IRISH FORESTRY

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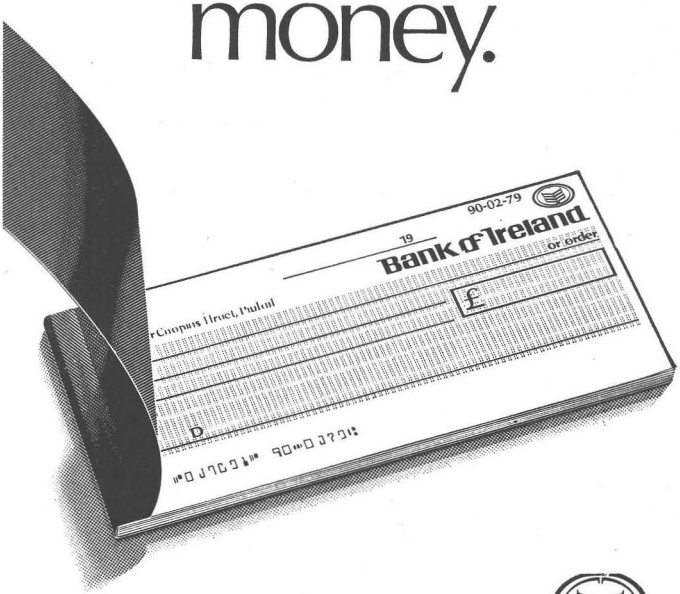

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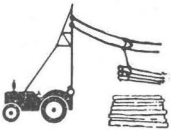

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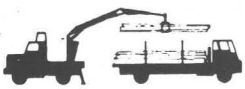

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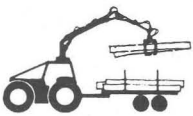

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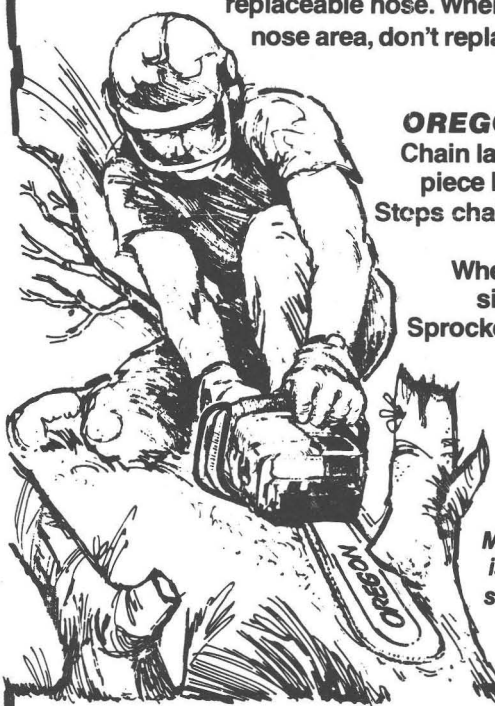

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IRISH FORESTRY

Vol. 34 1977 No. 2

EDITORIAL

SYLVIE RULES HERE – O.K.?

DESPITE the greatly accelerated afforestation rate of the past 30 years, this is still an island of bare mountains, of treeless, boggy plains. And with less than 5% of the land surface under forest, one might be forgiven for thinking that it will remain so for the forseeable future. However, this would be a dangerous attitude to adopt. A 500 hectare plantation in 10,000 hectares of blanket bog represents only 5% of the area under forest, but aesthetically it may radically alter the character of the whole bog. We have in our stark mountains and our wild, barren plains something quite rare in temperate regions, examples of which should be preserved and the pristine landscape maintained.

There are many examples in Ireland of forests established in recent years in large tracts of previously untouched blanket bog, or on the slopes of bare mountains. For the most part, these plantations represent a wise use of a resource which had previously been relatively unproductive.

Occasionally, however, the new forest may have appeared to some people to be a blot on the natural landscape, something foreign which did not belong there. It would be foolish in the extreme to condemn the afforestation of blanket bog or open mountains. It is difficult, without detailed information, to sit in judgement over the afforestation of any particular tract of land. The problem lies not in the decision to plant an area, but in the criteria upon which that decision is based. Each site is closely scrutinized to see if it is amenable to ploughing and is, therefore, plantable. But is there any room in the decision-making process for a consideration of what would be lost as a result of the establishment of a plantation?

There is a loss factor which should be taken into account. Who should be the accountant? Perhaps, in the Republic, this could be a function of the newly formed Department of the Environment.

Trends in Forestry Research and Its Implication on Silviculture[1]

C. P. VAN GOOR[2]

Introduction

THE starting point of any meaningful forestry research should always be the whole compass of forestry practice. Forestry practice is today faced by three weighty problems:

1. A rapidly increasing need for wood and wood products in the whole world. Estimates based on the area of forests and not the area of forest land indicate that demand is probably greater than production. Therefore competition for wood in industrial countries will become stronger and stronger.
2. Labour costs are increasing to the detriment of profitability of forestry, the more so because of relative lag in prices for timber.
3. An increasing voice and interference from environmentalists, ecologists, biologists and the public at large.

These are the problem areas, that modern forestry research must also face. One objective of research is to raise timber production, which can be done by extending the forest area, by improving the internal growth factors of the trees such as the genetic properties or by improving the external growth factors of the site. Forest fertilization, soil improvement etc.

Another objective is to develop methods for rationalization and mechanization of forest work to decrease costs. However we have to be aware that the productivity of the forest as ecosystem must not be endangered by methods resulting in irreversible negative processes. An important aspect of forest research is to develop methods for engineering the ecosystem. Forestry is a way of land use in which ecological and biological principles play a leading role.

Engineering ecosystem in forestry is considered as a basic principle since the main objective of forestry is the everlasting maintenance of forest for posterity as a natural resource for sustained production of material and immaterial goods. Foresters — managers and research workers — should never evaluate any measure on short term rewards. The criteria for evaluating our activities must always be gathered from the complete production cycle and not, for instance, from the quality of a plantation. It is fundamentally incorrect to evaluate methods, techniques or measures only by immediate effects, though it happens every day and everywhere, in particular for establishment

1. Invited paper presented to the Thirty-Fifth Annual General Meeting of the Society of Irish Foresters, March 26th, 1977.
2. "De Dorschkamp," Research Institute for Forestry and Landscape Planning, Wageningen, The Netherlands.

methods and harvesting techinques. The full production cycle, on which the forester has only limited influence, depends largely on self maintained equilibrium in the ecosystem of the forest. The forester exercises his influence somewhere in the cycle. This influence should accord with natural processes in the forest community.

This is emphasized, because there is a clear tendency for increasing costs of labour to dominate decisions. Methods for the establishment of stands, for tending, thinning and harvesting, by which manpower is replaced by machines, are often evaluated by costs alone, and short term effect. But do we know, what the long term effect is? The influence on the full production cycle? On the ecosystem?

Forestry, all over the world is facing this dilemma. Foresters have to work as economically as possible in a society in which even 5 years is a long term. The concern of environmentalists is partly due to doubt about the correctness of modern forestry methods. And not without reason, taking into consideration the exploitation of many tropical rain forests or the large scale clearcut methods in the forests of the Northern hemisphere. It is of paramount importance to know what the carrying capacity is of forests as ecosystems for modern methods directed to increase timber production and to decrease costs.

An *ecosystem* is a biological community, which forms an interacting system with its physical environment. Ecosystems are arbitrary in size and are not static. Changes in plant communities – succession – are very evident in forest ecosystems for instance. These successions lead to complex and stable communities of trees, plants and fauna, which are defined as climaces. In the most stable ecosystems, as are found in the tropical rain forests, the balance between the inflow of energy and the production of biomass is in full equilibrium. Natural regeneration takes place without appreciable changes in the plant community. Exploitation of these systems should be carried out on a small scale, comparable with the so-called plenter-system of Switzerland. Exploitation of these systems with large scale clearcutting or even with large clearings may cause a complete collapse of the ecosystem. In the cooler regions of the world – like Europe – the physical environment does not permit the development of such complex communities, as in the tropics. The less complex the communities, the larger the changes in the plant communities during the natural regeneration. Regeneration probably takes place after disasters. A famous example is the significance of the spruce budworm in the forests of *Picea mariana* and *Abies balsamea,* in eastern Canada. In mature forests of pure *Abies balsamea,* this species is killed by spruce budworm and *Abies* forests regenerate by succession of *Picea mariana* and birch, which are not susceptible to the insect.

Forest fire may have the same significance in forest ecosystem of

the temperate zones. In the mountains of Anatolia it appears, that forests of *Abies bornmulleriana* are destroyed by fire. After the fire the area becomes covered with *Pinus sylvestris*. Under the canopy of this species *Abies bornmulleriana* will regenerate. In general, natural regeneration is a fluctuation around an equilibrium. Fluctuation is stronger the more extreme the physical conditions, in other words the less complex the forest ecosystems.

What does this mean for foresters? Broadly it means two things: things:

1. With the due maintenance of forests as a natural resource, exploitation of forests in the temperate and cool regions of the world by clearcut is generally in accordance with natural processes. This is not so in complex systems as for instance the tropical rain forests.
2. By changing complex systems into simple systems, like the conversion of such tropical forests into pine or eucalypt stands, a major part of the energy is stored in the trees and production of timber can be increased enormously. Pure stands will generally show the highest timber production. But these stands are not always ecologically stable and need permanent human interference to maintain a certain equilibrium.

In Europe, man has used and abused forests for centuries. In particular grazing, litter removal and burning have impoverished forest ecosystems. In many cases the forest has been destroyed and changed gradually into bare land. By afforestation restoration of the forest ecosystem is taking place.

Topical matters in commercial forestry are mechanization, use of fast-growing species, soil improvement by fertilizers, drainage and tillage. These practices have effects on the forest ecosystem. They can be positive or negative and it is interesting to review them in more detail.

Choice of tree species

In those parts of Europe, where the natural forest is composed of hardwoods, foresters have introduced softwoods on a large scale to increase and speed up timber production. But serious die-back of such artificial stands of Norway spruce in Saxony at the end of the last century and the beginning of this one, caused a reaction to this practice. In particular in Central Europe, but also in our country and in Belgium use of softwoods on sites of natural hardwood forests was considered erroneous. It was assumed that plantations of such species would degrade the soil, form raw humus, fix nutrients and accelerate podsolization. It was considered necessary to mix softwoods with hardwoods or to underplant them with soil improving shrubs like

Prunus serotina – now a pest – to improve humification of organic matter.

After the Second World War this problem was studied more intensively after advances in soil science and it became evident, that, compared with hardwoods, coniferous species had little or no untoward effect on productivity of the site.

It was observed that:

1. soil development was independent of the difference in species of tree. For maintenance of productivity of the site use of exotic tree species appeared to be of no risk.
2. decrease of growth and die-back in subsequent generations of softwood stands was not caused by changes in the soil. The observed die-back proved to be related to incorrect choice of tree species, wrong provenance, or adverse soil conditions.
3. if properties of the site met with the needs of the species no difficulties of this sort arose.

A special case is choice of tree species in afforestation of heath. Heath is the result of centuries of misuse of land by man. The natural oak-beech forest was destroyed or degraded and biological, nutritional and physical status of soil has declined. Afforestation of such land is the start of a long succession to a more stable ecosystem. On these acid soils poor in nitrogen, phosphorus and other nutrients only a few species are adapted to the site. Specifically the species, with low demand for nitrogen, like larch and pine can be used successfully and sometimes spruces, when besides phosphate fertilization, some help is given with nitrogen supply. But mostly, spruces grow less than pine and larch.

After one generation of pines or larch, enrichment of the site can be observed. The nitrogen level in the soil has increased considerably and this has its consequences for choice of species. The site has become suitable for species demanding more nitrogen. Even the suitability for larch, which is more susceptible to excess of nitrogen than other species decreases.

It is interesting that the improvement is stronger with better moisture relations and a higher phosphate level. A normal Douglas-fir *(Pseudotsuga menziesii)* plantation of more than 50 years of age has been analyzed on height growth. Comparing this height growth with the height growth of Douglas-fir in the yield table, it appears that the site-index improved in time (Fig. 1). Comparing growth of second generation, with that of first generation Douglas-fir shows an increase in volume increment (Table 1).

Analyzing needles, which is done to get an impression of the nutrient status of the site, demonstrates, that with the low nitrogen demanding Japanese larch the nitrogen content of the needles is high

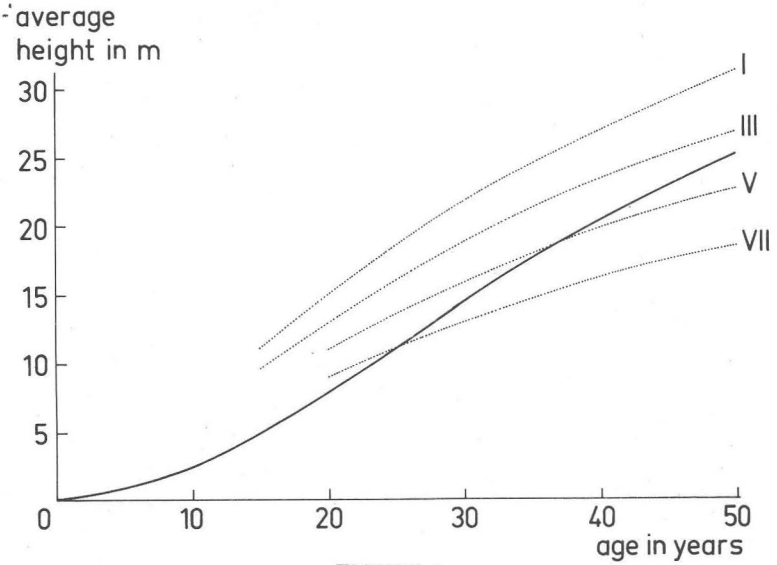

FIGURE 1

Height growth of a 50 year old Douglas-fir plantation as a first generation heathland afforestation (full line). Comparing this growth with the height growth according to the yield table (dotted lines) indicates a permanent improvement of growth with age.

TABLE 1

Average volume increment in m^3 per year per ha (based on yield table, 50 years rotation) of first and second generations of Douglas-fir plantations in heathland afforestations on identical soil types.

generation	age	mean height increment, last 5 years in m	mean annual volume increment in m^3/ha
1	25	3.6	17
1	24	3.1	13
1	23	3.0	13
2	22	4.0	20
2	18	4.7	22
2	19	4.7	22
2	18	4.6	22
2	24	5.0	25

and for first and second generation equal. For the more exigent Norway spruce however, first generation stands show nitrogen deficiency, while the stands of second generation are adequately supplied with this element. (Fig. 2).

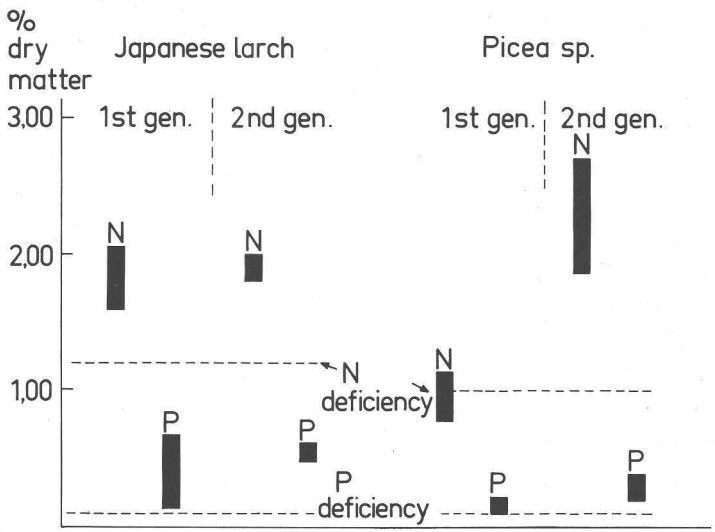

FIGURE 2

Nitrogen and phosphate content of the needles of a first and second generation of Japanese larch and Norway spruce in heathland afforestations. A distinct increase of the nitrogen content of the needles of the second generation of Norway spruce can be observed, which is not the case for the low nitrogen demanding Japanese larch. Nitrogen content of the needles of the first generation of Norway spruce indicate nitrogen deficiency. The nitrogen content in the needles of Japanese larch and the second generation of Norway spruce demonstrate adequate supply of this nutrient.

So without any nitrogen fertilization the soil has been enriched with this nutrient by means of the forest itself. Estimates indicate a 50-70 kg N/year/ha in a first generation.

By research on growth site relationship much information has been gained about the requirements of various trees and many countries now use site suitability maps for forestry planning.

Internal growth factors

Use of exotics — conifers on sites of hardwoods — requires choice of the correct provenance or race. Genetical properties have an important influence on growth and health of stands. The influence of the genetic properties on growth rate is assessed in experiments with various provenances, races, progenies and hybrids.

The contributions of tree breeding to increase wood production are in some cases sensational, like with the hybridization of Aigeiros

poplar. Volume production of new clones is sometimes doubled, comparing the traditional clones.

The effect of tree breeding on health of trees and stands is particularly with coniferous species, much more difficult to investigate.

Die-back without any pathogenic cause can be observed regularly in conifer plantations. Apparently these phenomena are related to physiological processes in the tree.

In the Netherlands the best growing provenances of Douglas-fir show die-back or top dying in the early stage of the plantations at a height of about 1 to 3 meters. In cold and sunny winters, young Douglas fir exposed to sunlight, becomes yellow and brown during February and March and sometimes die; at least the top is dying. This is not caused by drought, but probably by uncompensated respiration. If the trees are protected against the direct sunlight, they stay green and healthy. Growth in the season after the winter is better with than without protection. The phenomena are not observed when the winter is mild and damp. The best provenances of green Douglas fir from regions with a maritime climate are not adapted to continental winters. Therefore Douglas fir in our country is planted in strips which are protected by old forests.

The same kind of die-back is observed in Norway spruce and Scots pine, but mostly much later, when the stands are 25 years or older. In some stands of Scots pine, with discoloration during wintertime – symptoms similar to these of deficiency of potash – die-back occurs. This die-back begins with decrease of growth in height, die-back of the rootsystem and is followed by top dying. Sometimes, but not always, this phenomenon is accompanied by pests, which are probably secondary.

Even attack of pines by *Aradus cinnamomeus*, which is often noticed is probably not the primary cause. Also here it is supposed, that yellowing provenances of Scots pine – Northern, continental origins – are not adapted to certain climatic conditions in Western Europe during dormancy. There is as yet no evidence about decisive climatic factors. But provenances from England, Scotland and Western Norway do not show die-back.

Norway spruce, which has its natural range in continental climates with cold winters, shows severe die-back at 30 years of age and older after a series of mild winters. Perhaps here too the physiological activity during the mild dormancy season exhausts reserves of carbohydrates, retards regeneration of the root system and induces die-back. In the Netherlands die-back was serious before the gales of 1972 and 1973 and destroyed many Norway spruce plantations. It seems, that the practical significance of the physiology of trees has

often been neglected. The physiology of a tree is largely determined by genetic properties and changes with the age of a tree. If the physiological condition of a tree is weakened the tree will become more susceptible to diseases. A striking example is a trial with various provenances of Scots pine on a field intensively infested with *Armillarea mellea*. This fungus is generally considered as a primary parasite of conifers. But in this trial yellowing provenances were much more attacked by this fungus than others. Obviously some of

FIGURE 3

Lay-out of the test plot with different provenances of Scots pine. Die-back by *Armillarea mellea* is given in percentages within the parcels. German provenances show the highest percentages of die-back.

Block I			Block II			Block III		
sel. nr.	% dead trees	— h	sel. nr.	% dead trees	— h	sel. nr.	% dead trees	— h
1452D	34.5	3.12	1720	33.5	2.96	1448	31.7	3.45
1714	9.8	3.44	1718	24.2	2.98	1453D	62.7	2.70
1448	13.0	3.88	1451	24.0	3.10	1717	33.1	2.86
1717	9.9	3.68	1448	14.5	3.44	1455D	67.4	2.41
1715	22.7	2.97	1719	17.0	2.83	1454D	54.7	2.64
1713	15.9	3.27	1717	12.0	3.05	1715	48.9	2.20
1453D	35.6	2.86	1455D	36.9	2.47	1449	14.7	3.26
1454	34.0	2.99	1452D	33.3	2.50	1451	41.6	2.84
1718	12.8	3.50	1454D	55.6	2.43	1443	25.3	2.98
1449	10.8	3.95	1449		3.48	1713	15.0	3.21
1443	14.2	3.60	1715	26.8	2.46	1716	13.7	3.28
1450	11.2	4.04	1716	27.5	3.10	1714	12.6	3.38
1446	16.0	3.87	1714	33.2	2.97	1450	5.5	3.59
1716	9.6	3.48	1453D	60.3	2.50	1446	10.9	3.56
1720	14.5	3.14	1450	28.5	3.35	1719	7.7	3.07
1451	16.0	3.49	1446	19.2	3.27	1720	25.7	2.53
1719	12.4	3.01	1713	35.9	2.90	1452D	55.2	2.43
1455D	14.2	3.33	1443	36.3	3.28	1718	25.7	2.73

$\bar{h}$ = average height (m)
D = German provenance

the most maritime provenances were not attacked at all. The lay-out of the experiment and the percentage of dead trees, killed by *Armillarea mellea,* are indicated in Figure 3. The plots with high percentages are planted with German, more continental provenances.

Therefore it is not only of importance to use fast growing provenances, but also provenances of which the physiology is adapted to the site.

Soil preparation

For the afforestation of bare land – heathland, land reclaimed from the sea, peatland – some kind of soil preparation is always necessary to improve conditions for growth of trees. Often the soil is compact and should be loosened.

There is however also a current trend to cultivate the soil for reafforestation, with the aim of mechanised planting. But here soil conditions are different from those of non forest land. The soil is a distinct part of the ecosystem, it can even be considered as an ecosystem itself, with the edaphon in dynamic equilibrium with the physical environment. Tillage markedly increases biological soil activity, turn-over of the organic components and mineralisation. This will generally be beneficial in colder and wetter regions where there is a tendency for organic matter to accumulate. But in temperate and warmer regions it can be dangerous, because organic matter, which is the heart of the fertility in many forest soils may be affected. On the lighter soils on the Continent of Europe we clearly observe the adverse effect of soil tillage in the long run. Even in heath afforestations the enrichment of the soil achieved in the first generation is lost after soil tillage.

In several experiments soil tillage was tested in its effects on growth during subsequent years. One experiment was carried out with two types of planting material of Scots pine (transplanted and undercut) on tilled soil and soil with only a planting place prepared by the so-called kulla cultivator. After the first years the annual height growth of the pines on the cultivated soil is dominating, but in the last two years it is lagging behind the growth of the pines on the uncultivated soil (Figure 4). At the moment, the total height is still greater on the cultivated soils, but the conversion is already beginning. The effect of soil cultivation is persistent, because a tilled soil can never be converted into an untilled soil; an irreversible process therefore, which is harmful for the forest ecosystem.

Intensive use of heavy machinery for harvesting causing considerable damage to the soil, may have the same negative effect as soil tillage.

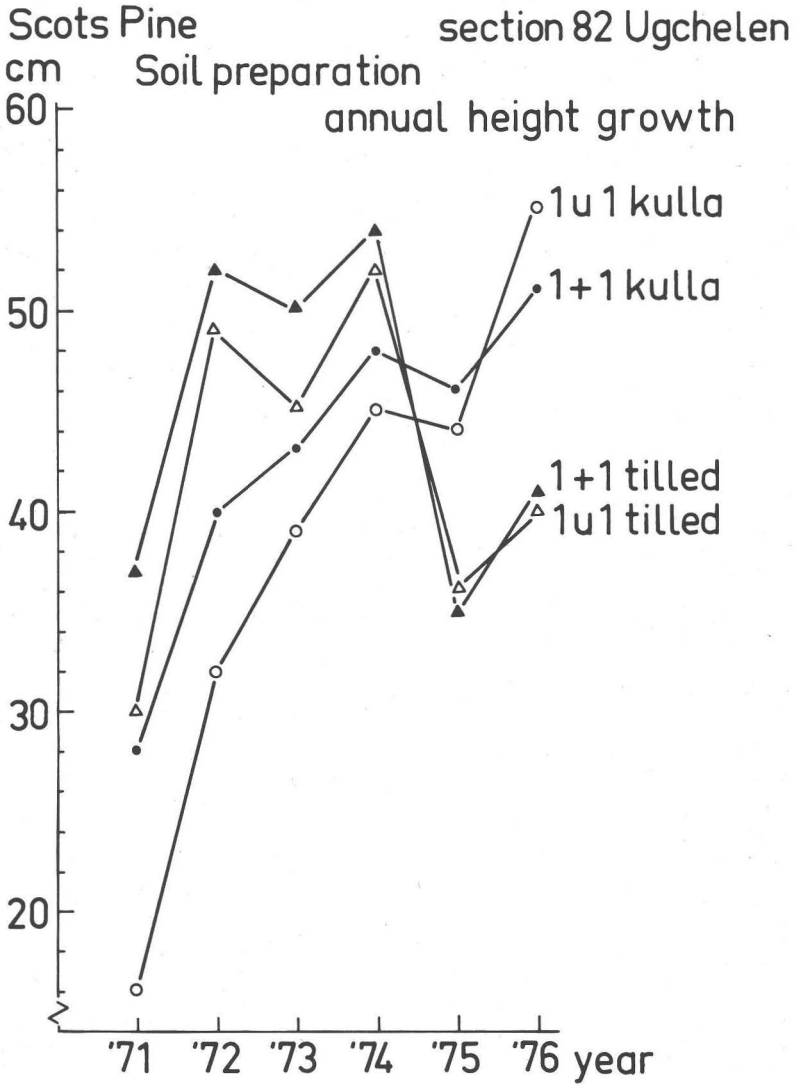

FIGURE 4

Annual height growth of Scots pine on tilled and untilled soil (kulla). The transplanted plants show a better initial growth, than the seedlings which have not been transplanted, but undercut in the nursery. Growth on the tilled soil is better in the first four years and after that lagging behind the growth of the trees in the uncultivated soil.

Herbicides and planting material

If the soil is not tilled before planting, weed growth generally is severe. Research with herbicides is well advanced and many techniques have been developed for forestry to apply herbicides, selectively and with undue harm to the environment. Herbicides like dalapon 2, 4, 5-Tester and glyphosate are optimal for controlling grass and dicotyledons. However, public opinion in many countries is against use of chemicals in forests. In some places chemical weed control is prohibited – so methods should be developed to carry out reafforestation without it. Planting stock must be adapted to the conditions of the site. Quality of the planting material is becoming a decisive factor for the success of plantations. The current trend in production of planting stock is efficiency in operations. In general this means rather small plants, not so well adapted to competition with weeds. They can only be successfully planted on sites with little weed growth. An improvement are the tubed seedlings, but, depending on the species, even these rather small plants suffer from large-sized weeds. Another development in research of planting material is the following. As pre-commercial thinnings are minimized or cut out, because they are becoming more and more expensive, spacing of plantations tends to grow wider.

Hence part of the selection of the precommercial thinnings takes place in the nursery. Grading in the nursery should therefore be directed to genetical properties of the planting stock. According to the effect of seed properties and germination on growth of seedlings, this grading should also take place in the year after germination. Planting material should therefore be older than 1 year. Moreover, larger planting material is better suited for competition with weeds, at least when its quality is optimum.

Within the Common Market criteria for this quality have been developed, these however are not related to the quality requirements of practical forestry but meant to liberate trade in planting material. Quality criteria are a minimum size with a certain age and a maximum ratio height and diameter root collar. But besides the physiological condition of the planting material should be such, that every plant after planting keeps on growing. Quality particularly has a great influence with Douglas fir planting.

The effect of quality on growth of Douglas fir after planting continues for many years. Even 5 years after planting, the height growth of planting stock with a height/diameter ratio of more than 5 is lagging (Figure 5).

In the Netherlands forest practice is working in this way at the moment with spacing as wide as possible and quality adapted to the competition. In fact in most of our reafforestation areas we use large

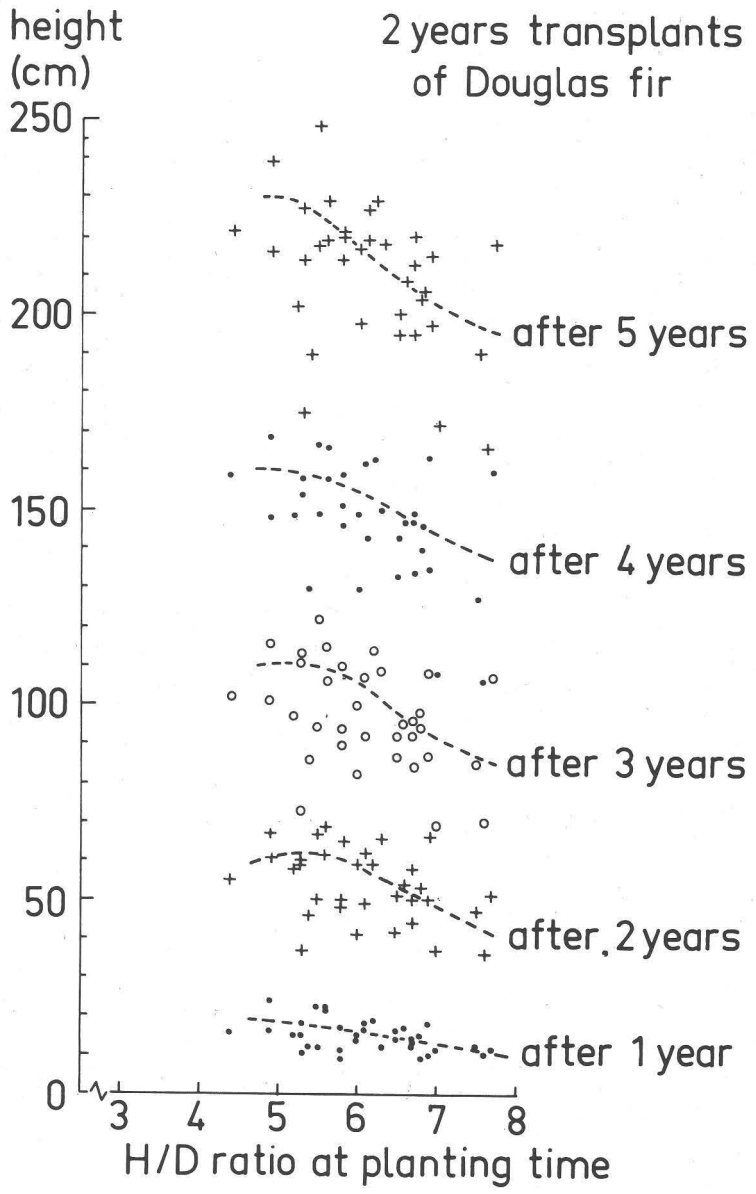

FIGURE 5
Height growth of Douglas fir plantations in relation to the height diameter ratio at planting.

planting material. Usually no soil preparation is needed and weed control can be kept to a minimum. Costs are relatively low, at least not higher than with small planting material, weed control and narrower spacing. Only on sites with little weed growth is smaller stock used, without weed control.

Fertilization

Research on forest fertilization started about 100 years ago and belongs to the most traditional subjects of research. But only after the Second World War has this research been enormously intensified. We have extended our knowledge of tree nutrition, soil fertility and techniques of applications, thanks to sophisticated methods of soil analysis, experimentation in controlled conditions, physiological research and soil classification. I will not enlarge, but I would like to discuss the significance of fertilizers in growth improvement and engineering of the ecosystem.

The main elements used in fertilization are nitrogen, phosphorus, potassium and now and then trace elements. The effect of these elements on the forest ecosystem is different. Almost always phosphate will remain in the ecosystem permanently. Phosphate is not very mobile in the soil and will be fixed by iron, aluminum or calcium and magnesium. As phosphate is a basic source for the edaphon, biological activity increases and the metabolism of the edaphon speeds up. In particular the nitrogen status is improved by nitrogen fixation of soil organisms. Therefore phosphate fertilization is extremely important to impoverished heathland soils in Western Europe. In fact it is very difficult, if not impossible, to start the enrichment of the forest ecosystem in such land without phosphate fertilizers.

Nitrogen itself is highly mobile if not combined with the organic components of the soil. So nitrogen fertilization has only a temporary effect. Only methods introducing nitrogen into the organic matter – urea, green manuring with lupines or alder – have a more permanent effect. Operations in the forest ecosystem with a temporary effect can disturb the equilibrium between the root system and the crowns. Therefore the wisdom of nitrogen dressing in later stages of a forest stand is debatable. In the colder regions of the Northern hemisphere the biological activity of the soil is so low that nitrogen is always at a minimum. Mobility of nitrogen is less than in the temperate and warmer regions. Probably the significance of nitrogen fertilization increases the colder the climate.

Potassium stands somewhere between phosphate and nitrogen. In certain soils it is rather mobile and is not built into the ecosystem. In others it depends on clay in the soil.

In Western Europe the most important trace element seems to be copper. Some minor elements are permanently built into the ecosystem like copper, others remain mobile, for instance boron. Generally it is of more importance to fertilize, if necessary, with elements that stay permanently in the ecosystem and let the ecosystem itself develop to the nitrogen level natural for other physical, chemical and biological conditions. Consequently, forest dressing should in my opinion be a one-time operation. An element added to the ecosystem, which remains in it, need not to be added again. All our heath plantations were fertilized with phosphate and after one rotation no effect in the second generation was observed with another phosphate fertilization. Other elements, which were not limiting in first plantations became limiting in the second rotation. This is so in particular with copper. Because of the higher nutritional and biological status of the soil in many stands copper deficiency can be observed, even when there was no reaction to copper fertilizer in the first rotation.

Harvesting

Mechanization of thinnings and clearfelling is a topical question. I think that if care is taken to preventing damage to soil and trees and if thinnings are not carried out systematically there is not much against it. Systematic thinning in stands with 2,500 trees per ha or less proved unsuitable.

The stands should be treated in such a way, that they become as stable as possible against gales, which are so common in Western Europe. That means full occupation of the area with regular distances between the trees. Moreover spacing should certainly be wide in the young phase to build up stability. In general stands with trees which have a height-diameter ratio of less than 70 from the start, are stable against strong winds. Heavy thinnings at the beginning of the development of a stand is essential. It will be difficult to combine systematic thinning with this requirement.

Some striking examples can be seen in storm-damaged Douglas fir plantations. In Table 2 you may observe that exposed stands with a H/D ratio over 80 have more damage than the stands with a lower ratio. A Douglas fir stand grown up from the beginning in a wide spacing was, though intensively exposed to the gales of 1972 and 1973, hardly damaged. A stand without narrow spacing in the beginning and light thinning intensities on the same kind of soil was severely damaged and lost more than 80% of its trees.

Mechanised clear felling is more profitable the larger the area cleared. But it is becoming more evident nowadays, that such large areas introduce certain ecological disadvantages. The conditions of

TABLE 2

Wind-throw in older Douglas fir plantations exposed to the gales of 1972 and 1973. Stands with a low ratio of height and diameter are less damaged than those with a higher ratio (*** = very heavy damage, ** = heavy damage, – = hardly any damage).

location	dom. height in m (H)	diam. in cm (D)	nr. of stems/ha	H/D	damage
Garderen-72	22	24	525	84	***
Garderen-73	23	51	–	43	–
Kon. Park	40	79	149	50	–
Kon. Park	39	68	147	57	–
Het Loo	34	54	205	63	**
Het Loo	37	54	183	68	**
Speulderbos-24	24	37	–	58	–
Uddel	33	42	287	76	**
Schoonlo	29	32	420	82	–
Kootwijk	31	37	295	81	**
Kootwijk-95	28	57	–	45	–
Vorden	19	22	960	84	**

micro climate change, wet soils can become waterlogged, weed growth is stimulated and regeneration is difficult. Therefore the current trend is, to limit the area of clearfelling in Western Europe.

I have given you a birds eye view of some problems in forestry and the way a research worker can look at them. I am aware, that my talk includes some personal philosophy. But when you start as an enthusiastic young fellow, you think that nature can be split up into separate aspects. And so you think of forestry. But as you grow older and gain more experience – often bitter experience – you discover more and more the interrelationship of all these separate aspects.

Forest is a living being, which is born, grown, dies and regenerates. We foresters have to know how this organism functions and to act accordingly.

Effects of Pig and Cow Slurry on the Growth of Sitka Spruce on Oligotrophic Peat and Gley Soils in Northern Ireland

J. S. V. McAllister[1] and P. S. Savill[1]

Introduction

Nutrients are normally applied to forest crops in the form of organic or inorganic fertilisers. Urea, rock phosphate and potassium chloride are the most commonly used forms of N, P and K respectively in Northern Ireland. There are no important naturally occurring sources of P or K in the province which are suitable for use as fertilisers. Nevertheless agriculture in the province shows a surplus of nutrients (McAllister, 1971) due to the large quantities imported in fertilisers and in feedingstuffs for cattle, pigs and poultry. The input surplus has been estimated at 20 kg P and 25 kg K/ha on agricultural land per year. On the more intensive livestock farms much higher local surpluses of nutrients exist and disposal of the excreta on grassland (which accounts for 90% of all agricultural land) can cause major problems. For example, grazed swards may be damaged or killed by severe scorching as a result of excessive applications of urine with subsequent recolonisation by inferior grasses; excessive dressings of excreta as slurry may produce a slow drying organic layer on the soil surface which renders it more liable to poaching, while the finer solids can block soil pores and restrict aeration; the high levels of potassium which may be built up in the soil increase the risk of hypomagnesaemia; and the spreading of slurry on land under unsuitable conditions increases the risk of pollution and nutrient enrichment of drainage water. These problems have been described and discussed by many workers e.g. McHugh (1973), Kelso (1973), Gracey (1974) and Watters and Thompson (1974).

From the early 1960s until the 1974/75 energy crisis large quantities of animal excreta in the form of slurry could be obtained simply for the cost of transport. It seemed possible that the application of these manures to nutrient deficient forest land might help solve the problems while at the same time providing nutrients required by the trees and might encourage more biological activity in infertile soils. To investigate the possible use of such organic manures two experiments were established in Lisnaskea Forest in 1967.

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Experimental Details

The aim was to determine whether pig and cow slurry applied at three different rates (in 1967) had any effect on the growth and the foliar nutrient concentrations of trees of different ages growing on two different soil types, as follows:

1. *Lisnaskea 5/67.* A Sitka spruce crop planted in 1953 on an oligotropohic peat. This crop was in a condition of serious "check" and was exhibiting all the symptoms associated with nitrogen deficiency – yellowness, slow growth and small needle size. It had received only a handful of basic slag (70 g/tree) at the time of planting in 1953.
2. *Lisnaskea 4/67.* A Sitka spruce crop planted in 1966, (the year before applying the experimental treatments), on an oligotrophic peaty gley (Savill and Dickson, 1975). This site had been fertilised with 250 kg rock phosphate (CRP)/ha broadcast in 1966.

Cow or pig slurry was applied to circular plots of 0.1 ha at rates of 1, 2 or 3 tanker loads, each of 3.2 m^3. The amounts of N, P and K applied in each treatment and equivalent amounts of conventional fertilisers are given in Table 1.

Table 1 Lisnaskea 4/67 and 5/67 — Treatments

		kg/ha element			Equivalent in kg/ha of:		
Treatment		N	P	K	Urea	CRP	KCl
Pig Slurry rate	1	131	20	64	285	136	128
	2	262	40	128	570	272	256
	3	393	60	192	856	408	384
Cow Slurry rate	1	83	29	56	181	204	112
	2	166	58	112	362	408	224
	3	249	87	168	543	612	336
Control		0	0	0	0	0	0

The experiments were laid out in unrestricted random designs with two plots of each treatment plus two untreated reference plots. With only seven residual degrees of freedom, the level of replication was normally too low to enable statistically significant treatment effects at the conventional 95 per cent probability level or more to be obtained. For this reason the actual probability levels for significance are shown in the final columns of Tables 2 and 3.

In terms of current Northern Ireland Forest Service recommendations for treatment of these sites (Anon, 1976), the quantity of nitrogen applied at the lowest rate was about the level considered suitable for checked Sitka spruce on oligotrophic peats though higher rates would not be regarded as harmful. Nitrogen is not considered necessary for young Sitka spruce on gleyed soils.

The recommended rate of phosphate application for P-deficient spruce on peat is 750 kg/ha rock phosphate. This was not achieved by any of the treatments though the highest rate of cow slurry approached it: on the gleyed site the recommended rate, 500 kg/ha rock phosphate, was exceeded only by this treatment.

Quantities of potassium supplied by both slurries were about the recommended levels for K-deficient sites (250 kg/ha KCl) at the middle rate of application. However neither site exhibited any visual symptoms of K deficiency in 1967.

Results

Effect of treatment on Growth and Foliar Nutrient Concentration on Oligotrophic Peat.

Table 2 shows the average annual growth of trees in Lisnaskea 5/67 for each treatment since 1967, mean heights at the end of 1974, growth 1967-74 and foliar N, P and K concentrations in 1976.

Table 2 — Lisnaskea 5/67 (Peat Site) — Annual Height Growth in cm, Total Growth 1967-74, Mean Heights in 1974 and N, P and K Concentrations (%DM) for Different Treatments

Experiment		Rate of applied pig slurry			Rate of applied cow slurry			Untreated plots	SE Treatment mean	probability level for significance
		1	2	3	1	2	3			
Growth	1967	6	5	6	5	8	6	4	1.8 NS	30.5
	1968	27	17	20	11	21	24	2	3.7*	97.9
	1969	33	31	33	19	33	36	4	7.6 NS	85.2
	1970	30	41	47	16	32	39	12	6.1*	96.7
	1971	19	29	39	9	20	27	13	7.0 NS	83.5
	1972	22	27	40	12	23	25	16	8.3 NS	57.4
	1973	16	21	32	7	17	22	7	7.4 NS	67.1
	1974	17	19	34	9	14	18	9	7.2 NS	66.2
	1967-1974	170	189	250	88	169	197	66	45.2 NS	80.7
Mean height	1974	269	291	342	180	287	307	153	55.3 NS	70.5
Foliar N	1976	0.73	0.67	0.86	0.77	0.70	0.80	0.80	0.021**	99.6
P	1976	0.08	0.09	0.08	0.08	0.12	0.11	0.11	0.019NS	45.6
K	1976	0.62	0.74	0.65	0.81	0.92	0.83	0.86	0.068 NS	88.4

The year following slurry application, 1968, saw a marked improvement in the growth of the trees in all treated plots compared with that in the controls. In plots treated with the lowest rate of cow slurry there was a further slight improvement in 1969 but in the following the subsequent years, growth was about the same level as in the untreated plots.

Plots treated with the lowest rate of pig slurry (P1) and the middle rate of cow slurry (C2) responded in almost identical ways. Annual growth increased up to 1970 and thereafter there was a decreasing trend down to a rate which was marginally better than the controls in

1974. The middle rate of pig slurry (P2) and highest rate of cow slurry (C3) also produced similar responses though in these treatments the fall-off in the rate of growth from 1971 was not quite so marked. Only in the plots treated with the highest rate of pig slurry (P3) did growth remain at a reasonably satisfactory level throughout the entire period (1968-74), though in this case too there was a decreasing trend from 1971. This pattern of an initial increase in growth following the application of nutrients to checked plots, followed by a decline towards the pre-treatment level is similar to that obtained following the application of inorganic N and P fertilisers on oligotrophic peats in Northern Ireland (Dickson and Savill, 1974).

Total growth during the period 1967-74 increased with increasing rates of application of both types of slurry, though the plots treated with pig slurry did better with an average increase of 208 per cent compared with the untreated plots. Those treated with cow slurry had an average increase of 129 per cent.

The foliar levels of N, P and K shown in Table 2 were determined from samples of needles from one of the topmost whorls of branches of five randomly selected trees per treatment plot. Samples were collected early in June 1976. Though levels of N and K in the middle of the growing season are generally lower than in the dormant season, it is clear that N and P concentrations in all plots are very near or below the "critical" levels of 1.0 and 0.1% respectively quoted by Van Goor (1970), except in the plots treated with the 2 higher rates of cow slurry where P was adequate. K levels, by contrast were well above the "critical" 0.4 per cent.

Table 3 — Lisnaskea 4/67 (Gley Site) — Annual Height Growth in cm, Total Growth 1967-74, Mean Heights in 1974 and N, P and K Concentrations (%DM) for Different Treatments

Experiment		Rate of applied pig slurry			Rate of applied cow slurry			Untreated plots	SE Treatment mean	probability level for significance
		1	2	3	1	2	3			
Growth	1967	22	18	17	21	17	19	16	1.0*	96.5
	1968	23	23	28	23	23	21	18	2.2 NS	78.8
	1969	35	38	36	36	33	35	31	2.1 NS	57.6
	1970	50	49	51	44	45	47	35	5.4 NS	49.2
	1971	39	45	49	36	40	46	28	6.2 NS	65.2
	1972	43	46	55	37	46	48	28	7.7 NS	62.2
	1973	34	69	46	26	39	39	21	15.3 NS	52.9
	1974	41	49	57	32	45	51	27	7.6 NS	79.2
	1967-1974	285	337	340	255	288	306	205	36.4 NS	74.3
Mean height	1974	309	362	366	281	313	328	230	36.3 NS	74.8
Foliar N	1976	0.83	1.00	0.99	0.92	0.84	0.92	0.92	0.047 NS	78.1
P	1976	0.06	0.09	0.09	0.06	0.07	0.09	0.07	0.010 NS	70.4
K	1976	0.52	0.47	0.52	0.56	0.40	0.48	0.50	0.084 NS	12.6

Effects of Treatment on Growth and Foliar Nutrient Concentrations on Oligotrophic Gley.

Table 3 shows the growth response in Lisnaskea 4/67, on the oligotrophic peaty gley site. Savill and Dickson (1975) have shown that nutritional deficiencies in this area of Northern Ireland are not as severe on gleys as on peats. Good growth can normally be promoted by applying rock phosphate at rates up to about 500 kg/ha.

Because this was a newly planted crop the pattern of response was rather different from the previous experiment; growth increased up to 1970 in the untreated plots and thereafter fell off slightly but maintained a reasonably steady level. Though growth in the treated plots was consistently better than in the controls it did not differ very much up to 1969.

From 1970 onwards growth in the treated plots was markedly better and within these it normally improved with increasing rates of applied slurry. It remained at a reasonably constant level in all plots from 1970: there was no indication of any fall-off with time as in Lisnaskea 5/67.

As in the previous experiment, among the treated plots, C1 gave the smallest response; responses to P1 and C2 were similar as were those to P2 and C3, though in both cases the pig slurry gave slightly better growth. Response to the P3 treatment was again the overall best. For any treatment, heights in this experiment were greater than those in the same treatment on the P53 oligotrophic peat site.

While foliar nitrogen levels in 1976 were generally just below the "critical" 1% level, if the seasonal depression in concentration is taken into account they were probably adequate to sustain reasonable growth in all plots except those treated with the lowest rate of pig slurry and middle rate of cow slurry, though it is possible that even these levels were also adequate. Foliar P levels appear surprisingly low in all plots. They do not normally fluctuate greatly during the year and the fact that P was just below 0.1% dry matter indicates that it might be limiting growth to some extent. Foliar K concentrations were adequate in all plots.

Discussion

These two experiments have shown that cow and pig slurry can improve the growth of Sitka spruce on oligotrophic peats and gleys in much the same way as can be done by the application of mineral fertilisers. The patterns of response were similar to those described by Dickson and Savill (1974) and Savill and Dickson (1975): on peat, growth improved for 3-4 years and then fell off again while on the gleyed site a more permanent improvement was achieved.

It is difficult to give a definite indication as to what constituents of

the slurry were responsible for the improvements in growth but some inferences can be made. For a given volume, the pig slurry contained about 60% more N, 15% more K, and 30% less P than the cow slurry. On both sites there were better responses to pig slurry than to cow slurry so it seems possible that N was having a greater influence on growth than P. Linear correlation coefficients between growth (1967-74) on each site and the quantities of applied N, P and K were:

Lisnaskea 5/67 (Peat): N = 0.95*** P = 0.72* K = 0.92**
Lisnaskea 4/67 (Gley): N = 0.94*** P = 0.78* K = 0.90**

These correlations tend to confirm that there was a closer relationship between growth on both sites and the quantity of N applied in the slurry than there was between growth and P. The relationships between growth and K were also good though work already quoted by Dickson and Savill (1974) and Savill and Dickson (1975) on peats and gleys suggests that little real importance can be attached to them. Though it would be unwise to read too much into the results of these correlations they seem to be slightly at variance with results of work with inorganic fertilisers on these sites where applied phosphorous normally had the greatest influence on growth in crops of the kind being dealt with here.

Growth in the plots treated at the highest rate of applied pig slurry on the peat site in particular remained at a high level for much longer than would be expected if only mineral fertilisers had been applied. It could be that the very high rate of nitrogen, some of it in slowly available forms, supplied by this dressing was solely responsible for this effect. It is also possible that from this heavy dressing there was some additional effect, e.g. the promotion of more biological activity in the peat resulting in a reasonably satisfactory recycling of nutrients for a period of at least eight years. Whatever the cause, it merits more detailed investigation.

There are many points to be considered when deciding whether slurry could be applied to forests:

1. Slurry is bulky and therefore expensive to transport.
2. Distribution in forests is likely to be a major problem. Whereas farms tend to be relatively well roaded and most parts are accessible at least to small tractor-towed slurry tankers, forests, particularly the upland ones, most in need of applied nutrients, are not.
3. In order to apply slurry at the rates at which nutrients are required, enormous quantities would be needed. To give some indication of the magnitude, it would require approximately 28 cubic metres or 28 tonnes of slurry to apply 115 kg urea to one hectare. This is the amount contained in 250 kg urea which is currently the recommend application per hectare to checked

crops. Based on figures quoted by Gracey (1974) the annual dung and urine output of upwards of 2.7 cows would be needed to provide this quantity of slurry. A more daunting prospect is that of supplying the equivalent amount of P contained in 750 kg CRP (the amount recommended per hectare for oligotrophic peats at planting). This would require 163 tonnes of slurry. With the same weight of rock phosphate 217 ha could be treated.

4. One of the great potential values of slurry for forestry is the nitrogen it contains. Work described by Dickson and Savill (1974) indicates that this nutrient is rarely, if ever, deficient in Northern Ireland forest soils in the early years of a crop's life when application would be relatively easy. At the time when nitrogen is really needed on oligotrophic peat, crops have just closed canopy and are virtually impenetrable. The only practical way to apply nutrients is from the air. This could not conceivably be economic with a material of such low nutrient concentration as slurry since aerial application of conventional fertilisers is itself only marginally economic.
5. Many upland forests lie in water catchment areas where run-off following the application of slurry could present some degree of health risk and of nutrient enrichment of the drainage water. With the latter, the possibility of algal "blooms" in reservoirs and the subsequent deterioration of the water would be greatly increased.
6. Finally, the handling of slurry is always a dirty and above all smelly job. Coping with the very large quantities needed by forests might create labour problems.

Thus, while slurry can provide all the nutrient elements required to promote good tree growth its use in forestry is likely to be extremely limited because of high costs and other problems connected with transport and application. If it has a place at all, it is likely to be confined to small areas of forest such as shelter belts which are convenient to the source of the material and to a road. Since the steep rise in the costs of fertilisers in 1974-75, farmers have shown more interest in the value of animal manures as a source of nutrients for their crops. They are now learning to recycle efficiently what was formerly regarded as a troublesome waste product. Consequently little slurry is likely to be available for use in forestry.

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Forestry in El Salvador

RAYMOND M. KEOGH[1]

Introduction

EL SALVADOR is the smallest and most densely populated of the five Central American Republics. It has an area of 21,000km², a population of 4.0 millions, resulting in a population density of almost 200/km².

Its economy is very much dependent on agriculture. Coffee is a very important product and is grown mostly on the fertile soils of the Volcanic Chain between 500 and 1,500m above sea level. Cotton and sugar cane are other important crops, found on the coastal plain, while sugar cane is also grown on good soils north of the Volcanic Chain. These crops are products of the big "Haciendas," "fincas" or farms and contrast sharply with the small holdings of the peasant population. The latter grows subsistence crops such as beans and maize and is often found inhabiting the poorer soils. The small holders contribute to the labour force of the three main crops whose requirements are seasonal in nature; peak needs cause periodic migrations of workers.

Livestock play an important role in the economy and livestock holdings are spread over much of the country.

Location

El Salvador lies within the Tropics, between 13°09' and 14°28' North latitudes and 87°39' and 90°08' West longitudes. It is made up of a fertile Pacific Coastal plain, backed by and in places broken by a volcanic chain of mountains, of recent geological formation, running east to west across the country. This volcanic chain rises to 2,000m and over. Between the latter and the older geological formations of the north are flat lands, lying from 100-500m above sea level. This plain is broken abruptly by the very steep slopes of the northern mountain chain which continues into Honduras. Some of the poorest land is found here. These mountains rise over 2,000m in El Salvador and peak at El Pital (2,730m) and Montecristo (2,447m). See relief map of El Salvador, Fig. 1.

Climate

The country is influenced by a tropical climate with moderately high mean annual temperatures (24-28°C) which fall considerably with the increase in altitude. The pattern of precipitation is well defined. There is a rainy season of 6 months duration, from May to November,

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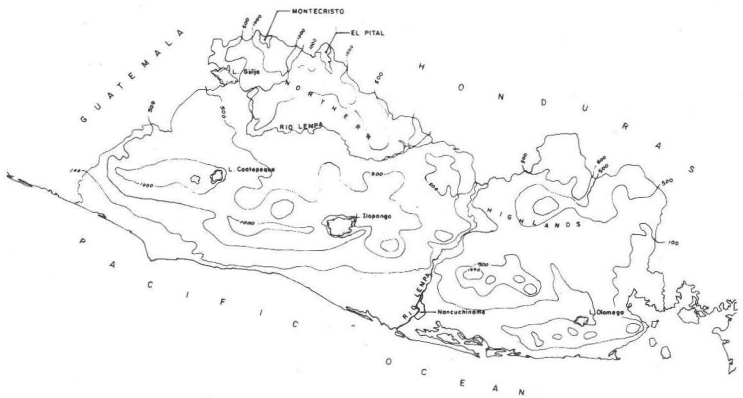

Figure 1. Relief map of the Republic of El Salvadore (for scale see Figure 2)

contributing to 90% of the total annual rainfall. Means vary from 1,100 to 2,800mm/year depending on the location. Such a brief description of the climate lacks consideration of the extreme and complicated variety of microclimates within the country (Daugherty, 1974).

The Forest of El Salvador

The lowland types, ranging from sea level to 800 or 1,000m, according to Daugherty (1974). He divides this mantle into two: the lowland and the highland types.

The lowland types, ranginr from sea level to 800 or 1,000m, contained three formations: the mangrove forest of the coast; the lowland evergreen forest originally occupying the banks of the most important rivers and backing the mangroves. The evergreen nature of the latter was due to an ever present underground source of water. The third formation, the lowland deciduous forest was the most important in that it covered approximately 90% of the country. Its deciduous nature was due to a water shortage in the dry season. Two formations were found in the high lands; the pine-oak forest from 800 or 1,000 to 1,800 or 2,000m above sea level and the cloud forest above 1,800m.

The map (Fig. 2) shows the probable distribution of the original vegetation (after Daugherty, 1973). Exploitation of these forests was not carried on to any great extent in the precolonial period. After the conquest of the native tribes by the Spanish in 1539 and through the colonial period which lasted until 1821, the forests of El Salvador

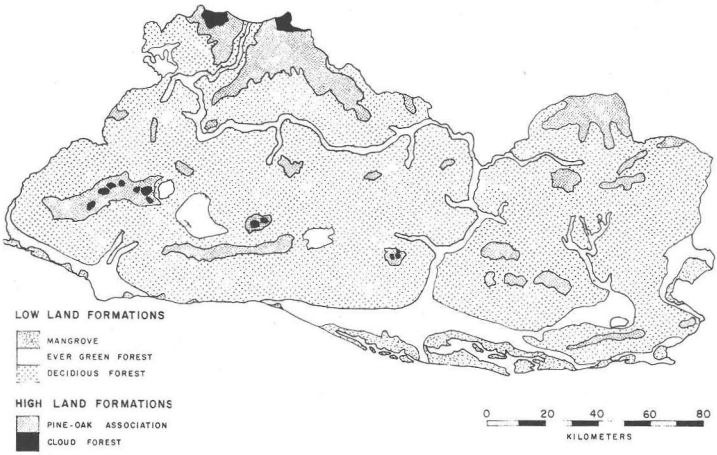

Figure 2. Probable distribution of the original vegetation of El Salvador (after Dougherty, 1973)

suffered a steady exploitation, to make way for cattle, a European introduction and indigo *(indigofera tinctoria* and *Indigofera suffructicosa),* a native plant that was to be a predominant supplier of the world's indigo market for three and a half centuries (Daugherty, 1974).However, it was not until after independence that the forest began to be destroyed at an alarming rate. This coincided with a dramatic rise in population. It has been estimated that in 1807, 60-70% of the surface area of the country was covered by forest but by 1900 it had decreased to some 10% (Bourne, 1946).

As far back as 1883 a plea to regulate the exploitation of the woods of El Salvador was made by Hernández (1883). However, neither this, nor later pleas, nor even the introduction of articles into the agricultural code of the 1890s and laws of 1907 and 1941 changed the downward plunge of the graph.

The destruction brought with it an appalling decline of wildlife, accelerated the erosion of the soil and decreased the water-holding capacity of watersheds. Table I shows what is now left of the original forest.

TABLE 1

Existing Forest Types in El Salvador

Forest Type	Area (ha.)
Northern pine forest	40,000
Mangrove forest	36,000
Others	5,000

After Moore (1975)

This table does not include some 200,000 ha. of coffee plantations, which are regarded as having a semi-forestry role, due to the nature of the tree cover required by the coffee plants. This tree cover provides protection for the soil and supplies quantities of firewood.

It can be seen that most of the lowland formations have been eliminated, except for a few areas which should now be preserved. One such area is Nancuchiname on the east bank of the River Lempa (See Figure 1), a 1,000 ha extension of evergreen forest which abounds in wildlife including the almost extinct spider monkey *(Ateles geoffroyi)*.

Highland formations have also suffered. Here too there are areas worthy of preserving, like the most exotic and beautiful cloud forest at Montecristo, that extends into Guatemala and Honduras (Figure 1). There are a number of rare species encountered here including the Quetzal *(Pharomarcus mocinno)* and an infinite variety of orchids and tree ferns. This gem of El Salvador is fortunately being protected by the Government.

Consumption and Production of Forest Products

Table 2 shows the estimated consumption for selected products for the year 1975 and projects it to 1990 (Moore, 1975).

TABLE2

Estimated consumption for selected products for the years 1975 – 1990

Product	Roundwood equivalents 1975 (m^3)	Roundwood equivalents 1990 (m^3)
Sawnwood	126,000	220,000
Poles	63,000	140,000
Paper products	235,000	550,000
Fire wood	2,500,000	4,400,000
TOTAL	2,924,000	5,310,000

Of the products listed above, only poles and in all probability, firewood are produced in sufficient quantity to satisfy the local demand. Some 10% of the sawn-wood requirements are met by local production and in the case of paper made locally from waste paper, the local production is some 2-3% of the demand (Moore, 1975).

To become self-sufficient, El Salvador would have to plant several thousands of hectares over a large area of marginal land, or a smaller area of good land to open a pulp factory and to supply the demand for sawnwood.

The increasing demands for firewood and poles would have to be met too. The country has not, however, reached the stage where a

decision has been made on the future role of the forestry sector in the economy as a whole and Moore (1975) stresses this need. But the country is unlikely ever to become self-sufficient in its wood and wood products.

The Present State of the Sector

Forestry at the present moment is at an initial stage in its evolution. Protection has an immediate role to play, especially in the steep sloping lands and eroded watersheds of the Northern Mountains, where the supply of water and the stabilizing of the soil is just as important to the overall economy as the supply of timber.

Thus the Salvadorian Government has taken steps to preserve what exists of the forest and a separate law was passed in 1973 with this aim in mind (Diario Official, 1973). The Government, with the support of FAO has been studying the existing forest stands with the aim of protecting certain areas of natural interest and of formulating management plans on a sustained-yield basis for the production areas.

Efforts have been made to extend both the production and protection forest area, but most problems are encountered here. Although limited subsidies for reforestation exist in the form of real estate tax exemptions and planting material at a below-cost price, to date they have not proved sufficient to induce large scale plantation programmes. The government has only a small area of its own to plant although this may not be the case in the near future. The planting programme has not been confined to strategic zones. On the other hand planting depends mostly on the good will and arbitrary decisions of private owners.

During a survey of artificial plantations carried out in 1975 the author found that most of these are small, dispersed, unmanaged and had a very high loss when the expected area from records and the actual area on the ground were compared.

Plantations have suffered from a high rate of planting failures in the first years. Various factors are responsible for this such as, for example, late planting, bad nursery stock and carelessness in the handling of the plants after they leave the nursery. These errors can be corrected and for this reason UNDP/FAO is co-operating with the Government in order to find solutions to these problems.

The Present and the Future

In summary, the role of the Forest Service in El Salvador is and has been, to preserve the existing forest, classify it into areas for protection, production and conservation and formulate management plans for the production areas to be maintained on a sustained-yield basis.

The next step is to extend the forest area. Most problems have

been encountered here. The reforestation programme will have to be concentrated within defined strategic zones with the aim of protecting watersheds and supplying, in so far as is possible, timber demands. Some sources have estimated that as much as 670,000 ha of the surface area of the country should be under some form of tree cover (Organización de los Estados Americanos, 1974).

The Forest Service is in its infancy and has a long road ahead which will not be without its "Knockboy" type of incidents. To decrease the probability of the latter, technical assistance will be needed and this statement is even more justified when it is realized that El Salvador has no forestry school nor separate forestry faculty in the University.

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The Production and Use of Tubed Seedlings in Irish Forests

IAN P. BOOTH[1]

Summary

THIS paper deals with the production of tubed seedlings in a forest nursery situation. It costs the process from start to finish. Also the matter of planting out in the forest is dealt with in some detail.

Introduction

The planting of container-grown stock has been carried out in many parts of the world for a considerable length of time. Different countries have developed different ideas in this regard (Low, 1975). In continental Europe transplants have been produced in small pots and balled roots in an effort to eliminate transplanting shock in young stock. These methods have also been used in establishing forest plantations on degraded and eroded sites in an effort to reduce establishment costs to a minimum, which is particularly useful in tropical countries and arid areas, as well as areas that are covered by snow for long periods each year (Unsat and Uutaru, 1974; Low 1970). A technique of raising transplants in peat/polythene rolls was devised by Nisula of the Finnish Forest Research Institute. The probable production total of these transplants in Finland in 1971 was between 20 and 30 million. Finnpots (known as Jackpots in this country) are peat pots manufactured by using a 65:35 by weight ratio of Sphagnum peat to groundwood pulp. A wide range of sizes is produced for horticultural use, both as single pots and trays. The Kopparfors Method is a method of producing ball-rooted planting stock in which the plant is removed from the pot prior to sowing. The method is based on the use of injection moulded polythene units which form moulds for the plant root ball. The shape is tapered to allow easy withdrawal of the plant at planting time (Low, 1972).

Another method of producing and planting bare root stock is worthy of mention. This was developed by Charles Tottenham of Ballycurry, Ashford, Co. Wicklow for use on land at Inagh, Co. Clare. Two-year plantable seedlings are produced in seedbeds which are root-pruned frequently. This yields a plant which has a larger crown than normal, and a compact root system. The method of planting is quite simple when use is made of a modified bulb planter. This device works on the same principle as a leather punch – push it into a plough ribbon and then pull it out – this action makes a socket for the plant and the plug is retained in the planter until pushed into the ribbon again. On the second stroke the plug is ejected from the planter

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and a new plug and socket are formed. (Prof. T. Clear, U.C.D., personal communication, 1975).

By 1966 an adaptation of the above methods was devised in Canada to replant cleared woodland with young seedlings in such a way that costs could be reduced to a minimum (Low, 1970). This pattern of regeneration called for a simple yet effective type of container – a small, rigid, split polystyrene tube. These containers were each filled with a growth medium and seeded. After twelve weeks the seedlings had grown and both tube and contents were planted out – the Ontario tube seedling.

The Finns wanted some method of speedy regeneration of their forests and decided that this procedure might fit their needs. However it proved unsatisfactory for them and they changed to Japanese Paperpots, which are at present extensively used, (Low and Brown, 1972). The British Forestry Commission (B.F.C.) also took advantage of the tubed seedling system and carried out some preliminary trials in 1967 which continued from 1968 to 1971 as a research programme (Low, 1975). The results of this programme were very promising. It is from this, that the Forest and Wildlife Service initiated their own trial and investigation of the possibilities of using the system to plant trees in our extensive peatland areas. The main advantages were expected to be:

(1) An extension of the planting season;
(2) Increased speed of planting;
(3) Greater suitability for development of mechanical planting;
(4) Rapid production which makes it easier to match plant requirements;
(5) The possibility of cheaper planting stock;
(6) The possibility of a reduction of basal sweep in conifer stands especially those of Lodgepole Pine *(Pinus contorta)*.

Production

The production of tubed seedlings was started early in 1973 at Glenealy Nursery, Co. Wicklow, which was equipped with a 20m polythene tunnel. The general specifications of the operation were similar to those used by the British Forestry Commission, (Low, 1970).

Seedlings were raised in split, open ended, polystyrene tubes 75mm long by 13mm internal diameter, filled with a 50:50 mixture by volume of moss peat and sand. The moss peat is passed through a quarter inch screen to remove any coarse or fibrous material which may be present and could cause uneven mixing. The sand is likewise passed through a one-eighth inch screen. To the mixture is added 1.5kg/m^3 slow release

NPK fertiliser, 1.5kg/m^3 ground magnesian limestone and 0.25kg/m^3 trace element frit.

The mixing of the sand and moss peat is carried out manually on a clean concrete floor. The fertiliser is then added to the sand/peat mixture using a cement mixer to ensure homogeneity.

Before filling, the polystyrene tubes are soaked for a few minutes in a fungicide to sterilise. Filling is done manually. The tubes are filled brim full with the medium and are then tamped down to 1cm below the top of the tube. The tubes are now ready to be seeded with one seed per tube. After sowing, the seed is covered with about 3-4mm washed sand of particle size ca. 1.5mm diameter. Trays are then allowed to stand in 5cm water for 24 hours to ensure complete absorption of moisture and afterwards are put into a germination room for 5-7 days at 25°C constant temperature. The trays are covered with plastic sheeting to prevent dehydration.

As soon as germination has commenced in about 10% of tubes, the trays are removed to the polythene tunnel where they remain for 8 weeks. The temperature in the tunnel is 21°C during the day and 15°C at night. For the first four weeks the 15°C night temperature is thermostatically controlled and heat is supplied by electric glasshouse heaters. Heat is only used when production of a batch begins in early April. Subsequent batches do not require any heat at night as the difference betwen outside day and night temperature is not as great as in the early part of the year. This fact is worth noting as there is a considerable reduction in heating cost with the heaters switched off at night. Also the effect of cooling during the night when the seedlings have reached a responsive age helps to harden them off. During the day if the house temperature rises above 21°C a 60cm extractor fan is automatically switched on and provides a through draught of air along the tunnel.

During the period of maximum growth i.e. 2-8 weeks, trays are watered once every two weeks by standing in 5cm water until saturated. One of the main problems associated with production has been a high incidence of damping off by *Pythium, Fusarium* and other wilt-causing fungi. This however, has been almost eliminated by virtue of the fact that the seedlings are watered from below. Watering from above has the tendency to permit dispersal of fungal spores by splashing.

Nevertheless, a check must be made at regular intervals to ascertain the correct amount of moisture per tube, and to make sure the temperature regime within the tunnel is correct. Apart from this minor amount of supervision, production is a relatively simple operation and any problems that arise can be dealt with as they occur. Any damping off that did occur, during the production of

Lodgepole pine *(Pinus contorta)* seedlings in the Spring of 1975, was caused by one of the *Pythium* fungi. The fungicide marketed as "Aaterra," which has 35% 5-ethoxy-3-trichloromethyl-1, 2, 4-thiadiazole (atridiazol) as the active ingredient, was extremely effective in controlling the attack at a dosage of 22g/18 litres water/m^2.

After a period of eight weeks in the polythene tunnel, the trays are moved outside for a minimum of two weeks to enable the seedlings to harden off before planting out. In the period up to the beginning of June it is necessary to cover the tubed seedlings with polypropylene mesh or some other type of screen as protection against late Spring frost. The average height of seedlings after 10 weeks is about 3.5-4.5cm. As there was some doubt as to the optimum period for retention within the polythene tunnel, a small test was carried out. The total number of trays was divided into four batches of 25 and each was treated differently as follows:

Batch 1 Moved out at 5 weeks
protected for 3 weeks
unprotected for 2 weeks
Batch 2 Moved out at 8 weeks
protected for 2 weeks
Batch 3 Moved out at 8 weeks
unprotected for 2 weeks
Batch 4 Moved out at 10 weeks
unprotected

In 1975 all batches were ready for dispatch at 12 weeks of age.

Result of Test

Batch 1 having been moved outside after five weeks indoors was most susceptible to climatic fluctuations; the period of drought that lasted from the end of April 1975 until early September 1975 caused a loss of about 75%.

Batches 2 and 3 were much hardier when moved and did not succumb to the effects of drought so readily; thus no advantage was gained in protecting the crop. Batch 4, the last to be moved was almost unaffected. It should be pointed out that no additional water was supplied save an initial watering on moving outside. The height growth was retarded in the case of Batch 1, but maintained in Batches 2 and 3. The height growth of Batch 4 was greater; this reflects the longer period of growth under optimum conditions.

It would appear on a visual assessment that it does not matter whether a crop is kept inside for either eight weeks or ten weeks as the

extra period of growth did not produce a significantly larger plant. In order to keep costs to a minimum the eight week period of growth would seem best suited to Irish needs. Certainly a five week period (Batch 1) is not sufficient in that it results in enormous losses, as indicated below.

The survival rates for each batch were as follows:

Batch No.	1	2	3	4
Survival %	25	80	82	80

Production Cost of Tubed Seedlings

The overall cost of production of tube seedlings may be broken down to components, each of which can be costed by means of work values which are applied when the job is being done. (Table 1) At £1.45 per hour the labour cost amounted to £407.45. The cost of materials was £250.00, giving a total cost of £657.45 (1975 prices).

Table 1 — Costs of various operations in Standard Man Hours (S.M.H.) based on 40,700 tubes.

Operations	Per 100 trays S.M.H.
1. Put tubes into tray	35
2. Grade Sand — 0.2 m^3	24
3. Grade Peat — 0.2 m^3	14
4. Mix Sand and Peat — 0.4 m^3	8
5. Weigh fertiliser (nutrient) and mix with medium — 0.4 m^3	8
6. Sterilise trays and tubes	6
7. Transport from Glenealy to Avondale and return	4
8. Fill tubes with medium	10
9. Tamp down	20
10. Sow seed	95
11. Cover seed with sand	15
12. Water and move to germination room and subsequent moves	42
Total S.M.H.	281

Production costs (cost per live plant) with 33⅓% added for overheads for the four batches of seedlings were as follows:

Batch No.	1	2	3	4
Cost (p)	6.65	2.05	2.00	2.05

Planting Out

Instrument

Planting of tubed seedlings is currently done with a simple steel dibble hereafter called a planting stick. This instrument in the shape of a walking stick, is made up from stainless steel tubing 15mm in

diameter and approximately 1m in length. At one end, half the tube is cut away for a length of 12cms. a stop which controls the depth of planting is placed on the otside of the stick at a distance of 1.2cm up from an internal stop, which is itself placed 75mm from the bottom of the stick.

Method of Planting

The tray of seedlings is carried on an aluminium frame, which is secured by straps over the shoulders and round the small of the back. Tubes are selected by the left hand from the tray and inserted into the channel of the planting stick with an upward and sliding motion, so they are brought up against the internal stop. This is performed with the planting stick held by the right hand, in front of the tray. The seedling shoot points up the channel. The planting stick and tubed seedling are pushed vertically into the peat, and, on withdrawing the stick, the tube remains behind. While the right hand is pushing the stick into the peat, the left hand is selecting the next seedling. Using this method a forest worker can, with some practice, achieve a planting rate of 740 seedlings per hour with easy walking conditions and good peat, and 415 seedlings per hour with difficult walking and poor peat (Low, 1975). Up to 3,000 seedlings per man per day was achieved by Forest and Wildlife Service in 1974, which rates lower than British Forestry Commission, but in practice planting rates increase with experience (J. Deasy, Forest and Wildlife Service, personal communication, 1976).

Preparation of Planting Site

The site should be ploughed in the normal fashion. It is a distinct advantage to have the ribbons running at right angles to the direction of the prevailing wind. Steps are cut by hand in the leeward side of the ribbon to afford protection to the seedlings. The cost of cutting these steps is about 4 SMH per 1,000 plants, but if tubed planting stock is to be competitive with normal, bare-root planting a cheaper method of cutting these steps will have to be used. In the UK, a method of cutting a continuous step on the ribbon during the ploughing operation has been tried and results so far indicate that this treatment of the ribbon is as good as hand stepping as far as plant survival is concerned (Low, 1975). In order to achieve a continual step, a plough has been modified quite simply, and the rate of ploughing remains unchanged. With hand stepping it is essential that the floor of the step has an outward slope to prevent waterlogging in the proximity of the seedling.

If stepping-down could be eliminated by modification of the plough, then the actual cost for tubed seedlings would be 18.04 SMH which is 91% of the cost of 1+1 transplants (Table 2).

TABLE 2

Comparison of Costs per 1,000 plants.

	Tubed seedlings	1+1 Transplants
Cost of Production	17	8.8
Cost of stepping-down	4	NIL
Cost of Planting	1.04	11
	22.04 S.M.H.	19.8 S.M.H.

Planting Trials

In 1975, Mountrath and Camross forests reported a large number of failures of the 1974 planting due to the long period of partial drought which caused the ribbon to dry out and shrink. As a direct result of this a considerable number of tubed seedlings fell out of the ribbon. The performance at the other sites was good, Lodgepole pine having grown 20cm and Sitka spruce *(Picea sitchensis)* 13cm in the first year. As they measured 4cm when planted, this gives a total height of 24cm and 17cm respectively (Table 3).

TABLE 3

Assessment (1976) of 1975 planting trials of tubed seedlings.

Forest	County	Species	No. Plants	Surviving %	Healthy %	Root spread % Satisfactory	Basal Sweep %
Greenane	Wicklow	S.S.	3,000	58	97	N.A.	
(1973)		L.P.	3,000	44	83	N.A.	21
Mountrath	Laois	S.S.	5,000	90	95	89	
(1974)		L.P.	14,000	91	79	94	10
Clonaslee	Laois	S.S.	14,000	N.A.	N.A.	N.A.	
(1974)		L.P.	4,000	779	73	86	50
Camross	Laois	S.S.	2,000	46	86	7	
(1974)		L.P.	3,000	11	80	92	N.A.
Ballyfin	Laois	S.S.	10,000	84	96	39	
(1974)		L.P.	3,000	94	91	50	N.A.
L. Ennel	Westmeath	L.P.	1,000	5	N.A.	N.A.	N.A.
(1974)							
Glenamoy	Mayo	Mon.P.	1,000	N.A.	N.A.	N.A.	N.A.
(1974)							

N.A. = Figures not available

S.S., Sitka Spruce; L.P., Lodgepole Pine; Mon. P., Monterey Pine, (Pinus radiata).

Optimum Season for Planting

The best period for planting out was found by the British Forestry Commission to be from May to July. This was based on a 1970

assessment of the survival rate of tubed seedlings planted at Selm Muir during the period April to October, 1969. The percentage survival of those planted in May, June and July was 95% (Low, 1975).

Conclusion

The production of tubed seedlings under polythene does not require any really specialised production techniques, and can be carried out by forest workers with the minimum of training. The main advantage is that the whole cycle of production is carried out independently of prevailing weather conditions, i.e. there are no delays due to inclement weather. Added to this is the fact that at least 90,000 seedlings can be raised at short notice in a polythene tunnel only 20m long.

The main criterion for use of such methods is a lowering of planting cost combined with increased speed of planting. The latter is most essential in countries where the climate affects the length of the planting season. The situation in this country is quite different as the planting season can extend from November to April for bare root transplants.

From the foregoing it can be seen that a major item in the cost of planting tubed seedlings is the expenditure on stepping down, viz. 4 S.M.H. per 1,000. This, however, can be eliminated by modification of the plough share at no extra ploughing cost.

This would mean that the cost of production and planting of tubed seedlings would be broadly competitive with that of bare-root planting stock, and the method would have most, if not all, the advantages already listed.

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Land Drainage in Co. Clare[1]

JERRY O'CONNOR[2]

UNDER the land project scheme (1949-1976) nearly 32,000 ha in Co. Clare were drained or improved with the help of state aid to the tune of £1.8 million. This has undoubtedly led to a much better stock carrying capacity on these lands, especially where the farmer followed up drainage with better management and improved fertility. Unfortunately, due to carelessness in keeping drains open, quite an area of these drained acres have been allowed to revert to their original state. With the price of good land around £1,000 per acre and the letting price in excess of £50 per acre in many cases, the time is now opportune to have a look at the present position of land drainage in the county, and to examine the contribution it can make to improving farmers incomes by increasing their capacity to keep extra stock.

Soils of County Clare

According to the National Soil Survey of Ireland (1971) 39% of the soils in Clare have free natural drainage, 32% of the soils are impeded and require artificial drainage. The remaining 29% are variable types and peatland, and for the most part also require drainage to be of use either for grassland or forestry. This means that about 60% of the soils representing a total of about 188,000 ha are suffering to a greater or lesser extent from excessive water problems. Even if we subtract from this figure the acreage already drained and lands which at this point in time may not be economically feasible to drain, we are still left with over 100,000 ha which could be economically drained. This is land with a very poor stocking rate at present and which, in general, makes very little contribution to its owner's income.

Drainage Problems

The main drainage problems in Clare arise from impermeable soils, due to their nature and also due to compaction. The second type that creates problems are peats of various types. Thirdly, we have a combination of both – with varying depths of peat overlying an impermeable subsoil. In the past it was extremely difficult to find a cure for these problems, but in latter years, due to the combined efforts of An Foras Taluntais, the Agricultural Advisory Service, the Farm Development Service and a few farmers who were willing to experiment, it is now possible to cure the vast majority of drainage

1. Reprinted from *Golden Vale News*, Vol. 1, No. 14, 1977 with permission.
2. Golden Vale, Clare Advisory Officer.

problems. The best way to illustrate how the job is being tackled is to take a cross section of the work being done by farmers in different areas.

Case No. 1 – The type of problem faced by Paddy Bugler, Mountshannon, and Tim Treacy, Scariff, is typical of about 16,000 ha in the East Clare area. In 1975 the staff of the Scariff office of the County Committee of Agriculture initiated a research and advisory programme in conjunction with Mr. Liam Galvin of An Foras Taluntais. A 2 ha field belonging to Mr. T. Treacy was selected. This field was practically useless. The top soil was like glue lying on top of a subsoil that was compacted hard and completely impermeable to the downward movement of water. The following series of operations were carried out on it:

1. Light rotovating.
2. Water courses opened and scrub removed.
3. The field was ripped using a 3 shank ripper mounted on a cat D7 dozer to a depth of about 50cm. The field was ripped in 2 directions at right angles to one another, but it is now felt by instructor Michael McGrath that a double ripping in the same direction is more effective.
4. Field levelled with D4 dozer.
5. Field drains laid with McConnell trenchless drain layer at 61 to 68cm at 31m spacings. The drains were of 60mm plastic piping covered with 20mm washed gravel to within about 30cm of the surface.
6. Land was then rotovated, levelled, fertilised and reseeded.

At the end of May 1976, in one cut for silage the yield of fresh material was a remarkable 40 tonnes per ha. The field was then grazed up to November and will be ready for cutting quite early this year. Since then, approximately 28 ha in the area on seven different farms have been ripped and are in the course of being reclaimed.

Typical of these is Mr. Paddy Bugler of Mountshannon. His farm is fragmented and because of this he is limited in the number of cows he can carry. He is now in the process of draining in the above fashion 24 ha of land in one block which he plans to be the centre of his dairy unit in the future, but which at the moment is of very little value to him. The one factor which he feels is limiting the amount of work that could be done is the scarcity of the specialised type of machinery needed. An approximate cost of the different machines mentioned previously works out in the region of £100,000. Few private contractors can afford this type of investment in machinery. The total contract cost per ha (including lime, fertiliser and seed) is in the region of £640. After a grant of approx. £270 the net cost to the farmer works out at about £370 per ha.

Case No. 2 – Joe Ryan and Martin Quelly are two dairy farmers working with an exceedingly difficult soil in the Inagh area. It is a poor structured Drumlin type soil of shale origin. In 1974 they travelled to Ballinamore and saw what was being done with land similar to their own by John Mulqueen of An Foras Taluntais, who is an expert in draining this type of land. They came home and installed a system of mole drains and tiled catchment drains under the direction of John Mulqueen and local advisor, Tom Woulfe. A McConnell trencher supplied by the Agricultural Institute was used for the catchment drains and the moles were pulled by drawing a mole plough (supplied by Golden Vale) with 110 h.p. tractor.

As a result of this work, Joe Ryan has built up his cow numbers to 58 on his 45 ha farm and hopes eventually to reach 80-90 cows when all drainage work is done. There is evidence in some fields of a breakdown in the moles after two years and re-moling will probably be necessary. Joe feels that draining with filled moles would probable be a better job and that this type of work (and also re-moling) should be grant aided.

As a result of the improvement brought about by drainage, Martin Quelly increased his cow numbers on his 12 ha home farm from 10 to 28 this year. The outside farm (also around 12 ha) is being used for providing silage and rearing the large number of replacement and extra stock he has needed up to now. Without drainage he says himself that he "just simply would not be able to get a living on that farm." After grant, cost worked out at about £148 per ha but a lot of the work was done by farmers themselves and gravel was available locally.

Case No. 3 – P. J. McGuane has built up cow numbers from 12 to 40 on his 24 ha farm in Cooraclare. His problem was how to drain cut away bog. He solved it with the help of local instructor, Murt Collins, and Land development Officer, Tom O'Dwyer. He opened a series of drains into deep catchment drains. The field drains were opened to an average depth of 1 meter and filled to within 15cm of the surface with gravel (available on the farm). They were opened about 18m apart. P. J. has been lucky in that the type of peat he is dealing with is of a broken down nature with a fair degree of permeability. The gross cost of the entire operation would be about £495 per ha if one takes into account the cost of purchasing gravel/chips. The net cost would be in the region of £245 per ha.

A few miles from P. J. McGuane up in Cree, Jim Kelly has started reclamation work on 16 ha. Deep open watercourses are presently being opened. His problem is again different to McGuane's in that there is a shallow depth of peaty type soil overlying a sticky gleyed sub soil. Drainage of this type will eventually have to include the

bursting of this sub soil, probably in some fashion similar to East Clare.

Conclusions

1. Draining the wet land of the county can be done. The technology and techniques of doing it are there, and the proof of success is there in plenty.
2. Demand for drainage is building up among the community. "Since the inception of the Farm Modernisation Scheme, farmers have contracted to drain and reclaim 12,000 ha" (Mr. Stephen Fahy, Deputy C.A.O., Co. Clare).
3. In Co. Clare at the moment, there are around 250,000 livestock units. With drainage and minimum nitrogen applications An Foras Taluntais estimate that the stock carrying capacity can be increased to 373,000 livestock units. If this could be brought about it would give a tremendous boost to farmers' incomes and would also be of great benefit to Golden Vale and the livestock marts.
4. "Each farm has its own drainage problems and what may cure one farmer's problem may not necessarily be the best method for his neighbour" (Mr. Liam Jones, Deputy C.A.O., Co. Clare). Liam feels that the best type of drainage should be ascertained individually in each case. He would also like to see deep ploughing tried out in certain areas, especially where you have an absorbent spongy peaty layer overlying gleyed sub soil.
5. A major limiting factor at the moment seems to be the scarcity of the specialised machines needed to do the job. While there seems to be adequate bulldozers and J.C.B.s there is a lack of trenchless pipe laying machines, rippers, deep ploughs, mole draining equipment, stoning carts, heavy cultivating and levelling equipment, etc. The need is great; the work is there. It is up to farmers and farm leaders to see that this need is met.

Acknowledgments

We wish to express our thanks and appreciation for assistance in compiling this article to Liam Galvin, John Mulqueen (An Foras Taluntais), Stephen Fahy, Liam Jones (Deputy C.A.O.s, Co. Clare), Michael McGrath, Oliver Kehilly, John O'Mahony, Murt Collins, Thomas Woulfe (Instructors in Agriculture, Clare Co. Committee of Agriculture), Tom O'Dwyer (Farm Development Services) and farmers P. Bugler, T. Treacy, J. Ryan, M. Quelly, P. J. McGuane, Jim Kelly.

Notes and News

EIGHTH WORLD FORESTRY CONGRESS

THE Eighth World Forestry Congress will be held in Jakarta, Indonesia, from October 16 to 28, 1978. The last World Forestry Contress, held in Buenos Aires in 1972, had some 2000 participants from forest services, institutes, universities, industry, commerce and professional societies. A similar attendance is expected at the next congress. In trade of tropical wood and wood products Indonesia plays a leading role in the world. Logs and wood products accounted for £390 million in foreign exchange in 1974, second only to petroleum as an export earner.

During the Congress, panelists will hold a debate on reports from 5 major discussion areas: Forestry for Rural Communities; Forestry for Food; Forestry for Employment Promotion; Forestry for Industrial Development and Forestry for Quality of Life.

Associated with the Congress, it is anticipated that there will be a main study tour to *East Kalimantan, Bali, East Java and Central Java,* lasting about one week, to see logging and planting operations, a transmigration project in thinly populated areas, protection and plantation forestry in an excessively densely populated area, integrated and less integrated wood processing complexes, agrisilviculture combining wood crops with either food or fodder crops, and finally, the management and the utilization of the most extensive teak plantation in the world. Other study tours are being planned for *North Sumatra, West Java and South Sumatra.*

NEW SERVICES FROM THE COMMONWEALTH FORESTRY BUREAU

From January 1978, the Bureau will be putting out two journals: *Forestry Abstracts* and *Forest Products Abstracts.* The new *Forestry Abstracts* will contain less than the present journal about the extraction and utilization of forest produce, but more about nature conservation, recreational forestry, arboriculture (amenity planting), range, game and fish. It will continue to give full coverage of the world literature on the silviculture of production forests, and all the other topics previously included.

Forest Products Abstracts will include the type of material at present dealt with under heads 3, 7 and 8 of *Forestry Abstracts,* i.e. (3) Work study, Harvesting of wood: logging and transport, Forest engineering, (7) Marketing of forest products and their utilization. It will also extend its interests further in certain directions, notably wook-working machinery and timber engineering, and will try to give fuller coverage to the wood-based panel industry.

The card title service run by the bureau will be made to match the two new journals, i.e. it will be prepared in two parts, which will also

be available together without duplicates. It is hoped that in the near future a more selective service will be available, so that subscribers should be able to order only those cards which are most likely to meet their particular needs. The cards will no longer bear the Oxford Decimal Classification numbers. These are being dropped in favour of a much simpler set of categories corresponding to the heads and subheads of the new journals. More attention, however, is being given to the provision of 'species' and 'geographical' references.

It is now possible to gain access to all the input to *Forestry Abstracts* since 1973 (and in future, to *Forest Products Abstracts)* through the Lockheed Dialog System in California. All that is required is a terminal about the size of a portable typewriter, access to the international telephone system, and a 'password,' corresponding to an account with Lockheeds.

LOSS OF TREES THROUGH DROUGHT IN BRITAIN

The Timber Growers' Organisation, the representative organisation for private forest owners in England and Wales, has released the results of a survey conducted among its members to assess the effects of the 1976 summer drought on forest and hedgerow trees. Their report indicates that many trees have died as a result of the drought, particularly in the South of England. The greatest losses have been in beech, including some trees up to 120 years old. On one West Country estate 570 mature beech have died. Damage to birch has also been severe and on one Devon hillside hundreds of birch have been killed. In general, oak has escaped the worst direct effects of the drought, presumably because it is deep rooting, but severe outbreaks of green oak tortrix moth *(Tortrix viridana)* have been reported. Conifers in general and in particular, plantation crops have not been severely damaged, although losses among newly planted crops have been abnormally high.

FORESTER HEADS EAST

MR. Harry Hutchman, a forester with the Northern Ireland Forest Service and a member of the Society, is going to help create a forest on the shores of the Caspian Sea. He has accepted a post as a forester with a Canadian forestry firm who have a contract with the Iranian Government to plant softwood forests in the north of Iran. The job will involve planting and maintaining 3,000 ha of forest each year plus the production of 3 million seedlings to plant this vast area.

This is Mr. Hutchman's second trip overseas. He returned in 1974 from Africa where he spent 3 years as a forester on a joint World Bank/Zambian Government afforestation project. Since his return he

has been attached to the Forest Service Work Study Section. Mr. Hutchman will be accompanied on his trip to Iran by his wife and three children. We wish him all the best in his new position.

OPENING OF CO. ANTRIM'S FIRST FOREST PARK

Glenariff Forest Park, the first in Co. Antrim, was opened on April 1 last. Situated amid the world famous Glens of Antrim, Glenariff is the sixth forest park to be opened by the Northern Ireland Forest Service.

Tourists have been coming to Glenariff for well over three-quarters of a century. In the early days they travelled by train to Parkmore Station. The railway had been built a few years earlier to transport the iron ore which was mined locally. However as the mining industry declined the railway company in an effort to boost its revenue developed the glen as a tourist attraction.

Work on the park commenced in 1970 when the area was acquired (see President's address, *Irish Forestry,* Vol. 28, No. 1, 1971). Since then an average of 20,000 people have visited the glen annually. The Forest Park covers an area of 1,185 ha of which 816 are planted and comprises not only the famous glen but also the relatively unknown Inver Glen once part of the Dobbs estate.

THE IRISH TIMBER GROWERS ASSOCIATION

ITGA was formed in March 1977, to promote all aspects of private forestry in the Republic of Ireland. It is confident that it deserves the support of woodland and farm plantation owners, and those in all branches of the forest industry. Already, after six months, considerable progress has been achieved and there are more than 100 members.

The organisation believes that the private owner can serve himself and contribute to the country's wellbeing in three main ways:

1. by making wise and profitable use of his marketable timber and replacing cutover areas by more productive forest,
2. by his capability to plant and purchase for planting highly productive forest ground,
3. by his potential as a private forester to contribute to the progress and betterment of forestry by original and independent thinking.

The Association hopes also to broaden the base of private timber growing in Ireland to include smaller owners of land so that any farmer who has marginal land can realise its potential for timber production.

ACKNOWLEDGEMENT

The Society acknowledges a donation of £50 from the Bank of Ireland.

Reviews

PROCEEDINGS OF THE SECOND CONGRESS OF THE INTERNATIONAL UNION OF SOCIETIES OF FORESTERS, HELSINKI, FINLAND

Supplement to Proceedings IU SF (1976)

THE Proceedings of the Second Congress of the International Union of Societies of Foresters (IUSF) and the Supplement which includes papers delivered at the panel discussions and plenary sessions have come to hand for review. This Congress, which was held in Helsinki, Finland, in August 1974, had as its theme "Forestry for People."

In the Manifesto printed on pages 2 and 3 of the Proceedings the participants were reminded that foresters all over the world were asking or were being asked such questions as – What formal training is required to meet todays challenges?

How can systems of continuing education keep foresters abreast of changing needs?

How can the forestry profession develop appropriate means of communication and interaction with other professions responsible for the environment and natural resources?

What are the roles of professional societies of forestry?

Should the foresters achieve and maintain a key role in land-use planning and policy determination in the high offices of government and industry?

As the Manifesto indicated these questions were the subject of concern at the Congress and the publications under review include a range of papers on these topics by contributors from all over the world. Also included are the opening addresses by the Chairman of the Organising Commitfee, Kalle Putkisto, the President of the Society of Finnish Foresters and the Minister of Agriculture and Forestry.

Of special interest is the account of the steps that led to the establishment of the Union, its growth and development and its future role given in the progress report presented by Dr. V. L. Harper, President of the Union.

The Keynote address by Professor Nils H. Osara, retired Director of the Forestry and Forest Products division of F.A.O. entitled "The Role of Professional Foresters in Economic Development and in Achieving Social Goals" deserves special mention. Professor Osara traces the origins of the professional forester in Europe and elsewhere and details the growing range of activity of professional foresters with examples from Finland and elsewhere. He asks "What is our destination"? "The tasks ahead are enormous. Forest devestation must be brought to an end. Barren areas, formerly green, must be

reforested. Problems of interrelationship between silviculture, recreation and environment must be resolved. The position of those who derive their living from forests must get serious attention. "Finally" writes Prof. Osara "the most important task – sufficient wood supplies must be made available now and in the future."

The publication includes lists of accredited members, the constitution and by-laws of the Union and Congress participants. The papers dealing with trends and issues in forestry education in the various countries are of special interest to anyone concerned with this field.

The final paper entitled "Professionalism and Ethics in a Forestry Context" by H. R. Glascock, Jr., Executive Vice-President, Society of American Foresters, is a thought-provoking contribution that deserves to be read by anyone concerned with the role of Forestry Professionals in society.

Professor T. Clear

WHAT WOOD IS THAT?

A Manual of Wood Identification. *Herbert L. Edlin, Stobart and Son. £6.95 (plus tax).*

On opening this book the reader is confronted with its most noteworthy feature: actual samples of each of the 40 woods described. The samples are attractively arranged in a fold-out section inside the front cover. They provide a valuable and extremely interesting collection of woods. Some such as lacewood plane and palado are quite beautiful and others display, remarkable clearly, the characteristic features of the wood.

The text runs into 160 pages of which 55 deal with wood identification. This section is centred around 14 keys to assist the identification of 40 woods. The author acknowledges that the keys are based on an earlier book "Welches Holz ist Das?" by Alfred Schwankel (reviewed in translation in *Irish Forestry*, Vol. 13, 1956) and the whole book appears to be very similar if not identical to a book of the same name, by the same author, published by Thames and Hudson in 1969 *(Irish Forestry*, Vol. 26, 1969).

The main problem with the keys is that they are not comprehensive, that is they do not cover all the woods likely to be encountered in everyday use. This might well seem an impossible task, but any manual of identification should state the totality to which it may be applied and then should strive to include all objects within that totality. Neither are the keys entirely satisfactory in that they are not designed for methodical sequential use. Rather the main

key puts the woods into one of six main colour groups with the other keys providing ancillary information on features of the wood such as rings, pores, grain, hardness etc. The trouble is that the most of this information has already been included in the descriptions of the woods in the main colour key.

It is not clear for whom the book has been written. The dust cover mentions "dealers, architects, carpenters and other craftsmen as well as householders, teachers, nature-lovers and youth-club leaders." Is there anyone left out? Perhaps the author would have been wiser to have confined his book to the identification of for instance furniture woods. However, one of four examples included to assist the reader in the use of the keys concerns the case of a "friend" who brings a log from the forest, requesting identification of the timber. As it turns out he proves to be a good and true friend. The log is quickly identified from the keys as Douglas fir, one of only four conifers included in the book. The other three are Ponderosa pine, Western red cedar and Cedar of Lebanon. While the difficulties of softwood identification with the naked eye may have deterred the author from including a wider selection, one feels that the more common forest trees of these islands should at least have been mentioned. The only reference to spruce, for example, is that it (Norway) is used in the manufacture of violins and guitars. Again, while the use of trade names in the varieties of tropical hardwoods is defended, the word "deal" which might be of help to both the carpenter and the householder is never mentioned.

The book contains over 60 black and white illustrations many of which are rather too small, with up to three figures crowded into half a page.

However, despite the criticisms the wood samples make this a book worth having, the chance for every man to be a collector of many fine and beautiful timbers.

E. P. Farrell

FOREST ROAD PLANNING

A. A. Rowan. Forestry Commission Booklet No. 43. 75p

THIS is a very comprehensive and concise document covering the whole aspect of Forest Road Planning, but concentrating mostly on the road as a means of access for the extraction of timber. The planning of all roads is dealt with by using cost benefit analysis methods.

The cost of pre-planting roads is offset against savings in establishment operations, no recognition being given to the part this road will play at the harvesting stage. The table given for general

guidance for pre-planting road densities (page 16) is very limiting, but it does highlight the need for careful consideration of the quantity and quality of the roads necessary at this time.

The calculation of optimum road spacing (from which the optimum road density can be calculated) for harvest roads, is based on the general principal that the combination of extraction cost per cubic metre of timber and the road construction cost per cubic metre of timber served is a minimum. Once the method of extraction has been decided, this can be reduced to a formula by equating the movement cost to the road construction cost (page 12 and graph, page 4).

The choice of road standard must be given careful consideration as it has a direct bearing on the road construction cost. The timing of road construction is closely related to the timing of first thinning. Delaying thinning or making roads to low-specification is recommended in areas of low yield class and high road costs.

The movement costs quoted, at page 10, are very low even by 1975 standards. Low movement costs give wide road spacing. There must be physical limits, especially at the early thinning stages, to the distance and number of times a vehicle can travel over the same track on the poorer soil types, but no mention is made of this. The range of the cable-crane automatically fixes the road spacing and therefore there is no need to use the forumla, but the cost of cable-crane extraction is such that it should only be used where vehicular extraction is impossible. Access to isolated blocks, road improvement schemes and the roading of small blocks are dealt with in some detail. The inclusion of a brief road specification is very helpful, and the illustrative cases given at the end of the book are most informative.

Overall this booklet is an excellent guide to the problem of forest road planning, and the method can be applied, with revised inputs, to suit any conditions. However, if the timber grower does not extract by direct labour to the forest road, he may have difficulty in convincing the timber merchant that extraction over long distances can be done economically. Remember also, that in the final analysis the theoretical figure for road spacing can only be taken as a guide to the actual layout in the field.

C. Browner

PAIRC FORAOISE COILL CHAOIN
KILLYKEEN FOREST PARK
Forest and Wildlife Service, Dublin

THIS multidisiplinary guide to Killykeen Forest Park consists mainly of a series of short chapters with straight-forward titles such as "The Mammals," "The Birds," etc. Like its predecessors, it is obviously

designed to stimulate the intellect rather than to catch the eye of the casual visitor.

It outlines the historical associations of the new park and gives a brief, though adequate description of the wildlife which the patient observer may expect to find. The forest itself is given surprisingly little space, though there is a dominant arboreal presence in the numerous illustrations and in the nature and tree trail notes. A route map of the forest park completes the presentation. Using this booklet, many visitors may have some difficulty in deciding which walk to take, for apart from "little" and "longer" (page 22) there is no indication of the distances involved. Experienced tourists will, with some justification, be very wary of such vague descriptions.

However, this guide maintains the high standard of scholarship already set in similar publications by the Forest and Wildlife Service. It should draw a proportion of the aimless visitors to the park into more serious pursuits and it will enhance the Service's reputation amongst the public.

J. J. Gardiner

FOREST ECOLOGY AND MANAGEMENT

An International Journal. Vol. 1, No. 1. December 1976. Editor-in-Chief: L. Roche. Elsevier Scientific Publishing Company, Amsterdam. Price £27 approximately. (4 issues).

It has become fashionable, and in certain circumstances may be profitable, to decry the arrival of new technical journals. World forestry in the broad sense, however, is not a subject which can be said to be overloaded with journals, at least in the English language, and this new journal is to be welcomed.

The editor gives a number of reasons why such a journal is needed: first, to synthesise fragmented and scattered information; secondly, to promote a better understanding of the world's renewable resources in order to conserve them for man's benefit; thirdly, to bridge the gap between resource managers and scientists; and finally to review publications of international importance. The editorial policy will take cognizance of the fact that aesthetic and utilitarian values other than the production of wood, are now considered in formulating the objectives of forest management.

Another consideration is the possibility of an increase in the dependence on forests for energy. It is pointed out that the world consumption of energy from fuelwood is greater than that from combined hydro-electric schemes, nuclear power, and geothermal sources. The dependence on forests for energy is at present a mainly tropical phenomenon, but the increasing scarcity and cost of fossil fuels, and the unsolved environmental problems associated with the production of atomic energy are causing an increased interest in the use of forests as a source of energy in many parts of the world. A book review in this issue of *Forest Ecology and Management*

indicates that the *unused* portion of the current annual increment of the world's forests is roughly equivalent to the world's total energy consumption in the year 1970.

The scope of the journal, as summarised by the editor, runs to nearly a page of text, and it is difficult to think of anything which has been left out. It is concerned in particular with the application of ecological knowledge to the management of man-made and natural forests, and covers all forest eco-systems of the world.

There are four main articles in this issue. The first deals with the problem of deciding whether or not to spray Monterey pine plantations in New Zealand infected with *Dothistroma* needle cast with a copper based fungicide. (It is interesting in passing to note that the plantations in question were 5 years old and "grown on a fertile site that had been recently converted from pasture"). The case is interesting in itself, but is treated as an example of the more general situation where it is accepted that resource managers "should look much more critically into the possible ramifications of the management practices they prescribe, and not just at the short-term gains that are likely to accrue from exploiting their resources."

Another article deals with the effects of phosphate, potash and lime applications to control-pollinated progeny of lobolly pine in North Carolina, U.S.A. The fertilisers increased growth, and the lack of any significant interaction with genotype is interpreted as simplifying breeding programmes, and indicating the possibility to "breed broadly adapted, general utility strains for diverse sites."

There are also, a short paper on pollen transport in a seed orchard, a long comprehensive one on natural regeneration of tropical forest, five book reviews and a news item on extended use of timber residues which at present go to waste.

This is a useful and interesting journal, and important in that it adopts a positive attitude towards the social responsibilities of foresters. It should be in every library having any connection with forestry, and any affluent forest manager might do worse with his spare financial capacity than take out an individual subscription. Free sample copies are available from the publisher.[1]

The editor-in-chief is an Irishman who learned his forestry in Dublin, and worked in British Columbia and Nigeria before taking up his present post as Professor of Forestry and Wood Science in the University College of North Wales, Bangor.

N. O'CARROLL

OTHER PUBLICATIONS RECEIVED

Forest Service, Belfast

Game and Wildlife at Seskinore Forest.
Randalstown Forest Nature Reserve.
Castlewellan National Arboretum; plant list of trees and shrubs.

Forestry Commission

Research and Development Paper.
No. 116. Impact of Green Spruce Aphid on Growth by C. I. Carter.

Address: Jan van Galenstraat 335, P.O. Box 330, Amsterdam, The Netherlands.

Forest Records

No. 110. Conifer Bark, its Properties and Uses by J. R. Aaron; *price 75p.*

No. 111. Some Important Foreign Diseases of Broadleaved Trees by D. A. Burdekin and D. H. Phillips; *price 40p.*

Leaflets

No. 68. Badger Gates by Judith J. Rowe; *price 15p.*

Letter to the Editor

Dear Sir,

Believing with Wittgenstein that "everything that can be said can be said clearly," I was dismayed by the chunk of verbiage printed under the "Letter to the Editor" heading in your last issue. I examined it for "abstract reasoning concerning quantity or number."[1] None. I looked for "experimental reasoning concerning matter of fact or existence."[1] None. I did not "consign it then to the flames"[1]—I want to keep intact my complete set of *Irish Forestry* (any offers?)—but instead I read it again, and again. I do not know what it means; in fact I am driven to the conclusion that it has no meaning.

I have consulted with the writer of the editorial referred to,[1] and with my former colleague Wood Kerne, and they cannot understand the letter either. In the circumstances it is not possible to offer any direct comment in reply.

What Mr. MacOscair, and others, need to realise is that the "taste" (i.e. the aggregate of fashionable attitudes) of this or any age or society has no absolute validity, and indeed may be culpably at odds with the material needs of the age or society. And it is no use referring to "beauty" when we try to define the nature and scope of our objectives. More precision is needed.

Yours Sincerely,
Your Former Editor

1. *Irish Forestry*, 33, (2), 1976, p. 79.

Society Activities

ANNUAL GENERAL MEETING, 1977

COUNCIL REPORT FOR 1976

Council Meetings:

In the year under review six meetings were held: Attendance of Councillors was as follows: P. M. Joyce, L. Furlong, E. Joyce, J. Dillon, 6 meetings; N. O'Carroll, 5 meetings; F. Mulloy, 4 meetings; J. J. Prior, 3 meetings; C. Tottenham, W. Luddy, M. O'Brien, 2 meetings; P. Savill, T. Clear, J. Mackin, T. Wilson, 1 meeting.

Society Meetings:

Three successful day-study tours were held in Tollymore Forest Park, Co. Down, Cloosh Valley Forest, Co. Galway and Ballyvourney Forest, Co. Cork. Sunday meetings were held at Hilton Park, Clones, Co. Monaghan and Avondale, Co. Wicklow. One indoor meeting was held in the Limerick region. The Society is grateful to all who acted as field leaders and speakers.

Guided Forest Walks:

Large attendances again participated in the Walks last September which were held at 30 centres throughout the country. The Society wishes to thank Mr. J. Connelly who undertook the organisation of this event and those members who acted as Walk leaders at the various centres. The assistance and co-operation of the Forest and Wildlife Service, Dublin, and the Forest Service, Belfast, is also acknowledged.

Annual Study Tour:

The south-eastern counties of Waterford, Tipperary and Kilkenny hosted the Annual Study Tour held in early June with headquarters at Tramore. A summary of Tour events is reported in Vol. 34, No. 1, *Irish Forestry*. Our thanks are due to Mr. L. Condon and Mr. K. Cremin, tour leaders, and staff who assisted with the organisation in conjunction with the Meeting sub-committee.

Annual General Meeting:

The 34th A.G.M. was held on Saturday, 13th March, 1976, at the Shelbourne Hotel, Dublin, the minutes of which are available in *Irish Forestry*, Vol. 33, No. 2. Under public business, Prof. T. Clear, University College, Dublin, delivered a very interesting paper entitled "New Zealand Journey" (published in *Irish Forestry*, Vol. 33, No. 2, 1976).

Society Publications:

Vol. 33, Nos. 1 and 2, *Irish Forestry* were published and a revised "Why Forests" was again issued with other literature in conjunction with the Guided Forest Walks publicity drive. The second and revised edition of "Forests of Ireland" is expected to be published during the coming year.

Examinations:

The results of the 1975 examinations were not available for inclusion in Council's report for last year. We are pleased to announce that the three candidates who presented themselves for the Preliminary Certificate were each successful. One candidate sat for the Foresters Certificate but was unsuccessful. The current examinations are being held shortly.

The examinations Syllabus and Regulations has been revised – the principal changes being:

(a) Up-dating of the subject matter and prescribed texts.

(b) Modification of the eligibility requirements for the Foresters Certificate to enable qualified and experienced candidates, who do not hold the Preliminary Certificate, to seek exemption by application to Council.
(c) Modification of marking standards in the Foresters Certificate examination to bring levels more into line with examinations elsewhere.
(d) Increase in Examination fees.

With the exception of increased fees which were applied in the present year, the other changes will not come into effect until April, 1977.

Elections:

Three positions of Councillor Technical and one position of Councillor Associate for the period 1977-'79 were filled by election.

Accommodation Facilities:

Council are pleased to announce that new and satisfactory accommodation facilities have been arranged with the the Royal Dublin Society.

Editors Questionnaire:

Opinion of members on the contents and format of *Irish Forestry* were sought in February, 1976. Results are reported in *Irish Forestry*, Vol. 33, No. 1.

New Members:

The large increase in recent years for membership application was again evident during 1976. A total of 58 new members were enrolled in the following categories: Technical 24; Associate 17; Student 17.

Signed: JAMES DILLON,
(Hon. Secretary)

MINUTES OF THE 35th ANNUAL GENERAL MEETING, SATURDAY, 26th MARCH, 1977 AT THE SHELBOURNE HOTEL, DUBLIN

ATTENDANCE:

The President, Dr. P. M. Joyce in the Chair, present were Miss Furlong, Messrs. J. O'Driscoll, M. Flannery, J. J. Gardiner, Lord Digby, Messrs. M. L. Carey, J. Prior, T. J. McCarthy, C. Little, N. O'Carroll, C. Tottenham, E. P. Farrell, D. McAree, M. O'Brien, D. Mangan, L. O'Flanagan, J. Brosnan, T. McEvoy, D. McGlynn, O. V. Mooney, M. Swan, F. Mulloy, and J. Dillon.

Secretary's Business:

The minutes of the 34th A.G.M. having been published in *Irish Forestry*, Vol. 33, No. 2, were taken as read and duly signed. Council's Report for 1976 was read to the meeting. Mr. McEvoy in proposing the adoption of the report thanked the Council for its work in the past year, particularly in relation to the day study tours, which he considered of great benefit to members. Seconding the motion, Mr. McGlynn asked for an explanation of Section C, Examinations, dealing with the modification of marking standards. In reply, Mr. Prior, Examinations Convenor, stated that there was need to have the pass level more easily attainable and that the higher achievement levels were now more in line with other examination systems. Mr. McGlynn also raised the matter of attendance at Council meetings. Without causing offence to anyone, he regretted that members accept nomination for positions on Council and then will not attend the meetings. In reply, the President

pointed out that in the past year half of the Council members attended no more than two of the six meetings.

The President in thanking Miss Furlong for her work as Meeting Convenor stated that a new system for the sharing out of the work load, associated with the Meetings Committee, was called for. Much discussion ensued on procedures for enlisting extra members to Council. Mr. McEvoy suggested that the existing powers of co-option should be exercised so that persons willing to work could be brought into the Council. Dr. O'Carroll pointed out that study tours needed the total services of one or more persons so that standards could be maintained and that such people should enjoy Council status.

Abstract of Accounts:

Mr. Mulloy apologised for the exclusion of the financial statement from the A.G.M. notice, but said it would be published in *Irish Forestry* in due course. He stated that the Society's affairs were in a particularly healthy state at the moment, but that expenditure on the coming *Forests of Ireland* booklet will erode much of the current balance. On the proposal of Mr. J. O'Driscoll and seconded by Mr. D. McAree the statement of accounts was formally adopted.

Elections:

The 1977 Council Elections were confirmed as follows: President, P. M. Joyce; Vice-President, F. Mulloy; Secretary, J. Gillespie; Treasurer, M. L. Carey; Editor, E. P. Farrell; Business Editor, M. O'Brien; Honorary Auditor, W. H. Jack; Councillors, Technical, J. Mackin, L. P. O'Flanagan, P. J. Morrissey; Councillor, Associate, C. B. Tottenham; Northern Regional Group Representative, W. J. Wright.

Other Business:

Mr. Little raised the possibility of regional groups being formed to look after meeting arrangements in their own area, and to lighten the burden on the already hard pressed Meetings Committee. In reply, the President pointed out that the Northern Regional Group functioned in this manner, but that a similar group in the Cork region failed to survive due to lack of support.

Mr. Carey asked if the poor attendance at the A.G.M. was of concern to Council. The President felt that this was the case with most A.G.M.s, not alone that of this Society. Mr. McEvoy felt that small attendances at such meetings could be taken as a vote of confidence.

The President thanked Mr. J. O'Driscoll who arranged for the binding of Vols. 1-30, *Irish Forestry*.

Programme for 1978:

Study Tour arranged for the Killarney region. Sunday meeting (a) Summerhill property, Donadea Forest; (b) Derryvullagh Island, Kilberry Bog, Co. Kildare. Day meetings: (a) Sitka spruce symposium in Belfield, held on March 11th, 1978; (b) General Moore's Estate, Mountfield, Omagh, Co. Tyrone, about June/July 1978; (c) a third day meeting to be arranged if a suitable topic is found.

Winter Programme–Indoor Meetings:

Plans to be finalised. In reply to Mr. Brosnan's query on voting patterns in the recent ballot on the Annual Study Tour venue, Miss Furlong explained that of the 56 replies received, 29 voted for an at-home venue, 18 for a British tour, and only 9 persons asked for a Continental venue. The President, in closing the meeting thanked all in attendance and also the Council members who helped him through the past year.

SOCIETY OF IRISH FORESTERS

STATEMENT OF ACCOUNTS FOR YEAR ENDED 31st DECEMBER, 1976

1975	RECEIPTS		1976	1975	PAYMENTS		1976
2,912.10	To Balance from last account		3,079.41	159.86	By Stationery and Printing		25.80
	" Subscriptions received:-			1,019.56	" Printing of Journals		1,163.19
	Technical 1976	1,010.16		303.00	" Postage		408.65
	Technical 1975	31.50			" Expenses re Meetings:		
	Associate 1976	241.00			A.G.M.	16.88	
	Associate 1975	2.00			Annual Dinner	44.00	
	Student 1976	18.00		195.07	Other	24.69	85.57
	Student 1975	6.00		9.00	" Bank Charges		28.75
	Other arrears	7.50		298.55	" Secretarial Expenses		380.95
1,325.36	Advance payments	154.51	1,470.67	71.25	" Value Added Tax		76.15
	Interest on investments			54.92	" Examination Expenses		55.10
	Dublin Corp. Stock 9¼%	20.10			" Honoraria:		
229.86	Savings account	257.08	277.18		Secretary	20.00	
	Journal Sales	126.60			Treasurer	20.00	
912.18	Advertising	839.08	965.68		Editor	20.00	
	Refund from Forest & Wildlife Service, Maps and Reprints	50.22		80.00	Business Editor	20.00	80.00
1,134.22	Forest Walks–carry over '75	6.41	56.63	1,198.10	" Forest Walks Outstanding from 1975 account		6.41
2.50	Examination Fees		12.50	56.00	Presentation		—
8.50	Donation		11.55		" Balance		
					Cash	4.50	
					Current	(291.26) O/D	
				3,079.41	Savings	3,849.81	3,563.05
£6,524.72			£5,873.62	£6,524.72			£5,873.62

I have examined the above accounts, have compared it with vouchers, and certify same to be correct, the balance to credit being £3,563.05, which is held in cash and on current and savings accounts at the Ulster Bank, less uncashed cheques totalling £325.74. There is also a holding of £206.19 in Dublin Corporation 9¼% Stock.

Dated 3rd March, 1977.

Signed: W. H. JACK,
Honorary Auditor.

Forest Walks

This year, the annual guided forest walks were held on Sunday, September 11th. Walks were organised in the following forests (leaders names are given in parenthesis).

Ardnageeha, Cong, Co. Mayo – Scenic walk by Lough Corrib through mixed woodland. (P. Campbell, B. Lambe, M. J. Maye).

Ards Forest Park, Co. Donegal – Forest Park. Conservation of native woodlands. Wildlife Sanctuary. (D. Connolly).

Ballinaboola, Ballylea, Charleville, Co. Cork – Forest Nursery practice. Diverse conifer woodland. (M. J. McCarthy).

Ballybrittas, Co. Laois – Wide variety of tree species and their management. Panoramic lakeside walk. (G. T. Hipwell, J. Prior).

Ballynastragh, Gorey, Co. Wexford – Nursery production of exotic broadleaf and conifer trees. (P. J. Cotter, G. Murphy, J. J. O'Reilly).

Brosna Forest, Co. Kerry – Large scale forest development on deep climatic peat. Duck pond, Grouse moor preparation. (J. A. Regan, D. Walsh).

Castlecomer, Co. Kilkenny – Mixed broadleaf and conifer woodlands. Wildlife interest. (G. McCarthy, K. Ryan).

Castle Lake, Bailieboro' – Amenity walk through broadleaf and conifer plantations. (E. Johnston, A. McGinley, M. Ryan).

Coole Park, Co. Galway – Mixed conifer and broadleaf woodlands. Historical and amenity interests. (J. Farrelly, C. Hanley).

Cratloe, Co. Clare – Mature conifer forest and natural oak woodlands. (E. Larkin, M. O'Donovan).

Drumboe Wood, Co. Donegal – River walk in mature conifer woodland. (N. Foley, T. Mannion).

Dromore, Ennis Forest, Co. Clare – Conifer and broadleaf woodland. Lakeside amenity. Wildlife interest. (M. Barry, L. Cawley, P. J. O'Sullivan).

Ely Lodge Forest, Co. Fermanagh – Scenic walk through mature broadleaf and conifer woodland on the shore of Lough Erne.(M. Devine, W. J. Wright).

Glenariff Forest Park, Co. Antrim – Forest Park and surrounding countryside, reception centre, wildlife interest. (W. J. Crawford).

Glencree, Co. Wicklow – Commercial and scenic aspects of mature conifer woodland. (J. Dillon, A. P. Higgins).

Glendine, Ossory, Co. Laois — Conifer forest at various stages of development. (B. J. Collins, T. McHugh).

Glengarra Wood, Co. Tipperary – Broadleaf and conifer woodland in picturesque river valley. (M. MacGiolla Coda, J. V. Roycroft).

Glen Island, Co. Mayo – Forest operations from nursery to harvesting. (T. De Gruineil, M. Hoban, R. O'Cinnéide).

Gosford Forest Park, Co. Armagh – Interesting variety of young hardwood and conifer plantations, arboretum and walled garden. (H. Conn).

Hollywood Demesne, Co. Wicklow – Mixed conifer woodlands interspersed with broadleaf trees. Reforestation of windblown area. (S. Casey, M. Regan, D. Sweetman).

Killakee, Co. Dublin – Wide variety of broadleaf and conifer trees overlooking Dublin City. (F. Mulloy, M. O'Brien).

Kilworth, Co. Cork – Forest management of mature conifer woodlands. (J. C. Crowley, P. Verling).

Lough Key Forest Park, Co. Roscommon – Scenic broadleaf and conifer plantations. Historical and amenity interests. (J. P. Duane).

Milltown Wood, Co. Leitrim – Scenic walk through mixed conifer woodlands. (P. McEneaney, P. O'Malley).

Moher Wood, Co. Limerick – Wide variety of young conifers and their

management. (D. Dineen).

Mullaghmeen Wood, Castlepollard, Co. Longford – Diverse broadleaf and conifer forest. (P. J. Morrissey, J. Quinlivan).

Newcastlewest, Co. Limerick – Pleasant walks through mixed broadleaf conifer woodland. Viewing point of counties. (J. Costello, D. Gleeson).

Pomeroy Forest, Co. Tyrone – Grace Drennan Woodland Trail. Mature mixed broadleaf and conifer woodlands. Forest nursery, wildlife interest. (G. B. Jones).

Rossmore Park, Co. Monaghan – Conifer plantation interspersed with broadleaf trees. Amenity, wildlife and historical associations. (M. Dooley, J. Finley).

Rosturra Wood, Woodford, Co. Galway – Diverse broadleaf and conifer forest. (E. McGuinness, S. O'Halloran).

Slish Wood, Lough Gill, Co. Sligo – Scenic walk by Lough Gill through broadleaf and conifer woodland. (C. C. Crowley, P. Finnerty, T. Gallen).

Trooperstown, Co. Wicklow – Wide variety of tree species in scenic setting. Interesting historical associations. (H. M. FitzPatrick).

ANNUAL STUDY TOUR 1977

Tuesday, 17th May

At the first stop, Rossacroonaloo property, Kilgarvan Forest (Forester-in-Charge, Mr. J. Donegan, Deputy, Mr. J. O'Sullivan), the President of the Society, Dr. P. Joyce welcomed the tour participants and introduced the tour leaders, Mr. P. White (Divisional Inspector) and Mr. D. Walsh (District Inspector). The President congratulated Mr. D. Mangan, the only society member present who had also attended the 1946 study tour which was held in the Killarney region and who moreover has attended all annual study tours since then. Mr. P. White remarked that forty years ago this pleasant picnic spot was a rock strewn mountain side supporting scattered oak and birch scrub. Lawson cypress planted along the roadside leading to the site had been thinned to give the area an open aspect. In response to a suggestion that water be laid on for picnicers Mr. I. Sherriff maintained that such a service would be costly to provide and would look unnatural.

The group then travelled to Dromore Wood, Kenmare Forest (Forester-in-Charge, Mr. T. Hickey, Deputy, Mr. M. McGerailt and Assistant, Mr. M. Ruane). An excellent stand of Sitka spruce planted in 1937 had been severely damaged in the storm of January 1974 when approximately 10,000m^3 were blown. Mr. Walsh invited opinions on what was the best management policy for the remainder of the crop. Mr. O'Flanagan advocated an immediate clear felling programme because of the dangers of further windblow. Mr. J. O'Driscoll, however, advocated waiting for a good Sitka spruce seed year before felling. Part of this stand was designated an EEC approved stand for the purpose of providing selected seed; hence Mr. O'Driscoll's reservations on immediate felling. He also pointed out that as one tree could yield seed worth £40-£50 it made sound economic sense to delay felling until after a good seed year.

We next turned our attention to a section of the wood where extraction was in progress. Extraction costs had been considerably increased by the fact that much of the timber was sold in small lots to local people. Marketing was once again identified as being of critical importance to any forestry operation. Mr. Walsh claimed that marketing was particularly difficult in the south Kerry area because of the absence of any major timber user in this vicinity, a point emphasised by the fact that timber from the area was often sent to Scarriff in Clare and even as far as Longford.

After a scenic journey we stopped on the roadside for a discussion on the possible impact of afforestation on the aesthetics of the surrounding landscape. The usual concern was expressed with regard to straight lines and sharp edges so typical of

many of the earlier established plantations but it was generally agreed that foresters were now conscious of the need to tread carefully in such high value amenity areas. Considerable controversy arose with regard to whether the valley bottoms and flat areas in such regions should be planted with trees. Mr. O'Flanagan expressed the opinion that the establishment of tree plantations would bring about too much of a visual change in the landscape. Others pointed out that newly reclaimed farmland was as likely to offend the eye as plantations of Lodgepole pine or Sitka spruce. Mr. M. Carey contended that lower lying regions were in general also the most highly productive and in view of the fact that forestry was essentially concerned with producing wood these were the areas that should be concentrated on. One despaired at the lack of overall national planning within this context. Land that could be acquired for afforestation within the severe financial constraints imposed was planted, all other areas being left practically devoid of trees. It seemed appropriate that the forester, agriculturalist, and landscape architect should get together with the economists and try to resolve the problem and ensure that the best possible use is made of our greatest national resource, land.

Having convinced ourselves that large blocks of forests are visually attractive, at least to foresters, we then drove on past Moll's Gap to Ladies View. Here we were introduced to Mr. P. J. Bruton, Forester-in-Charge, Killarney Forest, his Deputy, Mr. T. Prendergast and Assistant, Mr. J. Maguire. Mr. Bruton, in welcoming the party officially, pointed out that the surrounding area was probably one of the most photographed in the world and that therefore the remarks concerning amenity at the previous stop were particularly relevant. Mr. Bruton gave an interesting history of Killarney and its valley. The valley is renowned for the botanical wealth of its oakwoods which boast a primary oak layer, a secondary layer comprising yew, holly and the strawberry tree and finally a woodland floor covered in bryophytes.

Muckross Estate comprising 11,000 acres of mountain, woodland and agricultural land was granted to the state in 1932, whereupon it was entrusted to the Office of Public Works from whom the then Forestry Division of the Department of Lands leased over 1,300 hectares.

Oak regeneration was a major problem in these woods because of the presence of large numbers (up to 1,500) of Sika deer who were also threatening to take over from the smaller (about 350) population of native red deer. The problems and politics of culling the Sika deer population were explained by Mr. Mulloy and Mr. Maguire. It was obvious that the deer were interfering considerably with the management of the forest.

Our last stop for the afternoon was at Huntsmans Hill also in Killarney forest. There the problems and cost of controlling *Rhododendron ponticum* were spelled out by Mr. Bruton. The rhododendron grows vigorously in Killarney and the heavy shade it casts prevents oak regeneration. In recent years 160 ha had been cut and the subsequent regrowth sprayed with 2, 4, 5-T (7 gallons of 2, 4, 5-T in 100 gallons of water). The total cost of this operation was up to £200 per ha but unlike hand cutting which encouraged regrowth chemical control virtually eliminated the shrub. Mr. Brosnan pointed out that the cheapest method of getting rid of rhododendron was to use a bulldozer. However, this was not always feasible for a variety of reasons including uneven topography and lack of top soil. 2, 4, 5-t was now he said the most effective chemical to use and although Mr. Purcell expressed concern regarding its safety Mr. Brosnan pointed out that it contained less than 0.01 ppm (an internationally recognised safe level) of *Dioxine*, a toxic contaminant of all 2, 4, 5-T. In commenting on the dangers of the chemical Mr. Kerr said that in Northern Ireland forest workers were given an option as to whether or not to use it.

J. GILLESPIE, M. CAREY

Wednesday, 18th May

The first stop was at Toomies Wood, part of Killarney forest, situated on the western shore of the lower lake. Mr. H. Kerr of the Northern Ireland Forest Service, Chairman for the day, introduced Mr. M. Neff, Ecology Section, FWS who discussed the history of Toomies Wood. With its history of exploitation, there is considerable doubt as to whether or not this actually is the remains of a natural oakwood or if it was replanted. Nevertheless, it is one of the most extensive and scientifically important oakwoods in the country.

Mr. Neff showed us an enclosure erected in an attempt to quantify the destruction of regeneration by grazing deer. The forest floor inside the enclosure in contrast to that outside was covered with oak, birch, strawberry tree rowan, and many other species. However Mr. Neff expressed the view that should the deer be controlled then holly could become the dominant shrub layer. Much like rhododendron this canopy would exclude oak regeneration. A catch 22 situation in conservation!

The second stop of the day was at a Sitka spruce provenance experiment established in 1960. The Killarney region was chosen as it was practically frost free. Mr. J. O'Driscoll described the plot layout and explained that using tree height and diameter as parameters there is a highly significant difference between the provenances.

The party then travelled to Castleisland Forest where they were welcomed by Mr. J. Crowley, Forester-in-Charge, and Mr. P. McGrath, Deputy Forester. After lunch at Dooneen property, fire beaters of a type used locally were demonstrated and discussed. These beaters were made up of a long wooden handle to which a piece of durable and flexible rubber was attached. Local forestry personnel claimed they were very effective on a Molinia or low heather fire. Ironically as fire fighting equipment was being discussed news of a fire in the forest reached the party; at this stage two sections of the fire brigade were dealing with the situation.

Doneen property (32 ha in extent) was planted in 1959 with Sitka spruce. The soil is a peaty gley. The production as one would expect on this type of soil is mainly yield class 24+. Mr. Crowley maintained that there is no tradition of timber harvesting in the area. To date therefore local staff were dependent on local sales, satisfying mainly a demand for fencing materials. Mr. T. Purcell said the forest was about seventy miles from the nearest pulpmill, that at Scarriff, and as more thinnings were due this must offer an outlet, albeit a distant one, for the produce.

Thinning had been delayed from three to five years. Windblow was already in evidence, the danger being accentuated by the removal of a belt of trees on the most vulnerable side for road widening by Kerry County Council. How this area should be thinned, if at all, and how similar areas should be treated to avoid windblow were topics of discussion. Mr. Kerr expressed the Northern Irish preference for not thinning and a short rotation. His Southern counterparts favoured normal thinning using a line and chevron or line and selection methods. The advantages and costs of full pole as against shortwood extraction were discussed.

General opinions expressed on the treatment of these areas were:-

(a) Complete ploughing, modified double mouldboard ploughing or ripping in areas with a high stone content to improve rooting and so stability.
(b) Planting espacement wide, at least 2.4 metres.
(c) Thinning early and heavy in the hope of improving stability and the value of the final crop.

There was a demonstration of harvesting techinques which included the use of a cant-hook, breaker bar and crown puller. A neat box which carried sodium nitrate, brush, petrol etc. was on display. A tree was felled using a chain saw and this gave rise to a discussion of chain saw safety. This demonstration of a practical forest

operation sparked many into breaking their vows of silence and the overall participation in group discussion was very encouraging.

From Doneen the party was transported to Rathmore property. At this stage news arrived that the fire reported earlier was quite serious and hundreds of hectares of plantation were in danger. The President of the Society, on behalf of the members, offered the manual assistance of all the fighting fit participants to the local staff. This offer was gratefully accepted so it was decided to shorten discussion at the last stop and then hurry to the scene of the fire.

The area in question was planted with Sitka spruce in 1964 following double mouldboard ploughing. There was spot fertilisation at planting with 375 kg per hectare of ground mineral phosphate. Drainage was adequate. The spruce was in severe check and a strong growth of heather was present. Discussion centered around the reasons for growth limitation and how the area should be managed in the future.

From the discussion three main ideas on treatment were put forward.

(a) Application of nitrogen—500 kilograms per hectare of calcium ammonium nitrate was suggested by Mr. M. Carey. He pointed out that this is expensive and that the response may be limited to three to four years.
(b) Elimination of heather with 8 litres of 2,4-D per hectare plus the application of nitrogen if necessary. Mr. Brosnan stressed that if the site was of low nutrient status (particularly as Sitka spruce was a high nutrient demander) eliminating the heather was unlikely to provide the complete answer on its own. Nevertheless he felt that if the forest manager decided to retain his spruce then eliminating the heather should be his first remedial measure.
(c) Interplanting with Lodgepole pine on the old plough ribbon. Mr. L. O'Flanagan and Mr. T. Purcell felt that on oligotrophic peats this seems to be the surest and least expensive method of growing a tree crop.

After this discussion a bus load of members armed with Lodgepole pine branches were brought to assist in bringing the forest fire under control. Certainly a dramatic close to the day as with tanned faces and tired boughs the fire-fighters returned to a welcome late meal conjured up by the *'eminence grise'* Miss L. Furlong.

F. SHAKLETON, T. PURCELL

Thursday, 19th May

Muckross Gardens and nature trails were the setting for a pleasant Thursday morning session. Mr. J. Fennessy as Group Chairman introduced Mr. C. Foley, Assistant Park Superintendent and Mr. W. Carson, Head Gardener. Mr. C. Foley welcomed the party to the Bourne Vincent Memorial Park and gave a brief history of Muckross House and Park. It was interesting to learn that the house had the inevitable 365 windows without which any home worthy of the name would be incomplete. A visit by Queen Victoria in 1861 placed the house firmly among the elite of nineteenth century aristocratic mansions.

Mr. Carson enthusiastically led the party into the landscaped gardens which stretched from the house to the edge of the lake. Clever use of a rock outcrop has resulted in a rock garden sporting an array of alpines, dwarf conifers and shrubs. Warming to his subject he pointed out the world famous *Rhododendron* and *Azalea* shrubberies with their splash of colour which to the onlookers appeared as blossoms of each colour on the rainbow.

The party moved on to the Mossy Woods Nature Trail. Mr. J. Larner, Tour Guide and nature enthusiast explained that the trail was named after the abundance of mosses in these woodlands which stretch along a limestone ridge bordering the lake. Mr.

Larner drew our attention to the dwarfed natural yew, strawberry tree glades and the mosses, ferns and lichens present on the branches of the oak. Magnificent views of the Macgillicuddy Reeks across the island dotted lake were afforded on parts of this walk.

Mr. Larner was prompted into answering how the Office of Public Works dealt with Killarney's twin pests of Sika deer and *Rhododendron ponticum*. He favoured the dart gun and Dubai export approach to the former. At present *Rhododendron* is cut, windrowed and burnt and the cut stumps painted with 2, 4, 5-T. Mr. Brosnan commented that the method was labour intensive and that he felt foliar application as practised by Mr. Bruton in Killarney forest gave a more complete kill. We were shown some wire enclosures erected in 1969 to observe yew regeneration without deer grazing pressure. There were no yew suckers within the enclosure. Mr. O'Flanagan said that he felt the yew should be thinned to create a more ideal environment for its regeneration. There was evidence of deer damage to the bark of many of the mature trees some of which had wire screens to protect them.

When the party arrived back at Muckross House, the Chairman thanked our hosts and guides and our bus moved onwards and upwards towards the homely forested hills overlooking Killarney.

A Scots pine stand at the final stop before lunch provoked an interesting debate on species selection. Mr. Walsh claimed that the stand (P/Year 1948, volume 194m^3 per ha) was badly in need of a thinning but that timber merchants were reluctant to handle such a small lot. Nevertheless by including this quantity with a more attractive larger lot this problem could be overcome. Dr. Joyce estimated that a Sitka spruce crop on the same site would have in excess of 300m^3 per ha at present and further he stressed its heavy canopy effect in controlling the *Rhododendron* shrub layer which had build up under the Scots pine. Mr. P. White, while agreeing with Dr. Joyce's selection of species on purely economic grounds spoke of the importance of amenity planting in the Killarney region. This consideration could, he argued, stay the executioner's hand on a number of attractive but low productive stands. Dr. Joyce countered by suggesting a 2 storey high forest, interplanting the Scots pine with either Sitka spruce or Western Hemlock and on this sophisticated but compromising note the party repaired to a canvas canopy to lunch.

In the afternoon our first stop was at a European larch wood. The plantation which is on part of the Bourne Vincent Memorial Park was laid down in 1910 by Mr. Vincent. The area was heavily thinned over the years and many of the stems removed were used for transmission poles. The stocking is about 150 stems per hectare and there was a suggestion that at least part of the plantation should be retained, with it's present rather open appearance, as a deer lawn.

Our final visit in Killarney forest was at Dark Wood, property which was acquired from Lord Kenmare in 1940. An interesting talk on bird life in woodlands was given by Mr. J. Wilson, Wildlife Inspector. He said that a census in 1973 showed that the greatest density of Goldcrest in Great Britain and Ireland was to be found in Dark Wood. During the discussion which followed it transpired that, contrary to popular opinion, birds in a forest do not play a significant role in controlling insect pests such as aphids.

We then visited a plantation consisting of oak, beech and European larch planted in 1941. Mr. Bruton said that final crop trees had been selected about twenty feet apart and the aim was to produce a final crop of broadleaved trees. The subsequent discussion centered on the growing of good quality oak.

The President, Dr. P. Joyce, thanked the Forester-in-Charge, Mr. Bruton and his assistants for a most interesting day at Killarney Forest. Mr. P. White on behalf of the organisers hoped that all who attended had benefitted from the tour.

The tour ended as it had begun in bright sunshine and this sunny spirit was carried

over to the annual dinner where members and guests enjoyed a most pleasant evening.

J. BROSNAN, S. McNAMARA

Participants

Dr. Padraic Joyce (President), Pat White and Dan Walsh (Tour Leaders), Lily Furlong and Fergal Mulloy (Meetings Committee), Marie Aherne, George Beirne, John Brosnan, Michael Carey, Pauline Cleary, Michael Costello, Pat Doolan, John Fennessy, Michael Forde, John Gillespie, John Healy, Harry Kerr, Dermot Mangan, Tony Mannion, Liam Moloney, Evelyn McCreesh, Jim McSorley, Liam O'Flanagan, Martin O'Neachtain, Gordon Pickles, Tom Purcell, Margot Robinson, Freddie Shakleton, Harry van der Wel, Liam Berkery, Celli Breathnach, P. J. Bruton, Bernard Burke, Michael Byrne, Sean Carney, Charlie Crowley, Seamus Crowley, Noel Cullinane, David Cusack, Michael Donnelly, Declan Egan, Pat Fallon, Matthias Fogarty, Martin Lynch, M. Lynch, Jim Maguire, Jeremiah McCarthy, Ted McCarthy, Michael MacGiolla Coda, John McLoughlin, Sean McNamara, Con Nyhan, Seamus O'Domhnaill, Sean O'Laoighe, Brendan O'Neill, Jim O'Riordan, Con O'Shea, Tim O'Sullivan, Noel Ryan, Dan Scannell, Con Warren, Michael Ward.

EDITOR'S NOTE

Apologies for omitting to list those who acted as recorders during the Sitka Spruce Symposium *(Irish Forestry,* Vol. 34 (1)). So a belated word of thanks to J. Gillespie, E. Joyce, P. Saville, N. O'Carroll and J. Dillon.

Young boys and girls sailing on Poulaphouca Lake, Co. Wicklow.

A Question of Caring

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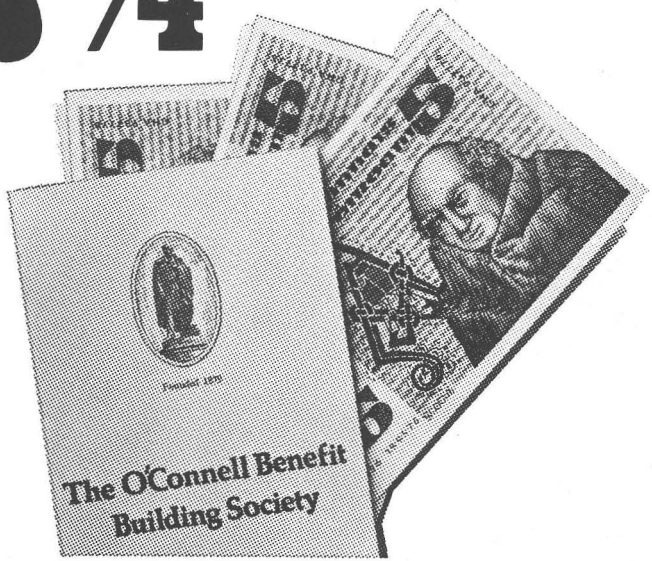

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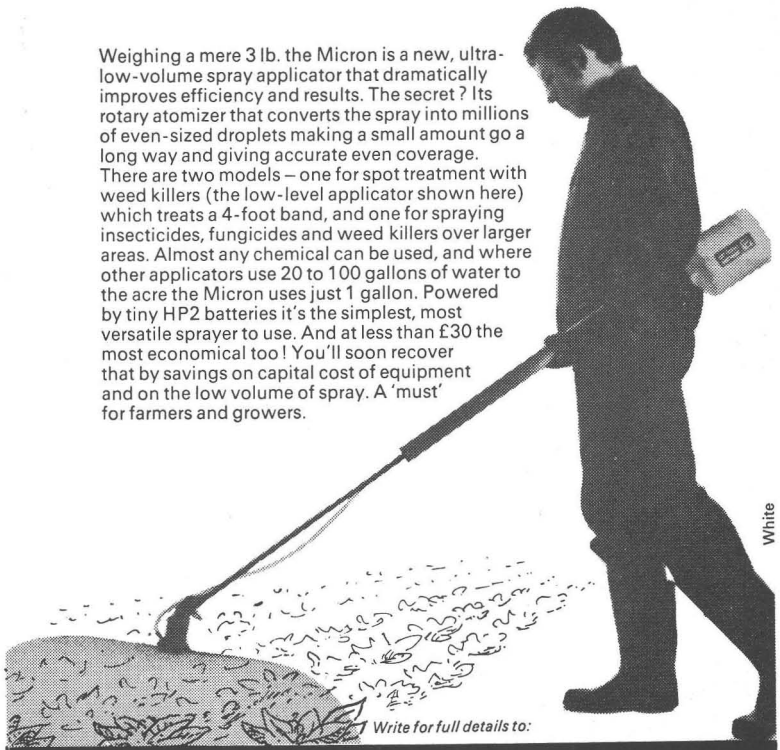
Weighing a mere 3 lb. the Micron is a new, ultra-low-volume spray applicator that dramatically improves efficiency and results. The secret ? Its rotary atomizer that converts the spray into millions of even-sized droplets making a small amount go a long way and giving accurate even coverage. There are two models – one for spot treatment with weed killers (the low-level applicator shown here) which treats a 4-foot band, and one for spraying insecticides, fungicides and weed killers over larger areas. Almost any chemical can be used, and where other applicators use 20 to 100 gallons of water to the acre the Micron uses just 1 gallon. Powered by tiny HP2 batteries it's the simplest, most versatile sprayer to use. And at less than £30 the most economical too ! You'll soon recover that by savings on capital cost of equipment and on the low volume of spray. A 'must' for farmers and growers.



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