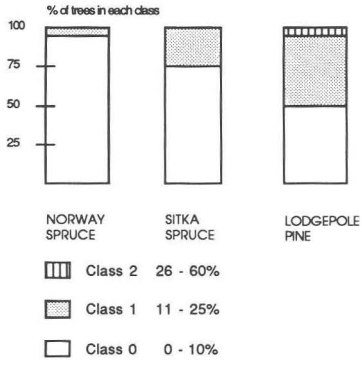


FIGURE 3. Percentage distribution of discolouration class by species (1988)

Conclusions

The data presented in this note indicate that defoliation and discolouration are evident in Irish forests. Although these two symptoms are those most commonly associated with forest decline on the continent, the crown thinning and yellowing of the survey trees described above were generally caused by factors other than atmospheric pollution.

Much of the defoliation attributed to atmospheric pollution in central Europe is found in older forests (>60 years old) – an age class not represented in the current survey. Likewise, highest defoliation levels caused by atmospheric pollution generally occur at an elevation at or above our current planting limit.

Since this is only the initial phase of the survey, the results can, at this stage, only be indicative of the general health status of the entire forest estate. Additional information, however, will be available from another project which examines the possible effects of atmospheric pollution on forests in 25 potentially vulnerable locations.

NEW STRUCTURAL TIMBER REGULATIONS

Effective from April 1, 1989

Sean Wiley

Forest Products Department, Eolas, Glasnevin, Dublin.

The Irish Standard Recommendation, SR 11: 1988 – 'Structural Timber for Domestic Construction' – was launched in Eolas in 1988 by the Minister for Forestry, Mr. Michael Smith. It was produced after extensive consultations with architects, engineers, distributors and processors. It reflects good trade practice in the use of structural timber in Ireland.

SR 11 has now been incorporated into the Proposed Building Regulations. These are modelled on the regulations currently in force in the U.K. They now form a basis for building control in this country through the specifications of consulting architects and engineers. The requirements of SR 11 formally came into effect from April 1, 1989. Under the new regulations all structural timber should be stress graded and marked to the requirements of SR 11.

By way of preparation for the introduction of the new regulations a series of workshops and seminars were held in Eolas. These were attended by representatives from the timber industry, State and semi-State bodies, building control authorities, designers and specifiers. Talks were delivered at meetings organised throughout the country by the National House Building Guarantee Scheme of the CIF and at meetings organised jointly by Eolas and timber suppliers. Over 3,000 people have attended these talks to date. A series of on-going visual stress grading courses are being held in Avondale Training Centre to train and certify timber graders to operate under the new regulations. Over 200 people have been trained and certified to date.

Strength Classification System

For ease in design and specification SR 11 introduces a strength classification system for all structural softwood timbers. There are three strength classes specified: SCA, SCB and SCC; the SCA being the lowest strength category and SCC the highest. See Table 1.

Table 1. — Softwood Species/Grades which satisfy the Strength Classes.

SOFTWOOD SPECIES	STRENGTH CLASSES		
	SC A	SC B	SC C
Irish Timber			
Sitka Spruce	GS/MGS	SS/MSS	M75
Norway Spruce	GS/MGS	SS/MSS	M75
Douglas Fir	GS/MGS		SS/MSS
Larch		GS/MGS	SS/MSS
Imported Timber			
Whitewood*1		GS/MGS	SS/MSS
Redwood*1		GS/MGS	SS/MSS
Fir-Larch*2		GS/MGS	SS/MSS
Spruce-Pine-Fir*2		GS/MGS	SS/MSS
Hem-Fir*2		GS/MGS	SS/MSS

*1 — European.
*2 — Canadian.

Ireland is by no means the first country to introduce a grading and strength classification system. Most of the major industrialised countries operate a similar system. In the UK, for example, timber strength classes were introduced in 1984 with the publication of British Standard BS 5268 – 'Structural Use of Timber'. The requirements of this standard have also been incorporated into their building regulations.

In this country Irish timber has approximately a 50% share of the structural timber market. The balance of the demand is filled by timber imports from Scandinavia, Canada and Russia. The strength classification system in SR 11 has made provision for both the Irish and imported timbers. It has removed the barriers of the past to trading for Irish timber and allows Irish grown Sitka or Norway spruce to compete on the same basis as imported timber for its share of our structural timber market. A technical research programme on Irish timber was funded by the Forest Service and used in the preparation of SR 11.

Stress Grading and Marking

The introduction of strength classes does not affect the stress grading of timber. It is a requirement of SR 11 that all structural timbers shall be stress graded and marked accordingly. The timbers are graded to the requirements of British Standard BS 4978 – 'Timber Grades for Structural Use'. Timber can be graded either visually or by machine. There are two visual grades specified – General Structural, (GS), and Special Structural, (SS), with complementary machine grades, MGS and MSS. A further machine grade, M75, is also specified.

Photographed at the launch of SR 11 were, left to right: Pat Colclough, Head Forest Products Department, Eolas; John O'Halloran, Chairman, Irish Timber Council; Christy Conway, Timber Manager, Brooks Thomas Limited; Peter Murphy, Marketing Manager, Woodfab Limited.

Timbers appropriate to a particular strength class are selected on a combination of species and stress grade. The combinations applicable to strength classes SCA, SCB and SCC are outlined in Table 1.

The stress grading and marking of structural timber is subject to the supervisory control of the Timber Grading Bureau of Ireland, (T.G.B.I.). The marking system identifies the stress grade and strength class of the timber member and the registered number of the timber grader and his company. The following is an example of the markings which occur on stress graded timber in accordance with SR 11.

TGBI

Grade	Strength Class
SS	SCC

BS 4978/SR11

Reg. No. 100/738

Table 2 — Permissible Stress and Modulus of Elasticity Values

PROPERTIES	STRENGTH CLASSES		
	SC A	SC B	SC C
STRESS*[1]	MPa	MPa	MPa
Bending	4.1	5.6	6.6
Tension	2.5	3.4	4.0
Shear	0.64	0.64	0.8
Compression:			
Parallel	5.2	6.1	6.4
Perpendic.	1.4	1.6	1.8
MOE			
E mean	7000	8000	9000
E minimum	4500	5000	6000

*[1] — 1 MPa = 1 N/mm²

Design Information and Span Tables

The permissible design stresses and moduli of elasticity values assigned to each of the three strength classes for the dry exposure condition are shown in Table 2. The design values given may be used for all structural applications by the design engineer.

It is a requirement of SR 11 that the moisture content of all structural timber shall not exceed 22 per cent at the time of fixing.

Maximum permissible span tables for specific loading conditions, and based on the strength classification outlined, are provided in SR 11 for floor joists, ceiling joists, rafters and purlins. The timber sizes given in the span tables are the minimum permissible sizes for timber at a moisture content of 22 per cent.

Letter to the Editor

Dear Sir,

I have just read Vol. 45, No. 2 and write to express the point of view of one no longer involved at the centre of things, and who is feeling out of touch with events. This applies particularly to members on this side of the border who read the Belfast papers and miss what goes on in Dublin.

Has "Irish Forestry" not a duty to inform its readers about the background to the major changes now taking place in the organisation and management of the Forest Service? Similarly, should southern members not be kept up-to-date with changes of this nature in the North? It is certainly not filling this function at present.

The Quarterly Journal of Forestry certainly does this as regards Great Britain and Scottish Forestry likewise.

Are our members only interested in Research? Have they got their eyes glued to a microscope so that they don't want to know about the world outside? Please Mr. Editor, as you take up your difficult and responsible task, spare a thought for those who are in the dark and look to you for light. Also try to hold Ireland together through what appears to be a lost cause. We can still try to hold the Society of Irish Foresters together.

Yours sincerely,

Cecil Kilpatrick,
8 Infirmary Road,
Hillsborough,
Co. Down.

We have been promised an article chronicling the events leading up to the formation of Coillte Teoranta. Hopefully this will appear in the next issue. (Editor).

ACKNOWLEDGEMENT

On behalf of the Society, I would like to thank our former editor, Pat McCusker, for his valuable contribution to the production of this Journal over the past three years. His efforts have resulted in a series of issues in which the Society can be justly proud.

Alistair Pfeifer.

Obituary

THOMAS REA 1931-1988

"Death is a poor untidy thing" wrote George Moore, misremembering Synge, but how apt it is we often have occasion to realise, never more so than with the death on 18th October 1988 of Tommy Rea, Assistant Secretary in the Forest Service of the Department of Energy. He was with the Minister on a journey to the U.S. to promote investment in forestry in Ireland when he died in his sleep in New York.

Tommy was born in Dublin on 30th September 1931. His formal educational qualifications included a B.Comm. (U.C.D., 1958) and M.Sc. (Economics/Statistics, T.C.D., 1976). He joined the Civil service in 1949 and served in the Department of Social Welfare before joining the Forest Service in June 1963. From November 1976 until his promotion to Principal in July 1980 he was analyst in the Forest Service. He became Assistant Secretary in December 1985.

In the course of his work in the Service Tommy was involved in a number of major developments. Perhaps the first of these was an interdepartmental study of the State planting programme (1974) which concluded that "the rates of return on the investment were sufficient to justify continuance of present afforestation policy". He was also deeply involved in the study published as *The Case for Forestry* in 1984 and which also led to confirmation of the Government's overall policy objective of an annual planting target of 10,000 ha. One of his tasks as Principal was to organise the servicing of the heavy demands for information and analysis which emerged from the Review Group on Forestry which reported in 1985, and whose report led eventually to the setting up of Coillte Teoranta by the Government in 1989.

A development which gave him particular satisfaction was the creation of the holiday chalet enterprise at Killykeen Forest Park, Co. Cavan, in which he played a central role.

This journal also is indebtedt to him for his carefully researched paper entitled *Irish State forestry: government policy 1948-1959,* which sorted out finally the history of that policy.

Tommy's personal character is easy to describe. He was a public servant of the highest integrity. At the same time he was one of the best known, most popular and highly respected officers of his own Department. He moved with equal ease in all other organisations with which he came in contact. He was serious about his work, but even the most earnest and difficult discussion or meeting would invariably be lightened by one of his witty remarks, always appropriate to the occasion.

Tommy was conscious of the achievement which the national forest estate represents, and of the extent of the human resource in terms of experience and knowledge which had been dedicated to that achievement. He was very concerned that the difficulties which have beset the public service in recent years should not be allowed to jeopardise any of that achievement. Time, of course, will be the ultimate arbiter of that.

Our sympathy goes to Betty and Susan as we say with Catullus: *"Atque in perpetuum, frater, ave atque vale".*

Niall O Carroll.

Forestry News

COILLTE TEORANTA – THE NEW IRISH FORESTRY BOARD IS LAUNCHED

The Minister for Energy, Michael Smith T.D. announced the formation of Coillte Teoranta, the Irish Forestry Board, on Wednesday 21st December 1988 at Avondale, Co. Wicklow.

In his speech to an invited audience of approximately 300 people, representing various sectors of the community, Mr. Smith briefly outlined the evolution of Irish forestry. He paid tribute to the people responsible for the early years of forestry development in this country, and he also commended the efforts of both the public and private sectors in bringing forestry to the healthy state that it is now in.

He went on to state that "in recent years, there has been a growing awareness of the need to exploit the full commercial potential of forestry and to operate it as a business. It has become increasingly obvious that a Civil Service structure was not the best way to achieve these objectives. While the Forest Service had done a very good job in operating Forestry within a Civil Service context, it lacked the necessary freedoms to respond to the commercial demands of forestry development and to ensure that forestry operations fully reflect commercial standards and criteria.

The Government, therefore, decided

The former Minister for Energy, Mr. Michael Smith T.D. left, photographed at Avondale with Mr. Pat Cooney, the chairman of the board of the new State forestry company, Coillte Teoranta.

to establish a new commercial state-sponsored forestry company, Coillte Teoranta, and to assign to it the major functions previously undertaken by the Forest Service. This decision was implemented through the Forestry Act, 1988."

In discussing the funding of the new company, Mr. Smith said "the Government recognise that, despite the progress which has been made in forestry development in recent years, and it has been very real progress, public forestry has not yet reached the stage where receipts from sales and other miscellaneous activities cover costs. The Government, therefore, accepts that the company will require substantial financial assistance in its early years, especially if it is to maintain significant planting programmes. All this is reflected in the Forestry Act, 1988, but I want to stress that the financial provisions in that Act are expressions of the upper limits which might be provided and are not to be regarded as self-operating mechanisms which will automatically provide the indicated funds on demand. The actual funding to be made available will depend on the particular circumstances prevailing and on the development plans and progress of the company.

It would be a serious illusion if the company saw the Exchequer as a constant source of financing. That certainly will not be the case. The Government expects the company to stand on its own feet, to conduct its business in accordance with the requirements of the marketplace, and to reach profitability as quickly as possible. I should also say that Coillte Teoranta is in the very fortunate position in that substantial assets, financed over the years through taxpayers' monies, are being transferred to it without any obligation to repay the expenditures incurred in their creation. For any company this is a tremendous head start. Accordingly, the onus is now on Coillte to put its inherited house in order and to provide substantial returns on the taxpayers' investment.

I will, therefore, critically examine the performance of the company in assessing its funding requirements. While I will, of course, be prepared to provide financial support where warranted, I do not intend to give Coillte a comfortable existence. In particular, I intend to look very hard at any proposals for the guaranteeing of the company's loans. In this regard, I will be very anxious to avoid anything which might give the impression that the State has any responsibility for the financial outcome of the company's activities. That responsibility rests with Coillte. A commitment to commerciality must permeate all parts of its organisation, from the Board downwards. The company is now being freed from Civil Service constraints and it will have the necessary flexibility and freedom to conduct its business in a commercial way like any other private sector company. It will have no excuse to do otherwise and I do not intend to accept any excuses.

The current development of our forest estate will have a major influence on the cash break-even date of the company. Because our trees are at a certain stage of growth, it will take some time before overall profitability is reached. There is not much the company can do to increase the growth of trees, but it can certainly do a lot in terms of increasing its revenues and reducing its operating costs. I expect it to do so and, in this

way, achieve a much earlier break-even position than would have been the case if forestry had continued to be operated within a civil service structure.

Because of the very important public business involved in this enterprise, it was inevitable that the Oireachtas would include in the legislation which it enacted a number of provisions giving various powers to Ministers of the Government. I want to assure the board that these powers will be exercised in a realistic manner. Obviously, we will expect the company to continue to achieve the national planting targets as otherwise we would not be able to bring into being the larger forestry activity which we foresee for the future. The burdens of achieving those targets will be diminished by providing access to Community funds and it must be expected, too that the Government will take them into account in considering the overall financial position of the company.

Another area in which the need for some control arises is the question of disposal of the company's basic assets outside what might be regarded as the normal course of its business. We are expecting the company to get the most out of the working of its assets and we could not look with equanimity at a situation in which bad performance is cloaked by the company selling off parts of its heritage to balance the books. On the question of performance we will also be looking to the company to establish accounting and management procedures which have the effect of placing responsibility for the achievement of results on the appropriate shoulders and enabling speedy action to be taken to ensure that the enterprise as a whole and all its constituent parts are maintained on course to reach the goals which we lay down for it."

In relation to the restructuring of the State forestry organisation, Mr. Smith said that the Forest Service, like any other organisation, is capable of improvement. He stated that "in my view, there is considerable scope for organisational reform, for the elimination of unwieldy and costly procedures, for the adoption of better practices in the forests, for the introduction of new arrangements to reduce outgoings on purchases and increase income per unit of sales and for the identification of the optimum utilisation of land and other assets. There is a need in general for the creation of an entirely new culture in relation to forestry which will eliminate outdated procedures and emphasise instead the need to run an efficient operation which will give the people of Ireland a better deal for their money.

In short, I expect Coillte Teoranta to have a fundamental look at forestry organisation, structures and practices, to identify the most efficient and cost effective way of conducting the business of forestry within a commercial environment, and to bring about radical improvements in productivity at an early date.

To the Board of the company I therefore say this: You have been given very great responsibilities. You are now the custodian of public forestry development. I look to you to discharge your mandate wisely and to take the necessary action to ensure that Coillte Teoranta operates to the highest standards of effectiveness in dealing with the important public assets which are being placed in your care. If you provide the proper leadership and motivation I have

little doubt that you will procure the proper response from the staff of the company who also have such a vital role to play.

I know that I have set the company, its Board and staff hard tasks. But I am also very confident that they will meet these challenges with confidence and commitment and that Coillte will fulfill our high hopes for it. I am sure that it will be a company of which we all can be proud and will be a standard bearer among state-sponsored bodies."

Mr. Smith finally announced the board members of Coillte Teoranta as follows:

Chairman	
Pat Cooney	M.D. Tipperary Water.
Board Members	
John O'Halloran	Woodfab, Aughrim, Co. Wicklow.
Mary Leonard	Stokes, Kennedy, Crowley.
Tony Stapleton	47 Woodlands, Navan.
John Costin	Portgloriam, Kilcock.
Benny Moloney	Former Asst. Chief Inspector Forest Service.
Jan Alexander	Crann, Killegar, Co. Leitrim.
Paddy Glennon	Glennon Bros., Longford.
Patrick Flynn	Federated Workers' Union of Ireland.

Coillte's New Chief Executive

Mr. Martin Lowery (right) was appointed on the 11th January as Chief Executive of Coillte Teoranta, the new State sponsored company with responsibility for forestry. Mr. Lowery is a native of Galway and left the position of an executive director of the Industrial Development Authority where he was responsible for natural resources, Irish industry and company development divisions. He was formerly operations research analyst with Aer Lingus. Mr. Lowery now takes responsibility for Coillte's 2,500 strong workforce and faces the task of changing a State controlled venture into a commercial business.

We wish him every success with his new appointment.

TROPICAL DEFORESTATION – WHY BOTHER?

A report of Chuck Lankester's visit to Ireland

by

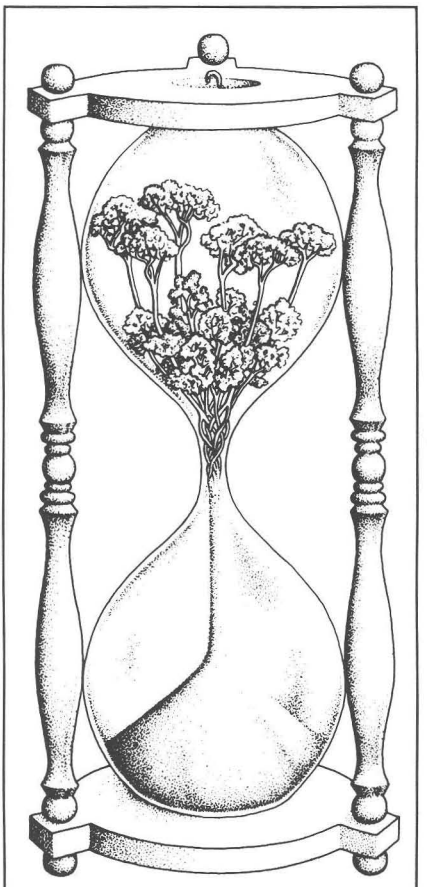
John Gilliland

The Tropical Forestry Action Plan (TFAP) was started in 1985 and acts as an unbrella organisation for international agencies and governmental and non-governmental aid agencies to combat tropical deforestation. It co-ordinates strategy and policies on a national level to ensure a unity of approach and purpose. TFAP hope to channel $800,000 to stopping deforestation over the next five years. Chuck Lankester of the United Nations Development Programme was one of the founders of the Programme and is deeply committed to its success.

Chuck Lankester agreed to address a meeting organised and partly sponsored by the Society of Irish Foresters on December 3rd entitled 'Tropical Deforestation – why bother?' On the day of the meeting the Forest Service hosted a lunch for him at Avondale House where he met representatives from the Forest Service, Society of Irish Foresters, Department of Foreign Affairs, UCD Forestry and Agricultural faculties and from various overseas aid and development agencies.

The meeting, which was open to the public, was held on a Saturday night in Belfield where over 250 people filled a lecture hall to capacity. Chuck Lankester is a natural orator who believes with a passion in the cause of stopping deforestation and as a result his lecture was excellent.

He explained that tropical forests are being destroyed at a rate equivalent to clearing the Phoenix Park every 50 minutes. Such wide-scale destruction of forests results in water and wind erosion, loss of species and genetic diversity, lack of forest produce and the removal of peoples' natural environment. Some



Graphics: Gillie Newman/World Forest Action

three hundred million people are sustained directly by the existence of forests, nearly one hundred million can now no longer find enough fuel to satisfy their cooking and heating needs. One species of life form in the tropical forests becomes extinct every day where 40% of all life forms are present. Recent famine in Ethiopia can be linked to loss of forest where forest cover has dropped from 40% to 4% resulting in large-scale desertification in only a hundred years. Floods in Bangladesh are directly related to felling of the watershed areas on the Himalayas. Degradation of apparently lush rainforests can easily occur as most of the sites' nutrients are locked up in living matter and in many cases the underlying soil is poor and impoverished. Deforestation can also affect climate. It is estimated that the burning of forests contribute to 20% of all the carbon dioxide produced which adversely affects the ozone layer as well as removing a sink for carbon and a source for producing oxygen.

He went on to state that clearly deforestation is having dramatic global consequences. The main agent of forest clearance is the slash and burn practice whereby landless farmers clear a plot of land to farm for one or two years before the site is devoid of nutrients and then move on. Other reasons are logging, roading and development operations, agricultural expansion, resettlement programmes and urbanisation. These may not completely destroy the forest cover but can result in a degradation of the site which becomes increasingly worse over time.

Those clearing the forests, however, are only the agents and not the cause of deforestation. The underlying problem is poverty and the inequitable distribution of land. The solution is primarily a political one allied to education, financial and technical support. The aim of the TFAP is the management of trees and forests for sustained output of forest goods and services without destroying soil, genetic and other environmental resources. It has taken 60 million years to create the tropical forests but only 60 years to destroy half of them.

Mr. Fergal Mulloy of the Forest Service gave a reply to the paper from an Irish Foresters perspective. He explained that over £21 million of tropical hardwoods were imported in 1987 mainly from West Africa. This represents the clearing of an area of tropical forest of some 4,000 ha. He said that there is a role for Irish species such as lodgepole pine and ash which, if suitably processed and treated, can substitute for many of the tropical imports. There is also a role for Ireland to play in helping to change the ecological, social and economic disasters that face tropical countries.

The meeting created a great awareness about the problem of deforestation amongst the media. Chuck Lankester was interviewed for several radio programmes and accounts of his talk appeared in the national press.

Such a visit cannot be achieved without sponsorship and the help of the Department of Foreign Affairs, Department of Environmental Studies, UCD and the Forest Service in gratefully acknowledged.

An interesting postscript to Ireland's role in tropical forestry is the recent appointment of Ray Keogh of Coillte to identify and develop the potential of overseas forestry consultancy work.

DEVELOPMENTS IN SILVICULTURE

by

Gerard Murphy

Cherry – A Forgotten Species

S. N. Pryor, in a publication entitled "The Silviculture and Yield of Wild Cherry", (Forestry Commission Bulletin No. 75), describes the silvicultural characteristics of a rarely planted species. His findings are based on a study in which 40 stands throughout Britain were visited. The natural range of the species extends throughout Europe and into Western Asia and North Africa. The species thrives on deep moist well drained soils. Light sandy or badly drained soils should be avoided, as should exposed sites.

The species is easy to establish and is a rapid early grower. Spacing can be as wide as 3 x 3m (110 per ha) provided regular pruning is carried out. The species is a light demander and heavy thinnings are recommended to produce large diameter stems as soon as possible. This is essential for a species which is short-lived with a marked tendency to form heart rot. Heart rot is considered to be an economically devastating disease. Pryor suggests that good silvicultural practices and site selection can reduce it to an acceptable level. The yield class of the species is higher than most other hardwoods grown in Britain. A rotation of 55-60 years is feasible provided regular and heavy thinnings are carried out. The wood is much in demand for its good wood properties. It appears to have the same kind of potential as ash in terms of profitability of hardwood species.

Containerised Douglas Fir and Sitka Spruce

Provisional regimes for growing containerised Douglas fir and Sitka spruce are described in Research Information Note 141, issued by the Forestry Commission Research Division. The type of polythene greenhouse together with container design are described. Growing medium, fertiliser and fungicide requirements are outlined. Conditioning of the plants by drought stressing or manipulation of photoperiod are discussed.

Heterobasidion Annosum (Fomes Annosus) – Two Devastating Cases

In an article published in Forestry Vol. 61, No. 4, Pratt and Greig outline a rapid spread of Fomes in two young first rotation stands of Norway spruce. Evidence points to the fact that infection of inadequately protected or unprotected stumps served as the origin of the disease. Although most infection appeared to occur from stumps created in first thinning, it was also possible that infection may have occurred from some cut Christmas tree stumps on one of the sites. Also the second site, which had an intimate mixture of Scots pine and Norway spruce, had a rapid spread of the disease into the surrounding crop when the nurse species of Scots pine was removed. The reason for the rapid spread appeared to be a combination of susceptible species interplanted at close

spacing, and a light sandy soil which allowed effective disease transmission. There was a major economic impact on both sites, not only in terms of volume loss but in the decision to clearfell prematurely. Estimates of economic impact are provided. In one site they estimated a loss of potential revenue of 91 per cent. These case histories highlight the potential of the disease to markedly reduce the economics of a forest crop and the importance of proper stump protection.

Root Growth in Sitka Spruce and Douglas Fir Transplants

J. J. Philipson, in a paper published in Tree Physiology Vol. 4, pp 101-108, provides an interesting study on the relationship of root growth in Sitka spruce and Douglas fir transplants with carbohydrate reserves and shoot phytosynthate. He found that new root growth in Sitka spruce was relatively independent of shoot growth compared with Douglas fir. Sitka spruce relied more on the starch reserves within the root. New root growth in Douglas fir transplants was dependent on a living connection with the shoot. These findings are discussed in relation to the establishment of these species on forest sites. Rough handling of Douglas fir may result in a reduction of current phytosynthate, thereby inhibiting root growth and reducing establishment success. In contrast new root growth in SS can rely on starch reserves in the roots, giving the plant a chance to recover from handling damage.

Noble Fir for Christmas Trees

Research Note 3/88, published by the Research Branch of Coillte Teo., provides a long-awaited guide to the establishment and care of noble fir plantations for the production of Christmas trees. The Note provides information on the optimum seed sources, site selection, site preparation, planting stock, fertilisation, vegetation control, and pests and diseases. Seed from registered Danish and Irish stands should be the first choice. Noble fir grows on a wide variety of soil types but for Christmas trees moist mineral soils are recommended. A planting distance of 1.2m square is ideal. There is a great need for care in planting. Good quality 2+1 transplants or containerised plants should be used. Fertiliser and weed control schedules are supplied. The Note also outlines the various pests and diseases common to noble fir. Two fungal diseases, needle cast and a needle blight/root rot complex, are described. The length of time it takes for a crop to reach harvestable size (2m tall) depends on factors such as seed source, soil fertility and silvicultural management. However, harvesting normally starts at year 8 and is completed by year 10 or 11.

Harvesting Christmas Trees –Saw Attachment

A new clearing saw attachment that is said to increase the productivity of Christmas tree felling has been introduced by Husqvarna Power Products Company. The key to the design is a blunt six inch probe that acts as a sled to guide the saw along the ground and a guard that covers nearly three quarters of the blade. With the attachment the operator pushes the saw along the ground until the probe encounters the tree stem. The counter clockwise rotation of the blade pulls the attachment

snugly against the tree. This stabilises the saw until the cut, up to 6″ in diameter, is complete. The probe also acts as a sled, allowing the operator to cut a very low stump while protecting the blade from dirt and rocks. The design allows the operator to stand comfortably while cutting, eliminating the need for crouching. Blind cutting problems are eliminated.

(Journal of Forestry, January 1989)

SAFETY FIRST IN WICKLOW WOODS

by

Vanessa Downey

Lacken Wood in Glencree Valley, Co. Wicklow gave UCD forestry students the venue for their first chainsaw competition which was held on 8th April 1989.

The event, which took place on a beautiful spring day amid idyllic Wicklow scenery, was organised by Eoin Murphy, a third year forestry student at

Photographed at the students chainsaw competition were, left to right: Clare Boylan, 3rd Prize; Hugo McCormick, 2nd Prize; Andy Murphy, Liffey Distributors; John O'Sullivan, Coillte Training Centre; Gary Williamson, 1st Prize; Pacelli Breathnach, Coillte Training Centre; and Dave Higgs, Liffey Distributors.

UCD. FDB Insurance, Liffey Distributors and Carlow Farm Machinery, gave sponsorship with Coillte, the new State owned forest company, providing the site for the event. The stand of timber used for the competition had been sold to Woodfab of Aughrim.

In total 13 competitors, which were all students, participated in the event. Each competitor had eight minutes in which to fell, trim and cross-cut one tree into three lengths. The tree had to fall between posts placed two metres apart. The average diameter of trees felled was 27 centimeters but some less lucky competitors had to tackle trees measuring over 40 centimeters.

The judges, Mr. John O'Sullivan and Mr. Pacelli Breathnach of Coillte Training Centre in Mountrath, Co. Laois, emphasised safety in their assessment and awarded marks for safety clothing, correct techniques and accuracy as well as speed and skill.

Gary Williamson (third year, UCD) won first prize. Hugo McCormick (also third year) came second, and Clare Boylan (fourth year) took the third position. Mr. Dave Higgs of Liffey Distributors presented prizes worth £200. Announcing the winners, Mr. O'Sullivan commended Gary Williamson for achieving the remarkable score of 146 out of a possible 152. He also commended Clare Boylan for her outstanding safety technique and expressed satisfaction that most competitors had paid particular attention to safety.

Mr. O'Sullivan said that he hoped the Wicklow chainsaw competition would become an annual event. The organiser, Eoin Murphy, stated that this would be the case and he hoped that it would attract spectators as well as competitors.

Society News

WOOD IRELAND

Following on the very successful two-day FORESTRY '88 Show held at Emo Forest last September, which was attended by 7,000 people, the Society of Irish Foresters has decided to organise an indoor exhibition of Irish wood and wood products. The exhibition, called WOOD IRELAND, will be held on the 29th and 30th of September 1989 at the Sports Centre of UCD in Dublin.

WOOD IRELAND is the first venture of its kind in this country. The aim of the exhibition will be to promote the use of Irish wood and to demonstrate it's properties and potential, for as wide an array of end-uses as possible. To achieve this, every organisation and firm involved in wood production, processing and promotion will be encouraged to participate.

An extensive publicity campaign will be undertaken to promote the show. While it is intended that the general public will be encouraged to visit the show, a specific effort will be made to attract architects, builders, designers, engineers and furniture manufacturers. Retailers involved in the whole range of wood products from D.I.Y to crafts will also be targeted. The Department of Education will be asked to co-ordinate the involvement of schools.

I would be grateful if you, as a member of the Society, would let the trade and the public in your own area know about the exhibition.

John McLoughlin, PRO.

COUNCIL REPORT 1988

Symposium

"Planting Stock for Tomorrows Forests" was the theme of the Symposium held at Carysfort College on 8th April, which was attended by 148 members. Six papers were presented on the subject and published in Irish Forestry Vol. 45 (2).

Annual Study Tour

The annual study tour was based around the Thurles area from the 23rd-27th May and a full account of which is in Irish Forestry Vol. 45 (2).

Day Meetings

A one-day meeting to J.F.K. Park planned for October was cancelled as a mark of respect to Mr. T. Rea, Assistant Secretary, Forest Service.

Public Meetings

Two public meetings were organised by the Society during 1988. The first meeting was entitled "Forestry and the Environment" was held on Friday 18th March in UCD. The speakers were Mr. J. Phillips, Director of Conservation Service, Northern Ireland and Professor F. Convery, Heritage Trust Professor of Environmental Studies, U.C.D.

The second public meeting was entitled "Tropical Forestry – Why Both-

er?" and was addressed by Mr. Chuck Lankester, Chief Forestry Officer of the United Nations and Mr. F. Mulloy, Senior Inspector, Forest Service, Department of Energy.

National Forestry Show

The Society in conjunction with the Irish Timbermen's Association hosted the first National Forestry Show, FORESTRY '88, which was held on the 9th and 10th September in Emo Forest. A full report on the show is documented in Irish Forestry Vol. 45 (2).

The Society wishes to thank those who presented papers at the Symposium, all those who helped in organising the field days. Thanks are also due to the Forest Service, Dublin, the Forest Service, Belfast and University College Dublin for their co-operation and assistance during the year.

Annual General Meeting

The AGM was held at UCD on 7th April. The Minutes were published in Irish Forestry Vol. 45 (1).

Regional Conveners

Two Regional Conveners, Mr. J. Dillon and Mr. W. Murphy, were appointed by the Council to organise Public meetings/events in their areas.

Publications

Irish Forestry Vol. 45 was published. The Why Forests? leaflet was updated and reprinted.

Public Relations Officer

A new post of Public Relations Officer was created following the AGM. Dr. J. Gardiner was co-opted as PRO for 1988.

Examinations

Three candidates successfully completed the Forester's Certificate Examinations.

Educational Award Fund

The winner of the current year's prize is Mr. John Moorehead from Bangor, Co. Down (UCD recipient).

Elections

The post of Vice-President along with three posts of Technical Councillor and one of Associate Councillor were filled by election. The successful candidates, subject to the approval at the next AGM, are Vice-President – E. P. Farrell; Technical – J. Fennessy, E. Hendrick, and R. Whelan; Associate – A. J. van der Wel. as there was only one candidate for each of the other posts they were filled without election. The total valid poll was 197.

Membership

Number of members on 31st December 1988:

Technical	*Associate*	*Student*	*Total*
516	135	24	675

New Members elected in 1988:

6	10	7	23

Attendance at Council Meetings

Six meetings have been held during the year. Attendance was as follows:

J. Prior, K. Collins, P. Breathnach, D. Magner, G. Murphy	6 meetings
J. Fennessy, E. Hendrick, B. Wright, J. Neilan	5 meetings
R. Whelan, L. Furlong, J. O'Dowd, A. van der Wel	4 meetings
P. McCusker	3 meetings
J. Gardiner	2 meetings

Signed: **K. Collins,**
March 1989. *Hon. Secretary.*

MINUTES OF THE 47th ANNUAL GENERAL MEETING FRIDAY 28th APRIL, 1989 JOHN F. KENNEDY PARK, CO. WEXFORD

The outgoing President Mr. J. Prior took the Chair.

Attendance

J. O'Driscoll, A. Pfeifer, E. Hendrick, K. J. Hutchinson, L. Furlong, J. Neilan, B. Dean, N. Ó Muirgheasa, F. Mulloy, M. Bulfin, J. Durand, G. Patterson, B. Dagg, T. Prucell, C. Fahy, D. Fitzpatrick, T. Hunt, P. Kelleher, C. Kelly, R. Clear, G. Fee, D. Magner, M. Aylward, R. Jack, P. Dodd, D. Ward, A. Coffey, M. Keane, J. Killbride, B. Wright, B. Lacey, J. McLoughlin, R. Sweetman, M. O'Malley, G. Murphy and K. Collins.

Apologies

M. O'Brien.

Secretary's Business

The minutes of the 46th Annual General Meeting, having already been circulated to members were agreed and signed. Proposed by B. Lacey and seconded by J. O'Driscoll.

Council Report 1988

The report having been circulated to members was taken as read. Proposed by D. Magner and seconded by J. McLoughlin.

Abstract of Accounts

G. Murphy, the outgoing Treasurer, presented the Statement of Accounts for the year ended 31st December 1988. The balance to credit is down on the 1987 figure of increased journal cost and secretarial expenses. Proposed by M. Keane and seconded by J. Neilan.

Confirmation of Elections

The meeting confirmed the 1989 Council Elections as follows: President, B. Wright; Vice-President, E. P. Farrell; Hon. Secretary, K. Collins; Treasurer, K. Hutchinson; Editor, A. Pfeifer; Business Editor, G. Murphy; PRO, J. McLoughlin; Auditor, W. H. Jack; Northern Ireland Group Rep., F. Topping; Technical Councillors, J. Fennessy, E. Hendrick, R. Whelan; Associate Councillor, A. J. van der Wel. Proposed by D. Ward and seconded by P. Dodd.

At this point the new President, Mr. B. Wright took the Chair.

Motion Proposed by Council

"That the annual subscription for Technical and Associate membership be increased from £15 to £25 and Student membership from £5 to £10; the new subscription rate to come into effect from the 1st of January, 1990."

The discussion on this motion centred on whether there should be separate Associate and Technical subscription rates since some Technical members may gain tax relief on the subscription. This suggestion was dropped when it was pointed out that none of the Coillte or Forest Service members received tax relief. Concern was also expressed in the large increase in the Student rate but it was pointed out that the £10 rate does not even cover the cost of the two journals issued. The motion was carried unanimously.

Any Other Business

The current position on the Forester's Certificate was raised. It was stated that the certificates were being printed and will be circulated.

F. Mulloy stressed the need to issue certificates to Coillte's foresters before the EC reciprocal recognition of qualifications in 1992.

Messrs F. Mulloy, M. Bulfin and J. Durand strongly suggested that the Society be affiliated to The Tree Council of Ireland due to its capacity to generate publicity. This matter will be discussed at Council level.

There was a request from the Meetings Committee for suggestions for Symposia and Day tours.

To commemorate the 50th Anniversary of the Society in 1992 J. Durand suggested that An Post issue a special stamp. A tour to the west coast of North America was also suggested.

The meeting concluded at 5.30 p.m.

SOCIETY OF IRISH FORESTERS — STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1988

1987	*RECEIPTS*		*1988*
8,580.82	*To Balance from Last Account*		3,718.33
	To Subscriptions Received		
	Technical 1988	4,186.01	
	Technical 1987	530.43	
	Associate 1988	872.00	
	Associate 1987	156.00	
	Student 1988	50.00	
	Student 1987	29.00	
	Other Arrears	210.50	
	Advance Payments	591.35	
6,130.57			6,625.29
	To Interest on Investments		
	Savings Account	19.19	
	Educational Building Society	6.47	
797.47	Lombard & Ulster	197.07	222.73
	To Journal		
	Sales	1,136.72	
3,784.76	Advertising	1,751.70	2,888.42
12.46	Gains on Sterling		47.12
—	Forest '88 Show	870.00	870.00
10.00	Donation		25.66
19,116.08			£14,397.55

1987	*PAYMENTS*		*1988*
109.90	By Stationery and Printing		237.00
9,631.70	By Printing of Journals		3,448.50
1,613.54	By Postage		2,631.32
103.40	By Expenses re Meetings		610.00
113.50	By Bank Charges		185.50
2,116.00	By Secretarial Expenses		3,109.60
549.41	By Value Added Tax		823.56
50.00	By Examination Expenses		—
—	By Insurance Liability		888.37
—	Affiliations		177.46
590.30	Return of overpayments		—
	By *Honoraria:*		
	Secretary	50.00	
	Treasurer	50.00	
	Editor	50.00	
200.00	Business Editor	50.00	200.00
520.00	By Study Tour Expenses		—
—	By Forest '88 Show		870.00
	By *Balance:*		
	Current Accounts	(9.79)	
	Savings Account	1,061.89	
3,718.33	Educational Building Society	164.14	1,216.24
19,116.08			£14,397.55

I have examined the above accounts, have compared them with vouchers, and certify same to be correct, the balance to credit being IR£1,216.24 which is held in current accounts at the Ulster Bank. (IR£2,494.50 plus refund due IR£4.00 — IR£2,508.29 uncashed cheques), Ulster Bank Savings Deposit Account, 6751465, and Educational Building Society Account 130441. There is a holding of IR£100 Prize Bond No. R855061/080. IR£1,510.67 is held in Trustee Savings Bank Account 323 001 35909 for the Educational Award Fund.

Signed: W. H. Jack, Hon. Auditor

SOCIETY OF IRISH FORESTERS — EDUCATIONAL AWARD FUND FOR YEAR ENDED 31st DECEMBER, 1988

1987	*RECEIPTS*	*1988*	*1987*	*PAYMENTS*	*1988*
1,508.73	To Balance from last account	1,453.47	182.47	By Awards	100.50
100.59	To Interest	67.29	1,453.47	By Balance	1,510.67
—	To Donation	—			
26.62	To Dirt Refund	90.41			
IR£1,635.94		IR£1,611.17	IR£1,635.94		IR£1,611.17

I have examined the above account and certify same to be correct, the balance to credit being IR£1,510.67 which is held in the Trustee Savings Bank Account 30013591 for the Educational Award Fund.

Signed: W. H. Jack, Hon. Auditor.

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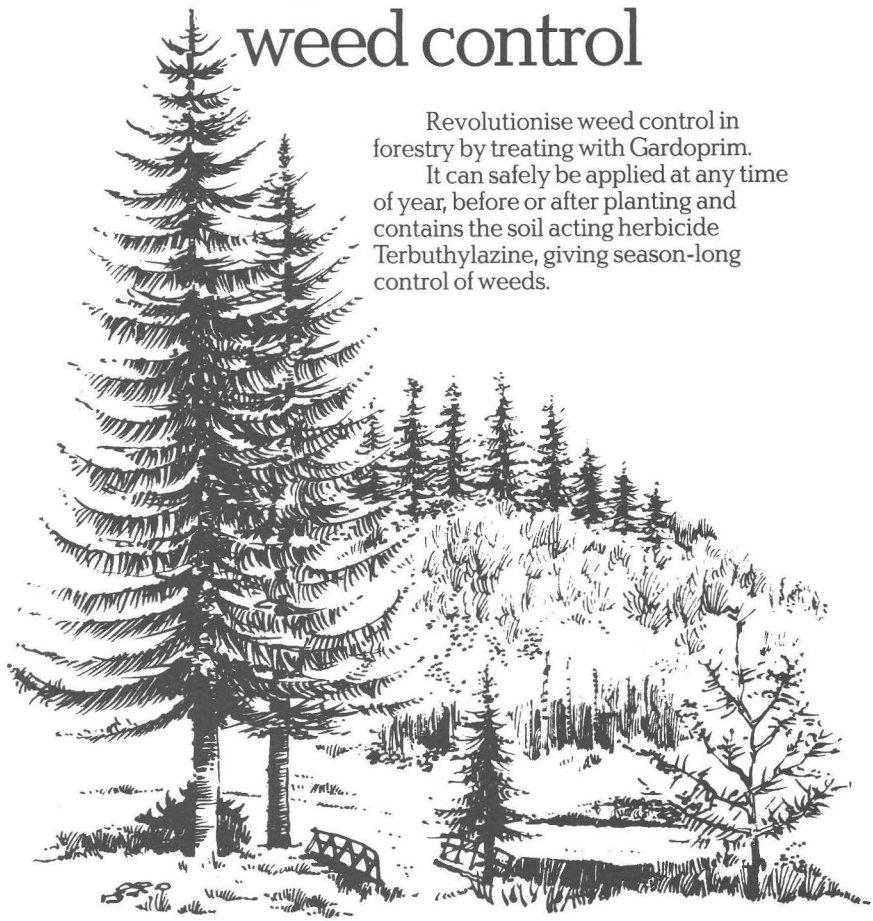

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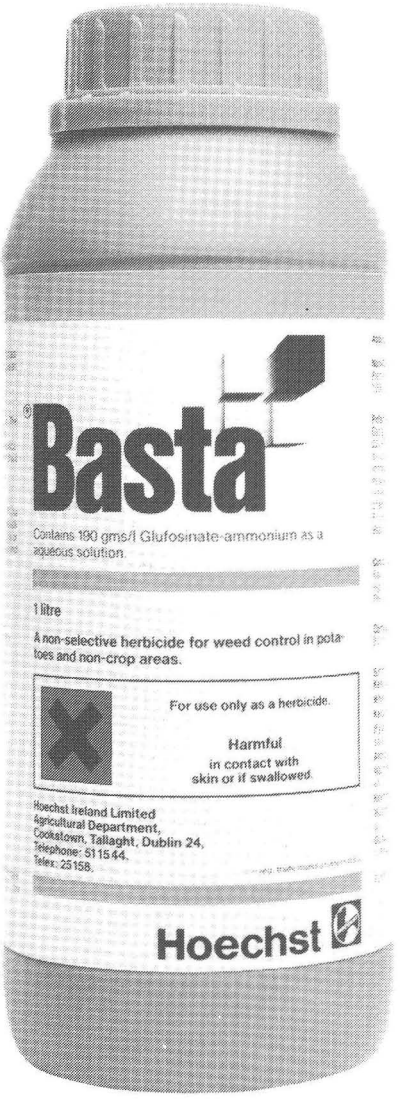

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Pre-plant treatment

Overall spraying of plantation areas prior to planting. Target weeds should be actively growing, with sufficient leaf area to give good reception of the spray. Woody weeds, heather and bracken are best treated in full leaf or frond, before the foliage changes colour in the autumn. Best results are obtained between mid-July and end-August, when brambles and most scrub species will also be susceptible.

Overall treatment

During their dormant season, the following species are tolerant to Roundup:
Pine: Corsican, Scots, Lodgepole.
Spruce: Sitka, Norway.
Douglas Fir*
Japanese Larch**
Roundup applied from August to end-February, after extension growth has ceased and before buds swell in early spring, will control actively growing grass, broad-leaved and woody weeds.

* *treat only in late summer months; avoid early spring treatments.*
** *treat only during autumn and winter.*

Selective treatment

During spring and summer, Roundup may be applied using a knapsack sprayer or Micron 'Herbi.'
Care should be taken to prevent the spray from contacting any part of the tree. Use a tree guard to protect tree growth from drift in inadvertent spray contact.
Selective application of Roundup herbicide can also be made using specialised hand-held applicators, such as the Weedwiper Mini.

For details of application techniques, please contact your usual chemicals supplier.

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Notes for the Assistance of Contributors

The following notes are designed to aid the speedy processing of scientific contributions to the Journal.

1. Two copies of each paper should be submitted in typescript, with double spacing and wide margins, correct spelling and punctuations expected.
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:

   GALLAGHER, G. and GILLESPIE, J. 1984. The economics of peatland afforestation. Proc. 7th Int. Peat Cong. Dublin. Vol. 3:271-285.

   KERRUISH, C. M. and SHEPHERD, K. R. 1983. Thinning practices in Australia. A review of silvicultural and harvesting trends. New Zealand Journal of Forest Science, 47:140-167.

   Forestry Abstracts may be used as a guide in the abbreviation of journal titles.
6. A short summary of the paper should be included. It should precede the main body of the text.
7. Proofs will be sent to the senior author for correction. Proof corrections are costly and authors are requested, as far as possible, to confine alterations to the correction of printer's errors.
8. Reprints can be supplied as required by the author. The cost of reprints will be charged to the author at a standard rate per page. *Reprints must be ordered when returning corrected proofs to the editor.*

IRISH FORESTRY

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Articles

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