A WORKSHOP ON CANTERBURY FORESTS

PETER J. BERG*

Abstract

This paper summarises the material presented, and the discussion which took place at a seminar held in Christchurch from 27 February to 1 March 1978. Its purpose was to examine the current state of forest management practice in Canterbury, to review recent research results, and to discuss the rationale for future forest management in the region.

BACKGROUND

History of Afforestation

The early history of exotic forests in Canterbury is well described by H. V. Hinds in a paper presented to the 10th New Zealand Science Congress in 1962. Briefly, at the time when the first settlers arrived the productive indigenous forests of the province were largely confined to Banks Peninsula and areas on the lower foothills (as at Oxford); these were rapidly depleted as settlement proceeded. The absence of trees on the bare, windswept plains was a strong stimulus to tree planting, initially for shelter and firewood, subsequently for timber.

As early as 1858, an ordinance provided for compensation to a land lessee, at the termination of his lease, for any trees that had been planted. There is no evidence that much use was made of this but it signifies the early recognition of the necessity for trees in Canterbury.

An important stimulus to forestry was given by the Forest Trees Planting and Encouragement Act of 1871, whereby farmers were given two hectares of Crown land for every hectare planted in trees. In the next few years various amendments to the Act were made, including one which replaced the grant of land with a cash subsidy. The Act was repealed in 1885, but it is clear that it had a powerful effect on the introduction of forestry on a scale larger than that of shelterbelts. In addition, thirteen thousand hectares of Crown land were set aside in the seventies and eighties for plantation purposes, mainly in the areas between the Waimakariri and the Rakaia rivers, but some also in the MacKenzie country.

*N.Z. Forest Service, Private Bag, Wellington.

The earliest plantings used the European species with which the settlers were familiar, and also eucalypts and wattles from Australia, both quick growers and of good fuel value.

Conifers appear to have been introduced in the late 1850s, including radiata pine and Douglas fir. The former was very quickly found to be successful under a variety of conditions. The tree planting in the first 20 years of settlement cannot be said to represent forestry in its wider sense, but did represent an essential pioneering in species selection and establishment techniques.

While steady progress was made in small-scale tree planting, the first major development did not take place until the turn of the century, when the newly created Forestry Branch of the Lands and Survey Department established a nursery at Hanmer. This was primarily for the planting of Hanmer State Forest by prison labour, but also supplied other South Island forests as they were established.

The Selwyn Plantation Board was set up in 1910 to control some 6 400 ha of local body plantation reserves between the Waimakariri and Rakaia rivers, of which 2 600 ha had already been planted. Utilising revenues derived by leasing grazing on areas not scheduled for immediate afforestation, the Board was able to maintain a modest planting programme. From about 1919 on, revenue from sales of produce enabled steady progress to be made in creation of additional plantations.

Ashburton County was active in making plantations, but did not join the Selwyn Plantation Board amalgamation. The Christchurch City Corporation carried out some effective reclamation of sand dunes at Bottle Lake, and the plantations so formed have become a valuable asset owing to their accessibility to markets.

The State established a plantation at Balmoral in 1917. It was a poor site on the plains, and droughts and infestation by rabbits made establishment a difficult task. A Forest Service plantation on a similar site was started at Eyrewell in the late 1920s, partly as a relief measure. Seventy percent of the planted area of 14 000 ha was in radata pine, with Corsican pine (10%) and ponderosa pine (9%) being the other main species.

The 1930s saw the formation of another State forest, this time on the low foothills south of Mt Grey. It is interesting that the impetus to create it was due to the enthusiasm of some of the local inhabitants, who formed an Afforestation Committee from representative local authorities. The hills were of low fertility and gorse was encroaching with some rapidity; it was considered that forestry would be the best

use for them. The committee obained options to buy several properties and then offered them to the Government, who completed the purchases and began to plant what is now Ashley Forest.

One hundred and sixty hectares at Omihi State Forest were planted in 1949 to control nassella tussock, and this area has been increased progressively to total over 1 200 ha in 1977.

By 1 August 1975 it was estimated (Wilson, 1976) that 44 000 ha of shelterbelts and plantations had been established in Canterbury.

Hazards of Afforestation

High temperatures, drought, and violent north-west winds of the Fohn type make the danger of fire consistently higher in Canterbury than in the rest of New Zealand. In 1940 a major fire damaged Eyrewell Forest, while in 1955 more than 2 400 ha of Balmoral Forest were destroyed in a fire lasting for some days. More recently, in March 1976, Hanmer Forest was the victim of a large fire driven by strong winds.

The same strong wind, coupled with shallow soils overlying hard compacted gravels, has been responsible for severe windblow of Canterbury forests. Although records describe damage as early as 1939 (Prior, 1959) the first major windblow occurred in Balmoral Forest on 13 July 1945, when 1 400 ha were thrown (Jolliffe, 1945). In 1964 extensive areas at Eyrewell Forest were thrown, leading to a major salvage operation (Childs, 1966). On 1 August 1975, 25% of the exotic forest area of Canterbury was windthrown or broken, leaving an estimated volume of 3.0 million cubic metres of roundwood on the ground, requiring a massive recovery operation (Wilson, 1976).

The low rainfall and shallow soils make for poor site conditions, with the plains forests having site indices (top height at the age of 20 years) as low as 20 m. Foothill forests, while more productive, are still below the New Zealand average. Drought is rarely responsible for mortality in the forest situation, although some influence on seedling survivals in the first year or two after planting is obvious.

Weeds have been mentioned. On the foothills gorse is a constraining factor on forest management, while at Omihi Forest afforestation has in turn been used to control nassella tussock.

Given the hazards listed, it is not surprising that attempts have been made to modify forest management methods to compensate. Grayburn (1963) described the rationale for the silviculture of Canterbury forests; Wendelken (1955) examined root development relative to wind firmness; Potter and Lamb

(1974) expanded on that study to account for the effects of soil cultivation and planting technique; Guild (1971) described soil ripping operations devised to increase rooting depth and improve wind firmness, while Papesch (1971) described wind tunnel tests designed to identify forms of plantation management and layout for higher inherent stability. Much of this experience was exposed to a critical test by the storm of 1 August 1975. Since then, much additional information has been obtained, but the basic question of the future role of Canterbury forests has still not been answered.

Need for Reappraisal

In his presidential address to the New Zealand Institute of Foresters in 1964, A. P. Thomson said:

> There remains to consider what should happen to the land at Eyrewell and Balmoral . . . when the forests there blow down in their turn. I suggest there are only two justifiable alternatives, neither of them particularly palatable. We could grow second crops of radiata pine on a short pulpwood rotation and hope that a local pulpwood industry will one day be started in Canterbury; or we could transfer a large part of the land to agriculture, leaving only strips and blocks as permanent forest and at the same time seek replacement forest land in the foothill zones.

Speaking to the N.Z. Loggers Association's 1976 Conference at Christchurch, Mr Thomson noted that, with the great economic advantages of proximity to Christchurch, and of dry, flat terrain, the policy decision had been to attempt to regrow sawlog forests:

> The events of 1975 must, however, lead to a further agonising reappraisal of the role of the Canterbury Plains as a source of trees large enough to produce saw timber.

The 1978 seminar held at Christchurch carried out a reappraisal of Canterbury's forests, and the rest of this paper is devoted to summarising the papers presented and the discussions that occurred at the seminar. (The detailed proceedings of the seminar are in preparation.)

In opening the seminar, the Conservator of Forests for Canterbury, J. Levy, noted the past hazards encountered by forestry in the region and welcomed this opportunity to examine management constraints in a total context, including economic considerations. Mr Levy also stressed the value of the contributions from other conservancies, which had singly or together experienced most of the problems associated with forestry in Canterbury.

SESSION 1. MANAGEMENT CONSTRAINTS

The first session of the seminar dealt with the presentation of conservancy statements identifying the management constraints which were common to those in Canterbury, and presenting the results of trials or remedial practices where these had been developed.

It was clear that no area was completely free of wind problems which, in most cases ,influenced the timing of thinning treatments and/or rotation lengh. The nature of the wind in New Zealand varies. There are the violent but uncertain gales associated with the passage of intensive subtropical cyclones to the west or east of the North Island causing damage in most northern conservancies and as far south as Nelson; and there is the prolonged rush of severe winds from a constant direction, associated with the movement of dense cool air masses from (generally) the north-west. The concentrating and funnelling effect of the mountain axis of the South Island and the southern North Island results in much greater wind speeds in eastern districts, particularly Canterbury and the Wairarapa, although damage associated with such storms may be found as far afield as Tapanui District and the Manawatu.

To counter the risk of windthrow, a number of modifications to management regimes have been adopted. Most commonly deep soil ripping is practised to encourage maximum root anchorage, and this is generally associated with early stand thinning and pruning to engender greater stability of individual stems. The system attempts to simulate an open grown situation. Some conservancies advocated the completion of final thinning by approximately 10 to 12 m (height) and clearfelling by 30 to 33 m to minimise risk.

The Selwyn Plantation Board has adopted an interesting variation in rejecting ripping, which merely achieves a greater intensity of stem breakage in winds of the magnitude of the 1975 storm, and instead accepts trees which topple before breakage occurs and so remain alive, permitting salvage over a longer period. This is referred to as the "hinge" principle.

The second management constraint is the weed problem, those most commonly listed including gorse, blackberry, broom, bracken fern, ragwort, tea-tree and hardwood scrub regrowth. Although the use of chemical weedkillers is widespread there is general recognition that the best control is effective pre-planting preparation, generally including some combination of chemicals, fire and soil cultivation. In a few locations the weed problem is sufficiently severe to cause a modification of routine stand silviculture.

Generally drought was a constraining factor in only a few areas, although there was some comment on the detrimental

effect of a dry summer in the first season following planting. Several comments were made that soil cultivation increased survival and early growth under dry conditions.

Locally ice and snow damage is a problem, although this is associated with moves to plant areas of higher altitude. More care in the choice of species planted, for example, Douglas fir, could reduce the damage and extend the upper planting limit. It was noted that in one or two instances heavy wet snowfalls and wet ground conditions predisposed stands to windblow in subsequent storms.

The practice of blanking in the year following planting has generally been abandoned unless a significant number of sizable gaps occur. This results from a series of Forest Research Institute and conservancy trials which have demonstrated that blanked trees contribute practically nothing to the final crop, have negligible influence on branch control, and are generally removed with the earliest thinnings.

Mr Levack explored the longer term South Island wood supply and demand situation. He showed that, though overall the South Island has adequate supplies of larger diameter logs to meet its future domestic sawn timber demand, Canterbury will have a major deficit (as a consequence of the 1975 windblow) until 1996. From 1991 the South Island will be a net exporter of timber, and by 1996 a threefold increase over current production will be possible. The fact that current plantings in Canterbury will be maturing in an era of wood surplus was felt to be of particular signficance in any appraisal of future afforestation.

SESSION 2: RESEARCH RESULTS

In opening the second session of the seminar, Mr Familton commented on the difficulties encountered in getting research results from the trial stage through to general field practice. Seminars such as the present one offered a practical means of overcoming the communications barrier.

(a) *Treestock Quality*

Mr Balneaves said that, because of the very poor quality of treestocks utilised in most South Island afforestation programmes, an important research target for the Establishment group was to improve this quality. Areas where immediate potential existed included the use of seed grading and the improvement of sowing density, with the consequent increase in crop uniformity and sturdiness.

Irrigation in most South Island nurseries could also offer gains in terms of even germination and early growth. How-

ever, none of the existing nurseries have adequate irrigation systems and little significance has yet been given to the development of such systems in New Zealand. Wrenching has been shown to lower nutrient levels in seedlings, and trials have demonstrated the benefit of providing additional nutrients over the period when this is undertaken. Similarly, depletion of nutrients accompanies removal of the seedling crop for planting and a careful fertiliser regime is invaluable in countering this.

(b) *Weed Control*

Speaking on weed control, Mr Balneaves noted that the fundamental basis for weed control is to divert part of the resources of the site from weed species to the crop. The resources were described as light, moisture and nutrients, all of which could be found influencing growth in various localities in Canterbury. In stressing the economic aspects, Mr Balneaves identified the presence of gorse in a stand as responsible for an increase of 22% in low pruning costs. Such an increase, spread over all tending operations, would more than outweigh any extra cost associated with more thorough initial weed control. Gorse is a problem of many afforestation areas in New Zealand, and Mr Balneaves advocated a three hit control regime based on two carefully timed herbicide treatments and a burn.

(c) *Site Preparation*

Dr Valentine described trials comparing routine windrowing, burning and ripping operations with (i) broadcast burning; (ii) line-blading before and after burning; and (iii) random heaping wherever slash was concentrated. Broadcast burning alone was unacceptable because of the need to subsequently rip. However, the line-blading operation demonstrated a potential cost saving.

Burning cutovers in Canterbury has proved to be fraught with risk, and Dr Valentine described investigations designed to identify less hazardous times for this operation. The studies indicated that spring rather than autumn burning has advantages associated with the lower intensity of the fire and reduced risk of spread, owing to the less "cured" state of surrounding forest and grassland. The principal problem was seen as the less settled weather of the spring period.

(d) *Stand Stability*

Trials designed to examine the effect of ripping on tree stability were described by Mr Filer. The holding strengths

of the root systems of 12-year-old trees were tested in relation to (i) no rip; (ii) shallow rip and deep rip across the wind; and (iii) the intersection of deep rips across the wind with both shallow and deep rips along the direction of the damaging wind. Results demonstrated that ripping increased root-holding ability, but that up to 50% of stems planted on deep ripped sites suffered stem failure before toppling, thus reducing the available salvage time in areas subject to intense winds.

Mr Somerville described an investigation undertaken to examine past wind damage in heavily stocked stands on the Canterbury Plains forests. It was found that the intensity and distribution of wind damage was closely associated with the type and proximity of exposed windward edges. Open edges, sudden changes in stand height, and larger internal openings particularly predispose a stand to damage — the most severe damage being encountered within 100 m of the stand edge. The intensity of damage both on the leading edge and within the stand is greater in older stands (25 years or more) than in younger.

Mr Papesch presented an illustrated account of damage recorded in the 1975 windblow. This he related to field studies designed to determine the drag coefficient and the associated centre of wind pressure on a forest front; and to wind tunnel studies designed to simulate various stand heights and density. Analysis of the overall aerodynamic and mechanical properties of the edge trees in a forest front will enable a better understanding of the behaviour of trees in a windy environment, and can be used to identify a forest layout and stand management system less susceptible to wind damage.

Mr Filer described an investigation indicating that wind damage reduced piece volume by 8 to 25%, depending on the windfirmness of the stand. At Ashley Forest greater rooting depth was associated with increased breakage, while at Eyrewell Forest, where trees toppled more readily, breakage was at a much lower level. He therefore concluded that, on the plains at least, the wisdom of ripping the soil to induce greater windfirmness is of doubtful benefit.

(e) *Timber Quality*

Dr Sutton presented the results of timber grade studies carried out in log samples from the Eyrewell *P. radiata* spacing trial, which at the time of the 1975 windblow was 25 years old. The study was restricted to logs sampled from the four widest spacings, namely, 3.0 × 3.0 m, 3.7 × 3.7 m, 4.9 × 4.9 m and 6.1 × 6.1 m. Sample trees were selected on the basis of their being representative of a normal final crop stocking.

After 25 years' growth the mean tree and log sizes were still relatively small. Even in the 6.1 × 6.1 m spacing the mean tree was only 42 cm dbh. Final tree sizes in the 4.9 × 4.9 m spacing, at 36 cm dbh, are similar to those of thinnings from central North Island forests, and Dr Sutton saw this as implying higher extraction and sawing costs in Canterbury.

The average grade outturn at each spacing was also poor, the total percentage of No. 1 Framing grade for each spacing being:

Spacing	*% No. 1 Framing*
3.0	38
3.7	31
4.9	16
6.1	18

Although some butt logs had been pruned to 2.6 m no board grade improvement was identified, mainly because of the high incidence of resin pockets.

A further study in a 39-year-old stand planted at 4.9 × 2.4 m showed 35% No. 1 Framing (46% from the butt log), indicating again a relatively low wood quality.

All pieces from these studies were railed to the Forest Research Institute at Rotorua, for stress grading. The results of this examination were described by Mr Whiteside and were related to similar studies of North Island sawn timber. The results from the stress grading analysis identified *P. radiata* from both the Eyrewell spacing trial and the 39-year-old stand as having significantly lower strength properties than the North Island samples.

Further laboratory analysis of both green and dry timber for modulus of elasticity as a plank and as a joist, and for modulus of rupture as a joist, confirmed the lower strength properties of the Canterbury samples. Recent work on North Island timber at the Forest Research Institute has shown that stiffness, as measured by modulus of elasticity as a plank, is most strongly influenced by wood density. As *P. radiata* wood density is believed to reduce with increasing latitude, these results may have important management implications for *all* the more southern afforestation areas.

Because of the low strength properties of the timber processed in the studies, Dr Sutton and Mr Whiteside questioned whether stands grown on short rotations at a wide initial spacing on the Canterbury Plains would yield timber suitable for framing use. As Mr Whiteside pointed out, *P. elliottii* of comparable low stiffness has already been declared by the Forest Service to be unsuitable for framing uses in New Zealand.

The best prospect for growing sawn timber in Canterbury for the New Zealand market is the production of framing timber from stands grown at fairly close spacings on long (40 year) rotations.

SESSION 3: OTHER CONSIDERATIONS

(a) *Forest Fertilisation*

Dr Mead discussed both the short- and long-term gains from forest fertilisation in the South Island. Improved nutrition was considered important to:

(1) Correct gross deficiencies so as to obtain a useful crop from the area.
(2) Improve wood production in the short term to meet local deficits in wood supply.

Dr Mead identified South Island afforestation areas where

(3) Maintain productivity and improve wood production in the long term.
(4) Improve yields of produce other than wood.

various levels of response to nitrogen, phosphorus, potassium, magnesium and boron application were known. At present calcium, manganese, zinc and copper deficiencies do not pose problems in South Island soils, although in some cases application of fertilisers has been responsible locally for interactions resulting in levels of other nutrients becoming critical.

To obtain best growth Dr Mead advocated the use of good treestocks and intensive site preparation, in conjunction with fertiliser application. Trials have demonstrated that the effects of soil cultivation, weed control and fertiliser application are cumulative, particularly in areas where soil nutrient and moisture stress exists.

In established stands in the South Island, trials have shown some level of growth response to fertiliser application in almost every case, the exception being Berwick Forest. Some care is required, however, as the use of nitrogen on its own often leads to nutrient imbalance. Generally there is a positive interaction between thinning and fertilising, with a worthwhile response being demonstrated in stands up to 40 years old. However, fertilising in stands within 4 years of clearfelling is not economic.

In concluding that fertilising for increased yield was a viable proposition for overcoming some of the short- and long-term productivity problems of South Island forests, Dr Mead stressed that the forester needs to make use of positive interactions. He must develop a fertiliser programme integrated with his silviculture that will supply the right kind of nutrients, at the opimum rate, at the right time to meet the trees' demands.

(b) *Economics of Afforestation*

Mr Bashall described investigations that had been carried out to compare and rank various Canterbury and Westland afforestation areas, based both on supply to a Canterbury domestic market and on log exports. The biggest advantage for Canterbury forests related to their proximity to the domestic market and the current export ports. Timaru seems likely to remain the principal port for the region, and afforestation for export is therefore favoured in the Hunter Hills and Geraldine region. The North Canterbury forests occupy a position midway between this region and Westland forests. Production for the Canterbury domestic market favours North Canterbury ahead of South Canterbury and Westland forests (in that order).

Mr Bashall concluded that, on the basis of the calculations, forestry investment in Westland was considerably less profitable than in Canterbury. There was evidence, however, that the cost of intensive silviculture was not being recovered in many Canterbury areas, and that such treatment should be restricted to the best possible sites.

(c) *Marketing*

In discussing marketing constraints on forestry in Canterbury, Mr Cooper noted one paramount fact — that an established wood-using industry exists, with outlets to supply — and that the industry itself is dependent upon the availability of a resource to sustain it. Given this situation, the objective should be to grow wood of the required specification as close to the market as possible and at the lowest possible cost.

The current market was estimated at 208 000 m^3 sawn annually, being made up of two-thirds Canterbury exotic and one-third Westland indigenous wood. The tight resource situation over the next decade was seen by Mr Cooper as likely to generate pressure on the State to increase its contribution to the local market; at the same time it was inevitable that rationalisation within the sawmilling industry would occur, with a number of mills dropping out of the scene.

Given that a shortfall is likely to occur, if industry is to be sustained at present levels wood must be brought into Canterbury from elsewhere. With the diminishing podocarp cut on the West Coast, sources of exotic supply in Otago or Nelson appear to be required. Questions relating to such a supply, but as yet unanswered, are:

(1) Should the wood be imported in log or sawn form?

(2) Should Canterbury timber prices be raised to account for freight costs, and what are the implications of this on current indigenous timber prices?

(3) Should the increased costs be absorbed by the supplier in the form of lower stumpages, and what effect would this have on State revenues?

(4) Are freight subsidies possible to resolve (2) and (3)?

In discussing log exports, Mr Cooper said it was Government policy to maintain a viable log export trade for several reasons, one of which was to permit the economic disposal of large volumes of timber arising out of such natural disasters as the Canterbury windthrow. Maintenance of the log export trade until such time as the large volumes of wood come on stream at the end of the 1980s would also be a valuable source of negotiating muscle. Referring briefly to the Canterbury salvage, he noted that the volume finally likely to be exported was very close to the original estimate at 800 000 m^3. Export receipts as at 31 December 1977 totalled $20.86 million and total receipts $23.8 million.

(d) *Management Considerations*

Mr Wilson, in presenting Canterbury Conservancy's rationale for afforestation in the region, described those management considerations that could make forestry in the region a success. In Canterbury land is a limited and valuable resource, and at least part of the justification for afforestation relates to effective use of this resource. Two of the region's forestry projects had developed as a direct consequence of weed problems too difficult for the agricultural industry to handle. The formation of the farmed strips at Eyrewell Forest had proved a particularly unprofitable operation and, although in the wake of the 1975 windthrow the Forest Service had looked at alternative land use options, there had been no agricultural interest in the forested areas. The easy topography and the proximity to the market provided further inherent advantages over areas further afield.

Although hazards to afforestation were recognised in Canterbury, Mr Wilson felt that management had found ways to compensate for these to the extent that they were of little more significance than hazards to forestry elsewhere. The areas in which modifications were made to offset hazards included:

(1) Site preparation — to provide more effective weed control, and an expanded rooting zone for increased tree stability.

(2) Silviculture — manipulation of tending so as to enhance the stability of the tree without compromising form or growth rates.

(3) Rotation — harvesting trees as soon as merchantable dimension is achieved, to reduce the period at risk, and maintain diversity of age classes.

(4) Forest structure — the development of a diversity of age classes in strips across the wind, designed to give a wedge effect. Such a pattern exposes a stand to only 25% of the wind force encountered at a bluff edge and there is also reduced turbulence across the surface of the wedge.

These developments, plus the value of the existing forestry infrastructure, were claimed by Mr Wilson to give continued afforestation in the region a substantial advantage over the development of new projects elsewhere, particularly where supply of the local market was concerned.

SESSION 4: SUMMATION

Mr Tustin opened a discussion on the need for further investigations by pointing out the subjective nature of much of the comment made at the seminar, and in some cases the dearth of hard facts. The meeting should have been presented with a vigorous economic comparison of plains versus foothill forestry and data to support current intensities of management. In the absence of these a policy on the future for Canterbury forests was lacking in foundation. There were also a large number of management contradictions — for example, conservancy statements varied markedly in prescribing cut-off points. Some conservancies carried out intensive silviculture in all stands while others found it uneconomic at equivalent site indices; some planted at closer spacing to control weeds, while others planted at wider spacings to avoid the need to tend in the presence of weeds; and a variety of rotation lenghs and maximum dimensions were proposed for areas exposed to a windthrow risk.

The realisation that ripping, while improving tree nutrition and weed control, also predisposed a stand to breakage rather than toppling in severe windblow led to an ambivalence of thought on its future use. The potential of more windfirm species such as Douglas fir was discussed. However, moisture limitations on the plains and weed problems on the foothills effectively ruled it out in most cases.

The general feeling of the seminar was that foothills, particularly in the vicinity of Timaru, offered best prospects for

future wood exports. A change in planting emphasis to this area was indicated. Complicating factors included the fact that, while Canterbury faces a marked timber deficit in the short term, forest planted now will mature at a time of a large timber surplus. To date, timber grades from short rotations had also proven to be relatively low. However, this situation was further aggravated by the realisation that, for Eyrewell Forest at least, even timber of the highest grade was of unacceptable quality.

Mr Tustin commented that, while most North Island conservancies had a clear cut-off index below which pruning was not considered economic, South Island appeared to be pruning well below this. Dr Sutton commented that, based on the branch sizes encountered in the Eyrewell spacing trial, there appeared little point in pruning at all. Pruning could possibly avoid some degrade in sawing for framing, but the presence of resin pockets ruled out any advantage in sawing to boards. And in addition, pruning off actively growing branches would remove some of the effective crown of the tree and further reduce diameter growth.

Mr Tustin said the results of research presently under way would refine management prescriptions on existing forests. However, undoubtedly the biggest step forward in the management of Canterbury forests could come from a change in tactics. On the marginal sites available for forestry in Canterbury a minimum investment policy was indicated. He feared the forests were being overcapitalised by current attempts at intensive silviculture, and suggested that a better rationale was needed. Of prime concern was the need to use more decision tools to justify and evaluate management alternatives.

In summing up, the Deputy Director-General of Forests, Mr O'Neill, commented that the seminar had been very successful in providing the opportunity for contact, presentation of ideas, and discussion between research and management personnel. The choice of location for a seminar discussing contraints on forest management was quite appropriate, as Canterbury encompassed many of the problems also evident elsewhere. The conservancy statements indicated that in most areas wind and weeds were important problems. However, it was possibly more significant that very few statements mentioned biological hazards as a constraint. In view of frequent past criticism of monocultures, and experience in one or two areas where radiata pine has struggled, this attitude may be a little optimistic.

Asking whether forestry is in fact a reasonable land use for Canterbury, Mr O'Neill noted some reservation about the

plains but felt that the foothills had good prospects. The only economic evaluation carried out to date indicated an advantage, particularly for log exports from that area. However, the doubt over timber quality necessitated a more thorough look at this aspect on other South Island sites. On the plains current indications are that forestry is a competitive land use, although the constraint of wind could force further consideration of shorter rotations and a reduced level of tending. Social and political factors also have a bearing on decisions made in regard to the use of this area.

Areas where the seminar appeared to have reached some agreement, and to which Canterbury foresters should now give special attention, were identified by Mr O'Neill as:

(1) Ripping — Although giving better survival and early growth, there is a need to quantify the advantages of ripping in the longer term, owing to stem breakage, etc.

(2) Gorse control techniques have shown a good standard of site clean-up with a long-term effect. The advantages of this treatment relative to subsequent stand access are considerable, and the methods need extending to further sites.

(3) In view of the low average site index, the incidence of resin pockets, and weed problems, the perseverance with a multiple thinning and pruning regime is economically suspect. Further evaluation of tending schedules for the region is therefore required.

(4) Forest nutrition trials suggest the potential for shortening rotations, or conversely producing a larger log on the same rotation. Improved nutrition may also improve timber density. These are all aspects that require evaluation for the promise they offer forestry in Canterbury.

(5) As many cut-overs have now been prepared or replanted, and as there is also a significant area of young crop that survived the windblow, the decision on the future management of Canterbury forests is something of a foregone conclusion. The lack of any particular criticism of the method of timber sale indicates that by and large the present system is adequate for most people's requirements.

In concluding, Mr O'Neill noted that, as a consequence of this seminar, a solid base of Forest Research Institute data was available from which forest managers could work. It appeared that the potential existed for a modest rate of afforestation on the foothills, and that we were meanwhile

committed to a further rotation on the plains. During that time the economists, researchers and managers must clarify whether forestry is a justifiable land use in that area.

REFERENCES

Childs, B. H., 1966. Salvage of a windthrown forest. *N.Z. Jl For., 11* (1): 66-81.

Grayburn, A. W., 1963. Silviculture in the private and corporately-owned forests of Canterbury. *N.Z. Jl For., 8* (5): 814-9.

Guild, D. W., 1971. Windrowing and ripping — a comparative study with other site preparation techniques. *N.Z. Jl For., 16* (1): 88.

Jolliffe, W. H., 1954. Wind damage in Canterbury. *N.Z Jl For., 5* (2): 154-5.

Papesch, A. J., 1971. The problem of wind damage in Canterbury forests. *N.Z. Engng, 26* (10): 293-7.

Potter, M. K.; Lamb, K. M., 1974. Root development of radiata pine in the gravel soils of Eyrewell Forest. *N.Z Jl For., 19* (2): 264-75.

Prior, K. W., 1959. Wind damage to exotic forests in Canterbury. *N.Z. Jl For., 8* (1): 57-68.

Thomson, A. P., 1964. Presidential Address. *N.Z. Jl For., 9* (2): 122-4.

———— 1976. Recovery logging in windblown forest. *For. Ind. Rev., 7* (8): 7-16.

Wendelken, W. I., 1955. Root development and windfirmness on the shallow gravel soils of the Canterbury Plains. *N.Z. Jl For. 7* (2): 71-6.

Wilson, H., 1976. The effect of the gale of August 1975 on forests in Canterbury. *N.Z. Jl For., 21* (1): 133-40.