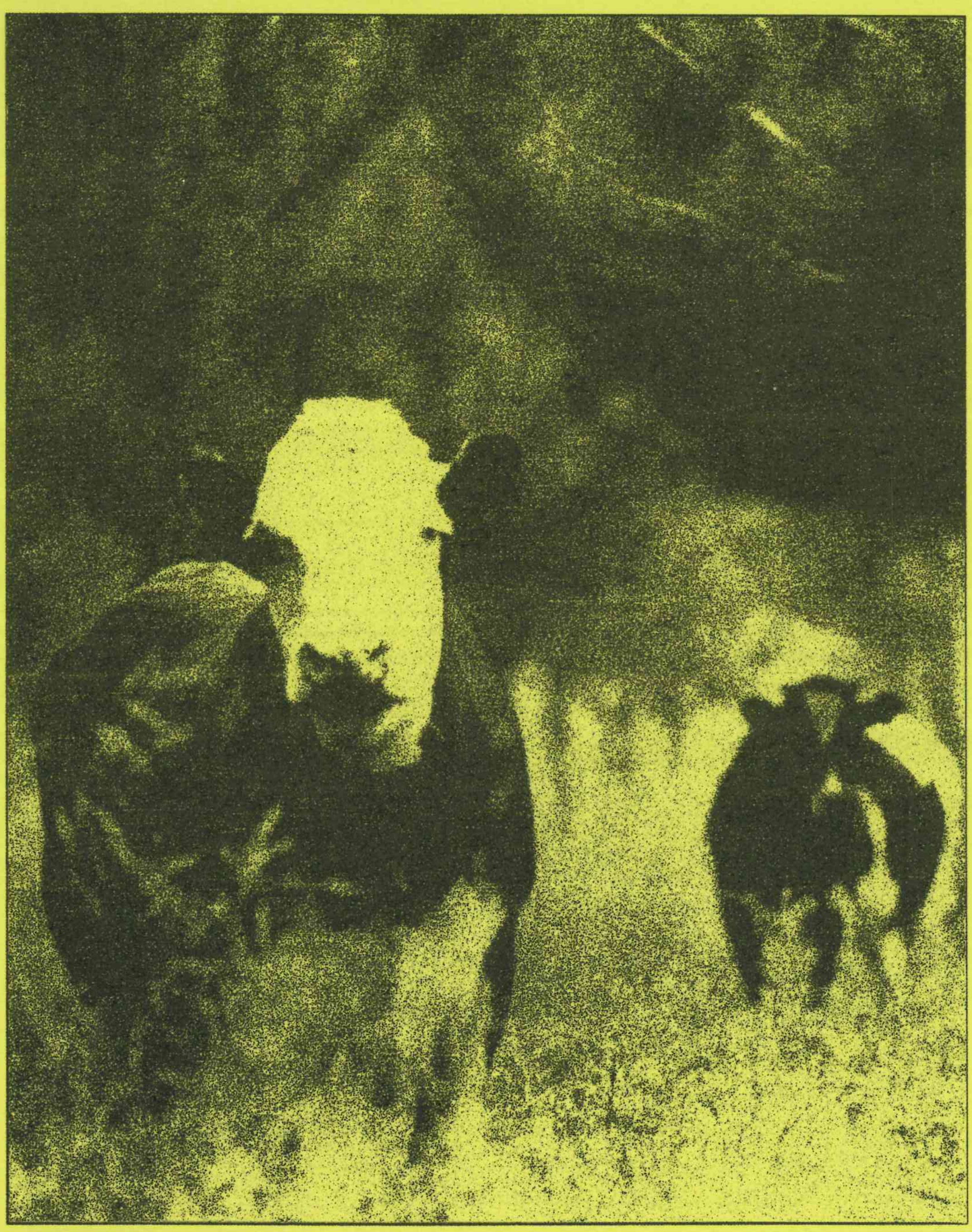
The Integration of Trees and Farming in New Zealand

by R. Moore



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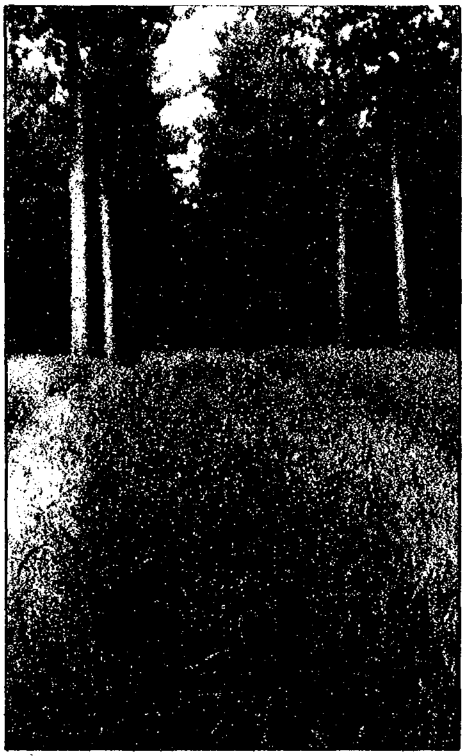

A report of a four week study tour under the Australia-New Zealand Forest Officer Exchange Scheme

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SUMMARY AND CONCLUSIONS

This report covers a four week study tour of New Zealand in May-June 1983 under the Australian-New Zealand Forest Officer Exchange Scheme. The purpose of the visit was to study ways that New Zealanders are integrating trees and farming, in particular their methods of farm forestry, agroforestry and their use of fodder trees. The main aspects reported are: reasons farmers plant trees; shelterbelts; financial assistance schemes; grazing in plantations; and agroforestry research. It was found that much of New Zealand practice is applicable to Australia.

FARM FORESTRY

Reasons Farmers Plant Trees

Many farmers in New Zealand are convinced it is worthwhile growing trees on farms. There are a number of reasons for this. Trees are more productive than pasture on some sites, they diversify income, they enable farm labour to be used more efficiently, they provide shelter, and they improve the living and working environment.

Farming land in Australia has the potential to produce timber and other tree crops. The practice of growing trees for timber and other products could improve farm income in areas receiving more than about 500 mm rainfall per year. In all farming areas trees would help to solve problems such as wind erosion and high losses of lambs due to exposure.

Tree planting based on the most appropriate land use needs to be investigated in Australia. There may be sites where trees would be more productive than pasture. For example, in Western Australia, on steep land in the Blackwood Valley and on deep sands in the Esperance sandplain.

Shelterbelts

Shelterbelts have many benefits. They can control wind erosion, shelter animals, improve growth of pasture, and produce timber and other products. Correct trimming of side branches and the pruning of well-formed trees improves the productivity and effectivness of shelterbelts. For example, studies on the Canterbury Plain have shown that well-managed radiata pine shelterbelts contain timber worth between $6 000 and $22 000 per kilometre, and produce better shelter than unpruned shelterbelts. Unmanaged shelterbelts provide less shelter, and eventually cost money to remove.

The method some New Zealand farmers use to manage radiata pine shelterbelts is applicable to many areas of southern Australia. Where rainfall is less than 500 mm per year or where soils are poorly drained, other species can be used. Demonstration areas need to be established to show how managed shelterbelts of radiata pine can produce effective shelter and saleable timber.

Forestry Assistance Schemes

Forestry and forest industries are major contributors to the New Zealand economy, and the government's policy is to continue to expand exports. The greatest potential for increasing the timber resource lies with private land owners. Therefore, the Forestry Encouragement Grant has been established to stimulate both farmers and private companies to plant trees for timber production. The Grant covers 45% of all establishment and tending costs.

Australian states which do not already have forestry grant schemes should seriously consider them. Such schemes need to cover a substantial proportion of costs, as there are no returns from forestry until harvesting takes place. Where trees have a protection value (such as control of salinity) as well as a production value financial assistance should be greater.

Joint venture agreements are an increasingly popular alternative way of financing forestry on farmland in New Zealand. Farmers provide the land, private industry provides the finance to plant and tend the trees, and both parties share the profits when the crop is harvested. Such agreements deserve more consideration in Australia.

Exotic Special Purpose Species

Radiata pine is unable to fulfil all timber needs. A group of eight exotic species has been selected to provide New Zealand with speciality timbers. These include five species of eucalypt and black walnut. Plantings of these special purpose species are being encouraged. The fact that a small plot of exotic species can provide a substantial income means these trees are particularly suited to combining with farming.

Socio-economic Issues

Forestry is expected to have a major impact on rural employment and economics in New Zealand because the area of plantations is increasing by 40 000 hectares per year. Farmers who have established significant areas of plantation find that they need to employ extra people to manage the trees. Therefore, forestry can help to create more employment in rural areas. This fact needs to be considered when evaluating new forestry schemes in Australia.

AGROFORESTRY

Grazing in Plantations

Grazing in plantations of radiata pine is practised by both the Forest Service and private growers in many parts of New Zealand. Foresters consider that grazing makes timber production more economic. It provides early financial returns, reduces scrub and improves soil fertility; the practice should be encouraged in Australia.

The prime aim of most radiata pine plantations in New Zealand is to produce sawlogs. Foresters generally pursue this aim by thinning non-commercially to a final-crop density of 200 to 300 trees per hectare by age 7 to 10 years. They reason that commercial thinnings are incompatible with maximizing growth of crop trees, and that it is better to use tops and mill residues for producing reconstituted products. Such regimes enable grazing to be carried out for much of the rotation.

Agroforestry Research

The recent findings of the New Zealand Radiata Pine Task Force indicate that densities of about 100 trees per hectare are the most economic, when the costs of tending, harvesting, transport and milling are all considered. The trend towards lower final crop densities will favour grazing and improve profitability.

Pine silviculture research in Australia needs to evaluate ways of growing pine, including wide-spaced trees with grazing, to determine the most profitable regimes. Computer modelling is probably essential for this work.

FODDER TREES

Fodder Tree Research

The main fodder tree being researched in New Zealand is tree lucerne. It is being studied by the Department of Scientific and Industrial Research at Lincoln. They have developed techniques for establishing and tending, and the next phase of the programme will evaluate management methods for farms.

The potential of tree lucerne as a multi-purpose tree is likely to be even greater in Australia than in New Zealand, because of our annual summer drought. Therefore, research into fodder trees needs to be encouraged, particularly to develop methods of management that can be used on farms.

INTRODUCTION

In Western Australia there has been a growing interest in farming systems involving trees. More appropriate methods of land management are needed to control wind erosion, to reduce salination of land and streams, to provide shelter for stock and crops, and to improve productivity.

New Zealanders have a great deal of experience in agroforestry and farm forestry, and Australian farmers and foresters can learn much from them.

I visited New Zealand under the Australia/New Zealand Forest Officer Exchange Scheme during May and June 1983. The purpose of my four week visit was to study ways that New Zealanders are integrating trees and farming. The scope of my tour was broad and covered three areas under the classification system of the Commonwealth Agricultural Bureaux (1982):

(1) Farm forestry - "systems in which farming and forestry activities are integrated horizontally within a farm". For example, farm woodlots and shelterbelts.

(2) Agroforestry - "systems in which farming and forestry activities are consciously combined vertically and/or temporally on the same piece of land". For example, wide spaced radiata pine with grazing.

(3) Fodder trees - "multipurpose tree production systems". For example, tree lucerne.

FARM FORESTRY

PRODUCTIVITY

Reasons Farmers Plant Trees

Most farmers plant trees with the aim of adding to farm income. Trees can provide income in a number of ways.

1. More productive use of land

   John Aitken, a farmer of the Tukituki Valley near Napier, has planted 50% of his farm with radiata pine over the past 15 years without a reduction in meat and wool production (Aitken, 1983). This is evidence that he is planting land that will be more productive under trees than under pasture (Plate 2).

   Graham Flett, a farmer in the Otago region of the South Island also bases his plantings on land use. On Graham's farm there are two main land classifications: land suitable for cultivation and flatland not suitable for cultivation because of rocks. He considers that land unsuitable for cultivation is more productive under radiata pine than under pasture.

   A quite different example of forestry based on land use occurs on a farm beside the flood-prone Oreti River in Southland. The land was offered to the New Zealand Forest Service because the farmer believed it would be better suited to forestry than traditional farming. Methods of using the land are outlined in the public discussion paper prepared by the Forest Service (Wiltshire, 1983). The plan proposes to evaluate a number of ways of combining trees and farming that might be useful on land prone to flooding.

They include poplars and willows for flood control and timber production, as well as strips of pine with cropping between.

2. Diversification of income
A number of farmers see trees as a new crop that can help some farms remain profitable.

On the phosphate deficient soils 100 kilometres north of Auckland, beef and sheep grazing is an unattractive enterprise. Neil Barr, a well-known New Zealand tree farmer, recognised this several decades ago, and commenced planting both softwoods and hardwoods. His original plantings were shelterbelts around small paddocks and blocks of trees on infertile soils. In recent years he has concentrated on establishing wide spaced stands of radiata pine and eucalypts (Plate 3). Many of his older stands are mature and have yielded valuable timber.

Bill Wise, a farmer at Pukekoma in Otago, also sees trees as a way of improving the farm income. Bill's farm is small and hilly and would not provide enough income with only sheep. He realized this 20 years ago and planted his first block of trees in a steep gully. Trees now provide an important part of the income for the farm. When the planting program finishes in a few years time, all the land too steep for tractors (27% of the farm) will be under trees (Plate 4).

3. Shelter

Many farmers consider that shelter from trees benefits stock and pasture. Gary Williams, a farmer near Napier, plants trees on the north and west sides of hills. He finds that under trees on these exposed slopes pasture grows better and sheep produce more wool.

I mentioned earlier that meat and wool production have not decreased on John Aitken's farm, even though 50% of the farm has been planted with trees. One of the reasons for this, according to John, is that pasture and animals are benefiting from shelter (Aitken, 1983).

4. Full use of farm labour

Trees enable labour on the farm to be used more completely. Tending of trees can complement other farm work, both in type and in time. For example, pruning trees can be a desirable change from milking cows. Tree planting is also more flexible than most other work on farms. Unlike harvesting a wheat crop for example, tending of trees can be done during the quieter times of the year.

John Aitken suggests that modern farm management techniques leave many farmers with spare time. If they wish to make more use of their time and increase their income, then growing a forest on their farm could be a solution (Aitken, 1983).

5. Improvement of work environment

Trees around farm houses and on farming land provide aesthetic and amenity values that are difficult to measure. For Peter Smail, a farmer on the Canterbury Plain, the shelterbelts on his farm increase his enjoyment of farm life. If there are storms after shearing he can relax knowing that his sheep have shelter.

Management of Trees

The opportunity to visit 12 farms (Appendix 2) enabled me to find out how farmers combine normal farm work with management of trees. Some farmers have methods that are the result of many years' experience.

1. Maximum area under trees

   Trees require a great deal of tending, and a common mistake for the inexperienced farm forester is to plant too large an area at one time. Neil Barr suggests that 4 hectares every few years, or 1 hectare per year is enough for one man to manage on his own. Where an extra man can be employed to do the forestry work, 12 hectares per year is about right, in Graham Flett's experience.

2. Proportion of trees to open pasture

   Some farms have been almost entirely planted up with trees. For example, at Glengarry Station and Puna Mara Ngaheri in Hawkes Bay the prime objective of both farms is timber production, and grazing is secondary. The managers of both farms say that too much has been planted with trees. They suggest that about one third of a farm needs to be left as open pasture. The open land is needed for mustering, for producing quality pasture that will fatten stock and for flexibility in stock management, to cope with, for example, the summer growth of pasture.

3. Grazing amongst trees

   I found that there were differences of opinion about when grazing can commence amongst trees. Ken Harris, the manager of Woodstock, considers that there should be no grazing for at least 20 months after planting radiata pine.

That way, he says, he avoids any trees being damaged, and the grass has time to re-establish on the areas sprayed with weedicide during establishment. Ken refutes the notion that grass degenerates when left. He finds that sheep put on weight with pasture that hasn't been grazed for two years.

Brian Gorrie, the farm manager of Waiotahi Forests Ltd., finds that he can do light grazing in the first year. As the trees grow, he builds up stock numbers.

The conclusion I have reached is that stock can damage young trees and that the most appropriate time to start grazing depends on such factors as the type of stock, the type of pasture, and how closely grazing can be monitored.

4. Species

Farmers are often keen to explore a range of species. They value the aesthetic benefits of a variety of trees, and grow other species with specific needs in mind. For example, Bill Wise at Pukekoma grows some poplar to provide posts and poles as well as fodder. I have made additional comments about different tree species in the section entitled "Exotic Special Purpose Species".

5. Finance

Most financial assistance in New Zealand is provided by either the government funded Forestry Encouragement Grant (pays 45% of all forestry costs) or by joint venture schemes.

A joint venture is an agreement between a farmer and a private company, whereby the farmer provides the land, the company finances the growing of the trees and both parties share the profits at the end of the rotation. I discuss both schemes in the section entitled "Financial Assistance Schemes".

6. Marketing

Farmers can easily sell logs of radiata pine. However, they often have difficulty finding mills that will buy hardwood logs. The problem is that in most areas the quantity of special timbers is too small to support a hardwood mill. The new policy on exotic special timber species aims to encourage plantings and to build up the resource on a regional basis.

Even though radiata pine can easily be sold in today's markets, farmers value the security of sale for new plantings offered by joint venture agreements (Aitken, 1983).

SHELTERBELTS

Background

The original settlers established agriculture on the plains and in the gentler countryside of New Zealand. Many came with plenty of money and tried to create another England, which meant that they planted mainly exotic species around their homesteads and on their farms.

The second phase of development was the establishment of farms in the hill country. The pioneers of this land didn't have much money, and they had to clear the bush to create their farms. They certainly didn't plant trees.

The third phase is just beginning. Many farmers are now realizing that trees can provide shelter, erosion control and additional income.

Reasons for Shelterbelts

Shelter has many benefits.

1. Control of wind erosion
   Soil erosion by wind is a problem on the Canterbury Plain. Dr. B. Painter has measured losses up to 5 tonnes per hectare per day at peak velocities (Sturrock, personal communication). Shelterbelts can control wind erosion.

2. Protection for animals
   Studies have shown that a quarter to half of all lamb deaths can be attributed to exposure. On the national scale this is a loss of $0.5 - 2.5 million per year* (Sturrock, personal communication).

3. Increase in pasture growth
   Radcliffe (1983) concluded, in her review of literature, that pasture growth is improved by shelter. Whilst there is a lack of data for New Zealand, all farmers with whom I spoke consider that growth of pasture is better in sheltered paddocks.

4. Diversification of income
   Shelterbelts can produce significant amounts of timber as well as good shelter. Patrick Milne (Forest Research Institute, Rangiora) in his assessment of shelterbelts on the Canterbury Plain, found that the timber value ranged from $6 000 - $22 000 per kilometre of belt (Forest Research Institute, 1983 unpublished data).

*N.B. All $ referred to in this report are New Zealand $s.

Management of Shelterbelts

Mention the word shelterbelt and many New Zealand farmers picture a single row of overmature radiata pine with enormous limbs, performing poorly as shelter and probably costing money to remove (Plate 5). However, the work of some innovative farmers, notably Peter Smail, has shown that with appropriate management, shelterbelts can provide both good shelter and valuable timber.

1. Permeability

   Studies have shown that for maximum benefit, shelterbelts should filter rather than block wind. The desired permeability is about 50% (Nicholas, 1982). Shelterbelts that are too dense cause winds to eddy and swirl close to the trees.

2. Length

   The length of shelterbelts needs to be at least 20 times tree height to minimize edge effects (Nicholas, 1982).

3. Distance between belts

   The maximum reduction in wind speed occurs close to the shelterbelt. As the distance from the shelterbelt increases the wind speed increases. At a distance of ten tree heights from the shelterbelt the wind speed is still 50% less than in the open. On the Canterbury Plain, where the tree height averages 22 metres, 200 metres between belts gives the desired shelter.

4. Spacing within belt

Both double and single rows will provide the desired permeability if pruning is carefully managed to ensure that enough trees have branches to ground level. Only a little extra timber is gained with more than two rows, as the middle rows become suppressed. Also, more land is lost to trees with each additional row per belt.

5. Species

The two main requirements of shelterbelts, good height and 50% permeability to ground level, need to be remembered when selecting species. Conifierous species are recommended because their branches persist and provide shelter to ground level. Eucalypts, especially those with timber potential, would be ineffective on their own because they shed their lower branches. Low shelter species are needed in conjunction with eucalypts. Species that produce nuts, fodder and timber could be selected (Nicholas, 1982).

Radiata pine performs better than all other species on most sites in New Zealand. Its growth rate is superior, its timber is marketable and, with appropriate pruning, good shelter is obtained (Plate 6).

To add diversity to a shelterbelt, special purpose timber species could be planted on suitable sites.

6. Orientation

North-south orientation of shelterbelts is considered the most appropriate alignment for New Zealand conditions. This alignment provides shelter from most strong winds and avoids the problem of pasture being shaded on the south side of the belts.

Plate 1 There are many ways of integrating trees with farming. This scene in Otaga, New Zealand, shows a rural landscape with wood lots and shelterbelts.

Plate 2 Typical hill country farming land on the east coast of the north island. This type of country has the potential to be made more productive by growing trees on the steep areas and by continuing to graze the pastured ridges. Note that the sheep are grazing on the pastured ridges while the steep gullies contain little pasture and few sheep.

Plate 3 Wide-spaced eucalypts (mainly E. saligna) with pasture for grazing on Neil Barr's (eminent farm forester) farm at Kaukapakapa. The self gripping ladder is used for pruning to six metres.

Plate 4 On Bill Wise's farm in Otago, land that is too steep for the safe operation of tractors has been fenced off and planted with trees. The photograph shows poplars and young radiata pine in the steep gullies.

7. Pruning

Pruning is the key to producing valuable shelterbelts. Pruning enables the desired permeability to be achieved and useful timber to be produced. Peter Smail, a farmer on the Canterbury Plains, has developed effective pruning techniques for radiata pine shelterbelts:

(i) Trimming

Trimming involves cutting back branches on either side of the shelterbelt to within 30 - 50 cm of the stem. A contractor on the Canterbury Plain has built a machine with large rotating blades for trimming shelterbelts. At a cost of $50 per hour farmers can have their shelterbelts trimmed to a height of 12 metres (Plate 7). The technique is expensive and must be repeated about every three years. However, Smail considers it worthwhile for several reasons. Firstly, trimming keeps the belt narrow and allows grass to grow right up to the fence line. Trimming creates bushiness and the desired permeability to ground level. Trimming also keeps branches small, which he considers improves the value of trees for timber.

(ii) Fan pruning

Fan pruning is a new approach. It involves pruning branches on the outer side (fence side) of the tree (Plate 8).

Fan pruning may be cheaper than other methods, may produce better timber, and may avoid the need to come back every three years as is the case with trimming.

Plate 5 A typical unmanaged and overmature radiata pine shelterbelt. It provides ineffective shelter because of gaps between the trees and browsing by animals near ground level. Large spreading branches prevent pasture growing for a considerable distance from the belt.

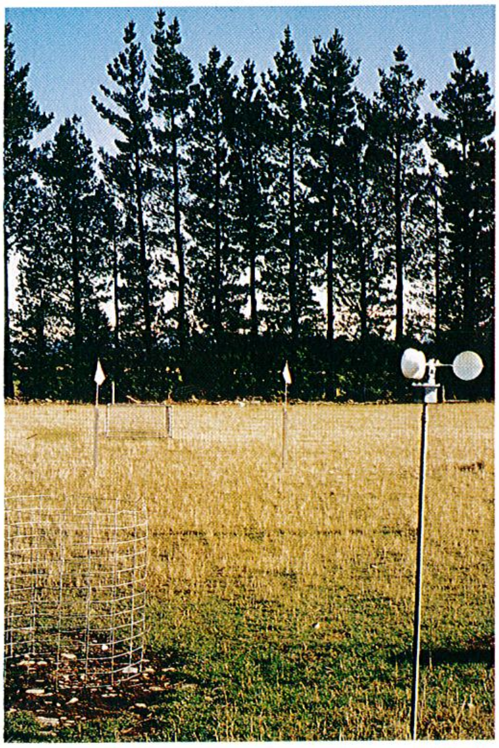


Plate 6
A well managed radiata pine shelterbelt on Peter Smail's property. There is effective shelter to ground level and the belt has the desired permeability (about 50%). Compare with Plate 5.

Plate 7
In this shelterbelt the radiata pine has been trimmed from ground level to 12 metres. This practise enables pasture to grow right up to the belt. It may also improve the value of the trees for shelter. Note, also, the row of slow growing <u>Cupressus</u> spp. on the windward side of the radiata pine.

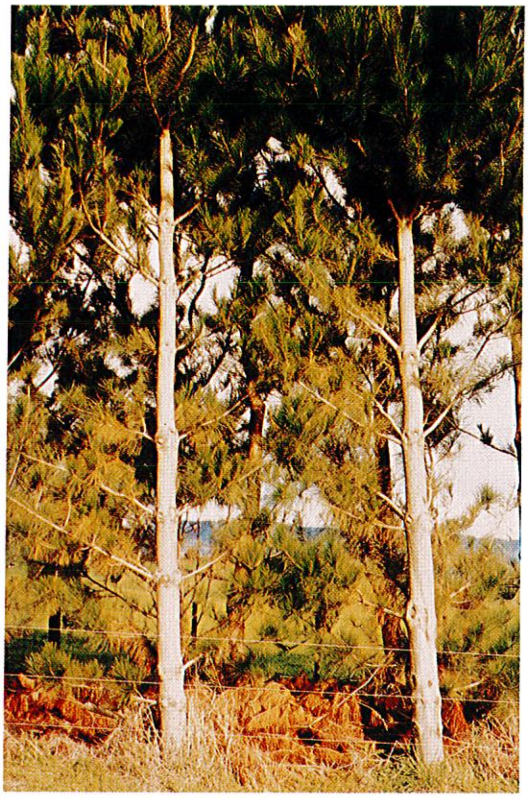


Plate 8
This shelterbelt of radiata pine has been fan pruned. The branches that were growing towards the fence have been removed. The practise may be cheaper than trimming, and may produce better timber.

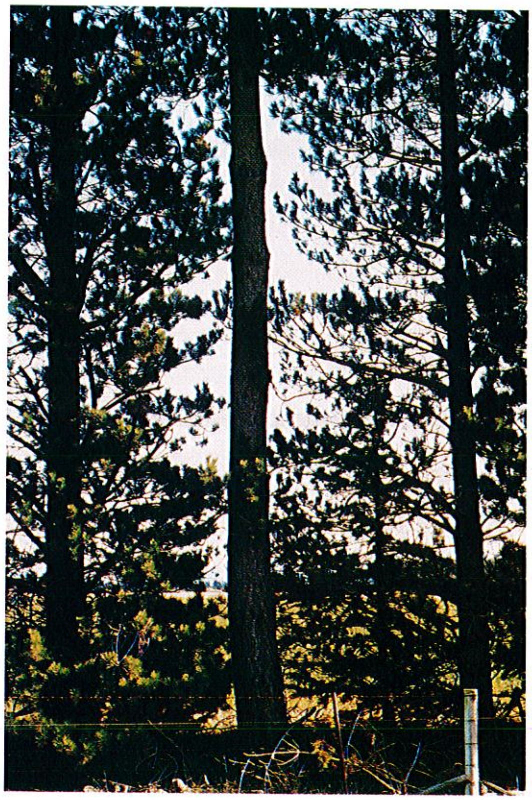


Plate 9
The centre tree in this radiata pine shelterbelt has been lift-pruned to produce knot free timber. Branches on the neighbouring trees occupy gaps created by lift-pruning and create the desired permeability.

(iii) Lift pruning

Peter Smail has found that there is scope for traditional lift pruning in shelterbelts. He selects the better formed trees and prunes off all branches up to about 6 metres (Plate 9). The desired permeability is maintained by branches on trees on either side of lift pruned trees.

It seems likely that all three types of pruning have their place in the management of shelterbelts. They are being evaluated by the Shelterbelt Group of the Forest Research Institute in Rotorua.

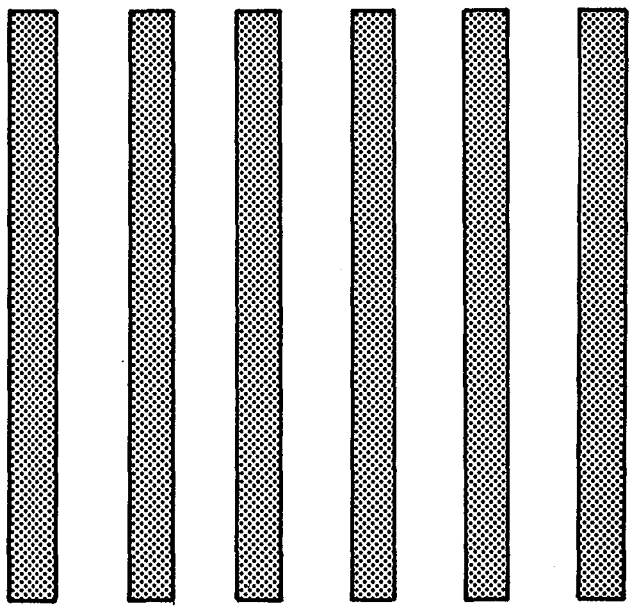
8. Future replacement

Planning of shelterbelts should take into account that trees have a limited life. The traditional approach has been to plant a slow-growing species and a fast-growing species so that the former will take over when the latter is logged (Plate 7).

The main disadvantage with this approach is that height growth is so slow that it is many years before the slow-growing species provides effective shelter. Returns from timber are also low.

Patrick Milne (Forest Institute, Rangiora) suggests that it is better solely to grow fast-growing species and to plan harvesting so that loss of shelter is minimized. An example of careful planning is to alternate the planting of belts and harvest in a similar sequence (see diagram below).

Plan View of Shelterbelts



Planting and harvesting sequence 1 4 2 5 3 6

It sould be remembered that a fast growing species provides effective shelter within a few years of planting. (Radiata pine is 8 - 12 metres tall in 6 years.)

Research

1. Background

   Farmers are asking important questions about shelter. They want to know, for example, what effect shelter has on pasture and where trees should be planted to maximize production on their farms. There is little data available to answer these questions.

2. The Shelter Committee

   For many years nobody was prepared to be responsible for shelter research. Both foresters and agriculturalists considered that such research was outside their sphere. In 1980 a Shelter Research Advisory Committee was established with the function of co-ordinating the research effort by government departments and other groups, such as the Farm Forestry Association. The committee identified the major areas for investigation and decided which agencies would be responsible for studying the various aspects. The committee has decided that the Forest Research Institute will study timber production, design for hilly country and species for difficult sites, whereas the Ministry of Agriculture and Fisheries will study the effects of shelter on pasture, crops and animals (National Research Advisory Council, 1982).

3. Current research

Researchers with the Forest Research Institute say that they are at the "throwing around ideas" stage. They are talking about reasons for shelter and raising questions such as:

i) what are the objectives of shelterbelts - windbreak or woodlot?

ii) what is the effect of orientation of shelterbelts on branch size, timber recovery and pasture growth?

iii) what land area does a shelterbelt take out of production?

iv) what contribution can timber from shelterbelts make to farm income? and

v) what is the best way to arrange shelterbelts to maximize production, on flat and on hilly country?

To answer these questions many variables need to be considered, including: layout of belts, orientation, direction of prevailing wind, aspect, type of agricultural production and factors that influence timber production. The shelterbelt team at the Forest Research Institute consider that a computer model which takes these variables into account will need to be built. Then farmers can decide on a rational basis, how and where to plant shelterbelts. Eventually the question of shelter will need to be tackled on a regional scale.

A number of other government agencies are carrying out research into shelterbelts. The main ones are the Ministry of Works and Development, the Department of Scientific and Industrial Research and the Ministry of Agriculture and Fisheries. The Ministry of Works and Development is testing a range of tree and shrub species, the Crop Research Division of the Department of Scientific and Industrial Research is concentrating on crop responses to shelter, and the Ministry of Agriculture and Fisheries is studying the effect of shelter on stock.

FINANCIAL ASSISTANCE SCHEMES

Forestry Encouragement Scheme

1. Background

   The objective of the grant scheme is to encourage private forestry. Forestry is seen as an important export industry for New Zealand. The greatest potential for increasing the area of forests is on farming land. The Forest Service is running out of land but many hill country farmers still have land that is under-utilized.

2. Scope

   The grant covers all establishment and tending costs associated with growing trees for timber. Where the objective is solely timber production, farmers are paid 45% of all costs. For plantings that have a protection function, such as erosion control, as well as a production objective, the rate of payment is 66.6% of costs (New Zealand Forest Service, 1982a).

3. Eligibility

   Grants are paid to all forest growers whether they be small farmers or large companies. There is no restriction on the area of plantings, but proven timber species must be used.

4. Applications and administration
Growers normally contact their accountants to arrange a claim for forestry expenses. Claims for grant payments pass straight to the Accounts Section of the Forest Service. This method avoids involving extension officers in time-consuming adminstration work, and leaves them free to fulfil their advisory role.

5. Advisory services
Under the grant scheme, farmers can proceed with tree planting without extension officers being involved. However, most farmers either seek advice or are happy for extension officers to call in.

6. Principles of successful encouragement schemes
The latest grant scheme, which came into operation in early 1983, is based on experiences with earlier schemes. In discussions with several extension officers (John Cawston, Joe Dennis and John Edmonds), I obtained comments about the ingredients of successful encouragement schemes.

i) Simple schemes, that are easily understood, will attract people.

ii) A minimum of controls is cost efficient. Most farmers will do the best they can with their money.

iii) There should be few limits on levels of assistance. It is better to set parameters (such as expected costs per hectare) rather than maxima.

iv) The service should be advisory rather than regulatory. This can be achieved by leaving the administration to the Accounts Section.

7. Additional incentives

Some foresters and farmers consider that the new grant scheme should provide more assistance. Aitken (1983) suggests that 100% of the costs need to be covered if farmers are going to plant significant areas of trees.

Joint Venture Agreements

Joint ventures in forestry are agreements between farmers and private companies.

1. Benefits

Joint ventures provide mutual benefits (Groome, 1982). Under a joint venture agreement the farmer can enjoy:

i) no cash outlay (except possibly fencing);
ii) sharing the profits;
iii) not having to plant, tend or harvest the forest;
iv) grazing and shelter;
v) more productive use of land;
vi) control of what land is afforested; and
vii) a guaranteed market.

The industrial partner can enjoy:
i) a guaranteed resource;
ii) land free of charge for afforestation;
iii) land owner on site to watch over forest; and
iv) co-operation from farming community.

2. Method

The method is based on the recognition that three parties contribute to the afforestation scheme. They are:
i) the land owner;
ii) the industrial partner; and
iii) the Government.

The land owner contributes land, fencing and annual rates. The industrial partner pays for site preparation, planting, tending and harvesting costs, while the Government provides 45% of all costs under the Forestry Encouragement Grant. The total inputs of landowner and industrial partner are compounded to the end of the rotation to determine the share of profits that each partner will receive.

EXOTIC SPECIAL PURPOSE SPECIES

Policy

New Zealand has a policy of growing exotic special purpose species because:

i) radiata pine cannot fulfil all timber needs. Other species must be used where high standards of hardness and stability are demanded or decorative features are required

ii) the supply of the native hardwood timber is declining

iii) it is considered unwise to rely solely on radiata pine.

To market speciality timber, the resource needs to be large enough to support a sawmill. The plan, therefore, is to build up the resource on a regional basis. Annual targets for regions range from 200 to 500 hectares per year (New Zealand Forest Service, 1981).

Species

Trees selected as exotic special purpose species satisfy two main requirements, their timber has the desired qualities and they grow well in New Zealand. The list of special purpose species is:

i) Tasmanian blackwood;
ii) Cypress pine;
iii) Alpine ash;
iv) Southern mahogany;
v) Brown barrel;
vi) Mountain ash;
vii) Sydney blue gum; and
viii) Black walnut.

All plantings of these species for timber production qualify for 45% rebate on costs under the Forestry Encouragement Grant.

Interest by Farmers

Many farmers are more interested in growing special timber species than radiata pine, for several reasons:

i) they are well-suited to growing in small numbers;

ii) high quality timbers provide high returns;

iii) farmers see potential for using the timber on the farm, perhaps to extend the house or to construct some furniture and they would like a quality timber for this purpose;

iv) some farmers are worried that there may be a glut of radiata pine; and

v) some prefer to grow a species other than radiata pine.

Research into Black Walnut

Black walnut is the most valuable timber grown in New Zealand. It returns $600 per cubic metre (New Zealand Forest Service, 1979). In 1979, Ian Nicholas (Forest Research Institute) established a provenance and progeny trial near Hamilton (Plate 10). Already there are big differences in growth rates and form.

Black walnut has three main requirements for good growth:

i) highly fertile soil;
ii) loamy soil to allow good rooting depth; and
iii) high rainfall.

In other words, it needs the best conditions. It is also very sensitive to herbicides. Experience with grazing amongst young black walnut has been variable. Some people have grazed successfully in the first year, others have not.

The research work has been trying various techniques for encouraging a single leader, such as pulling the stems together and pruning all but one. The stocking of the final-crop based on work in the U.S.A., is expected to be 70 trees per hectare.

Research into Blackwood

Tasmanian blackwood is another favoured special timber species. Work by the Forest Research Institute in the 1960s found that to produce a well-formed stem, blackwood needs to be grown in a light well (for example, as a group planting in a gap in native vegetation) (Plate 11).

It will grow with a single stem to the top of the surrounding scrub and then it will fork readily (New Zealand Forest Service, 1982b). Blackwood responds well to thinning, and will produce a millable log in 40 years. The rainfall pattern and soil type are unimportant in the growth of blackwood in New Zealand.

SOCIO-ECONOMIC ISSUES

Background

Forestry is an important component of New Zealand's economy. The value of exports of exotic timber in 1982 was more than $77 million (New Zealand Forest Service, 1983), and this is expected to rise steeply by the end of the century as large areas of pine planted during the 1960s and 1970s come into production.

With New Zealand's lack of natural resources suitable for export and the loss of markets for many farming products (for example, meat and butter), forestry is vital for economic growth.

Forest Research Institute Economics Group

With the area of exotic forests growing by 40 000 hectares per year, forestry is expected to have a large influence on rural economics and local employment. An interdisciplinary group at the Forest Research Institute is evaluating socio-economic aspects of forestry and farm forestry. The group is studying, for example, the effect of a transition from an agricultural-based economy to a forest-based economy.

Forestry and Employment

What effect does forestry have on employment? Several farmers who have planted large areas of trees on their farms have found that they need to employ extra people to tend the trees (Flett and Hindmarsh, personal communication). Their experience suggests that forestry creates employment.

AGROFORESTRY

GRAZING IN PLANTATIONS

Background

Under the Commonwealth Agricultural Bureau's definition of agroforestry (Page 2 of this report) there is a spectrum of approaches, varying from forestry dominant to agriculture dominant. Agroforestry with radiata pine in New Zealand is usually forestry dominant and agriculture (grazing) is an adjunct.

The objective of the majority of radiata pine forests in New Zealand is to produce high quality sawlogs for export. The practice of grazing in plantations complements this objective well (Knowles and Cutler, 1980).

Most New Zealand foresters grow sawlogs by thinning their forests non-commercially at an early age to the desired density of crop trees. They reason that, to maximize growth of crop trees and to increase the value of pruning crop trees, it is important that the trees be widely spaced. Table 1 shows a typical New Zealand regime for producing sawlogs.

Table 1

AGE (years)	HEIGHT (m)	TREATMENT
0	-	plant 1200 stems per hectare (s.p.h.)
4	5	thin to 500 s.p.h. - prune to 1.8 m
5.5	8	thin to 300 s.p.h. - prune to 4.0 m
7	12	thin to 250 s.p.h. - prune to 6.0 m

Grazing in plantations is favoured by these regimes and is practised throughout New Zealand by both the Forest Service and private forest companies (Plate 12).

Benefits of Forest Grazing

Benefits of forest grazing fall into three main categories:

i) financial returns;
ii) a reduction in hinderance problems; and
iii) improvement in tree growth.

1. Financial returns

The purpose of forest grazing is to use pasture and provide financial returns. Returns from grazing improve the profitability of forestry by reducing the size of the initial investment. The owners of Geyser Farm, near Rotorua, have planted up most of the farm for timber production. They say that grazing under the pine has helped cover the costs of roading, planting and tending.

In New Zealand the value of grazing ranges from $4 - $21 per hectare per year, depending on the quality and quantity of pasture (Webster, N.Z.F.S. personal communication). According to most forest managers, returns from grazing alone make forest grazing worthwhile.

2. Reduction of hinderance problems

Regrowth of thick scrub and grasses is common in many plantations in New Zealand. Scrub can make tending work in plantations difficult by restricting movement of workmen (Plate 13). New Zealanders refer to this as a hinderance problem.

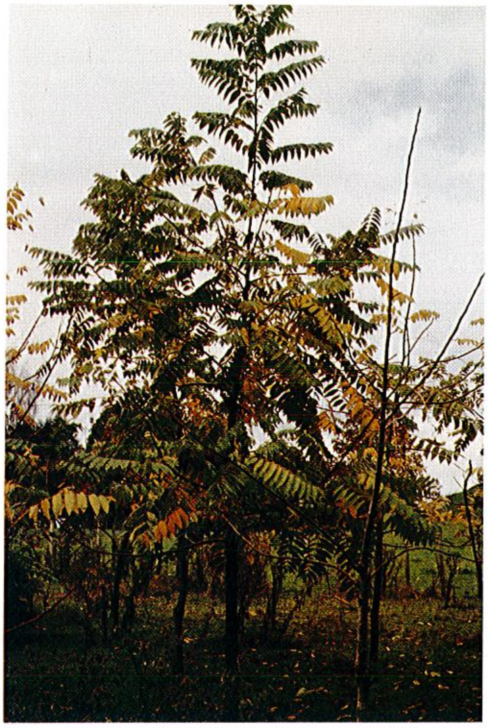


Plate 10
Black walnut (Juglans nigra) is one of a group of special purpose timber species that have been selected to provide New Zealand with high quality timbers. This photograph shows part of a black walnut provenance trial near Hamilton.

Plate 11
Blackwood (Acacia melanoxylon) is being grown in New Zealand for its high quality timber. The species requires a light well to produce a straight bole and will produce a millable log in 40 years. Farmers are often attracted to growing speciality timbers.

Plate 12
Tasman Pulp and Paper Co. Ltd. are establishing radiata pine forests on farmland in the Bay of Plenty. Grazing complements the objective of growing high quality sawlogs and improves profitability.

Plate 13
Ungrazed pampas grass amongst radiata pine in Waiuku Forest. The sharp cutting edge and the density of pampas creates a hinderance problem for tending operations.

Plate 14
Grazed pampas grass in Waiuku Forest. Pruning costs are reduced by $23 per hectare in areas that are grazed because access is improved.

Plate 15
Steep degenerated farmland in the Waiotahi Valley (Bay of Plenty) which is being planted with pasture and radiata pine in the same year. Grazing forms an important part of management by providing returns, by controlling scrub, by improving fertility and by reducing the fire hazard.

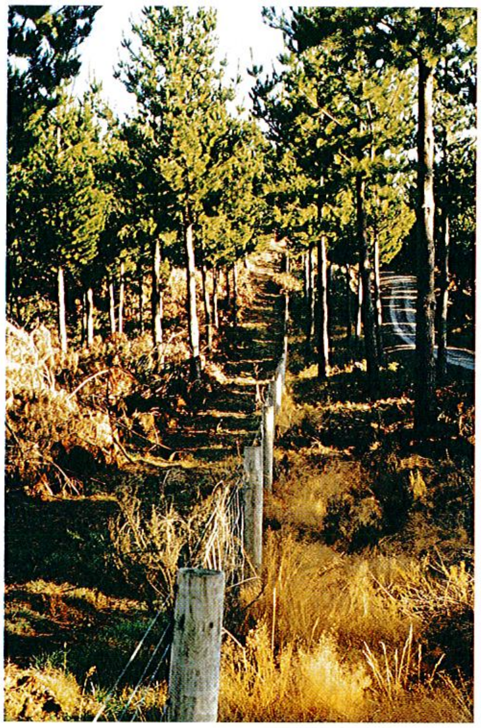


Plate 16
Mustering can be difficult in plantations. The managers of Otago Coast Forest have found that a cleared fire-break inside the boundary fence makes mustering much easier.

Plate 17
Maku lotus (Lotus pedunculatas var. maku) grows well under trees as it is tolerant of shade. The species is also good fodder. Large scale trials were established at Waiuku Forest in 1983.

Grazing reduces the hinderance problem. For example, at Waiuku Forest pampas grass is difficult to work in because it has a cutting edge, and forms dense swards. Fortunately cattle will eat pampas. At Waiuku it was found that the cost of pruning was $23 per hectare less if the area had been grazed before pruning was carried out (Plate 14).

Brian Gorrie, the manager of the Tasman Pulp and Paper Companies' forests in the Waiotahi Valley, has also found that grazing reduces the hinderance problem. By grazing cattle in the same year as planting the trees, he finds that the regrowth of manuka scrub (Leptospermum spp.) is greatly reduced.

3. Improvements in tree growth

Data has recently been collected from Woodhill Forest which shows that the trees have grown better where stock have grazed (Webster, personal communication). Whether the better growth is because of control of pampas or additional nutrients from animals or both is not known. As pampas grass has a deep fibrous root system which efficently occupies the site, many foresters consider that pampas competes with pine if it is left ungrazed.

Legumes are an important component of New Zealand pastures. The amount of atmospheric nitrogen fixed by leguminous plants has been measured and is about 150 kg per hectare per year (Forest Research Institute, 1981).

Therefore, it has been surmised that legumes under trees will improve the fertility of the soil and boost growth of trees, particularly if animals graze as well. However, there is no data available at the moment to support this idea. A trial in Waiuku Forest, set up by Leith Knowles (Forest Research Institute), aims to determine the separate effects of control of pampas, legume pasture, and animals on the growth of trees.

4. Lowered fire risk

   Some managers, for example Brian Gorrie (Waiotahi Valley), find that the risk of fire is lower with grazing (Plate 15). The animals, by reducing the amount of scrub and pasture, also make fire fighting easier.

<u>Management issues</u>

Combining grazing with timber production creates problems such as difficulties with mustering and pasture covered by debris. Some managers have developed techniques to lessen the problems.

1. Mustering

   Mustering is a major difficulty with forest grazing. Visibility and access are restricted both by standing trees and the debris from thinnings and prunings. Under these conditions, mustering is difficult and the chance of leaving stock behind is high. Mustering is easier, according to several forest managers, if some areas are left clear of trees. For example, Alan Rusk of Otago Coast Forest and Andrew Hindmarsh of Puna Mara Ngaheri Ltd. have found this to be the case. The most important areas to leave unplanted are around gateways, waterholes, camp sites and beside fences (Plate 16).

Leaving ridges unplanted is sensible too, because ridges are commonly the most productive areas for pasture and the least productive areas for trees, according to two farmers, John Aitken (Tukituki Valley) and Graham Cameron (Glengarry Station). Small paddocks and frequent handling of stock also make mustering easier. If stock are in the habit of being moved from one paddock to another, then mustering can become simply a matter of the farmer sounding a horn and opening a gate.

2. Pasture decline

It has to be accepted as part of forest grazing that pasture will decline. Debris from thinnings and prunings cover pasture and the crowns of trees expand and cast more shade.

However, regimes are being modified to prolong grazing. The new tending regimes involve heavier and earlier thinnings and more frequent prunings. Trees are smaller and consequently cover less pasture if culled at a young age. Similarly, branches are smaller if pruning is frequent. Stands are commonly thinned to final-crop density by age six to eight years (See Table 1).

The other approach to maintaining pasture under trees is to grow species that are tolerant of shade. Some work carried out jointly by the Forest Research Institute and the Grasslands Division of the Department of Science and Industrial Research is showing promise. The trial, set up near Rotorua to evaluate the peformance of a range of pasture species under a stand of radiata pine, shows that maku lotus grows well in forest conditions (Plate 17). Consequently, maku lotus is being tested on a broad scale at Waiuku Forest this year (Ian Curry, personal communication).

3. Better use of pasture

Forest grazing has traditionally been rough grazing with little effort to utilize the pasture fully. With the trend towards earlier thinning to final crop density, some managers have realized that there will be reasonable amounts of grazing for about half of the rotation and that it is worthwhile trying to use the pasture more fully. Better utilization of pasture can be achieved in several ways.

Firstly, paddocks need to be smaller. Small paddocks allow areas to be heavily stocked for short periods. Alan Rusk, who is involved with grazing Otago Coast Forest, finds that his 80 - 200 hectare paddocks are too large. He would prefer paddocks 30 - 40 hectares in size.

Brian Gorrie is planning to use electric fencing to subdivide the large blocks of forest at Waiotahi. According to Brian and many other farmers, electric fencing is cheap and effective for both cattle and sheep.

Ian Curry, forester at Waiuku Forest, is also convinced that electric fencing is the most sensible form of fencing for forest grazing. He is building electric fences with 3 wires for $300 per kilometre. Ian is keen that the Forest Service pay for the fences, rather than farmers, so that the Service has more control over directing grazing where and when they require it.

4. Stock health

Stock can lose condition if they live under trees continuously. Graham Cameron, the manager of Glengarry Station finds that he can no longer fatten stock under the trees. Graham's stands are 10 years old and contain about 300 trees per hectare. Shading is heavy (Plate 18). As most of Glengarry has been planted with trees, the stock are forced to remain under trees.

Most farmers who graze their stock in forests can rotate their stock between open pasture on the farm and shaded pasture in the forest. (See also comments in section entitled, "FARM FORESTRY - Management of Trees").

A problem of concern with grazing in plantations has been an increase in abortion with cows. Andrew Hindmarsh has noted a 20% drop in calving rate since his herd started living amongst pines. Eating radiata pine needles increases the risk of cows aborting (Knowles, 1980).

5. Tree Management

Pruning regimes have been modified for widely-spaced trees, to restrict the size of the knotty core. An interval of about one and a half years is commonly practised (Table 1). The time of the year at which pruning is carried out can influence the development of epicormic shoots. Inglis (1981) found that autumn pruning and avoiding severe pruning helps prevent the development of epicormic shoots. (Further comments on pruning are made in the section entitled, "AGROFORESTRY RESEARCH").

New Zealand foresters consider that planting 1200 per hectare is sufficient to produce a stand of 250 suitably formed crop of trees per hectare. As grazing is an adjunct to timber production, they are generally not concerned about the amount of debris that results from non-commercial thinning.

AGROFORESTRY RESEARCH

Background

The main type of agroforestry being researched in New Zealand is wide-spaced radiata pine with grazing (Plate 19). The Forest Research Institute and the Ministry of Agriculture and Fisheries are the two main agencies involved.

Research by Forest Research Institute

The Forest Research Institute is studying wide-spaced radiata pine as part of the broad spectrum of approaches to growing pine. The major objective of their silvicultural research programme is to determine the most profitable way of growing radiata pine.

It has been found that there was a great diversity of ideas on tending regimes. Recognition of this problem in the mid-1970s led to the formation of the Radiata Pine Task Force.

1. Radiata Pine Task Force

   The Task Force, comprising both researchers and managers, was set up in 1979. The first task was to review current practices. A questionaire was sent to forest managers and this was followed up with discussions in each Conservancy about objectives and regimes.

   A massive amount of data was available. It was also clear that there were many factors such as site, spacing, distance to the mill and cutting patterns that influence profitability.

   The obvious approach was to use a computer and build a model.

Forestry companies became involved as they could see the model would help them too. An interactive computer was purchased with funds from private industry.

The aim of the Task Force was to develop a practical system for forest managers to predict the profitability of growing radiata pine for most sites and locations and for any silvicultural regime (Forest Research Institute Report, 1982).

2. The computer model - 'SILMOD'

The model is a series of multiple regressions. To determine the regressions, data was collected from stands in many parts of New Zealand.

The main model is called SILMOD. SILMOD simulates the growth of a hectare of forest and incorporates planting, tending, harvesting, transport and sawmilling costs to estimate the present-net-worth of growing the forest.

SILMOD is composed of a number of separate models. Examples include the DOS model, which predicts the size of the diameter over stubs from pruning treatments and the EARLY model, which simulates the growth of the stand from age 4 years to about 13 years.

Plate 18 Wide-spaced radiata pine at Glengarry Station. The trees are ten years old and the density is about 300 trees per hectare. The quality of the pasture has declined and is no longer able to fatten young sheep.

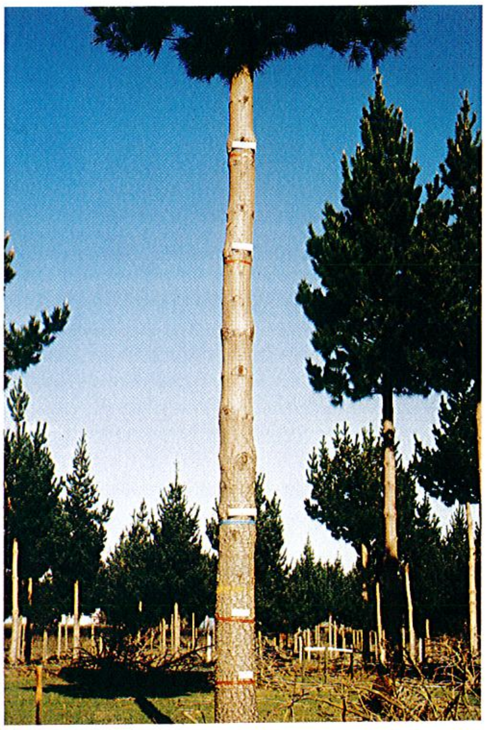


Plate 19
Wide-spaced radiata pine at the Tikitere agroforestry trial near Rotorua. The trees are ten years old, have been pruned to six metres and, in the stand shown in the photograph, are uniformly spaced at 100 trees per hectare.

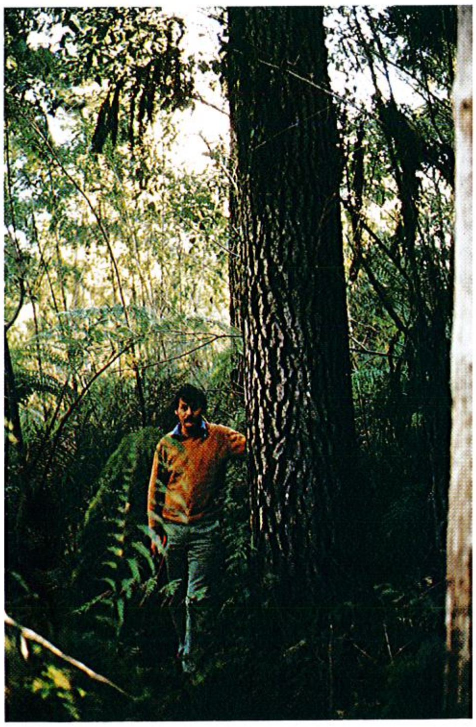


Plate 20
Twenty three year old radiata pine in a stand at Mohaka Forest thinned to 112 trees per hectare at age 14 years. The average diameter at breast height is 68 centimetres. The findings of the Radiata Pine Task Force suggest that growing trees in stands of about this density is the most profitable method.

Plate 21
How severely should wide-spaced radiata pine be pruned? Researchers from the F.R.I. have found that it is best to prune heavily. Growth is reduced but this loss is more than compensated for by having a small knotty core. Signs of over pruning are deaths and much epicormic shooting.

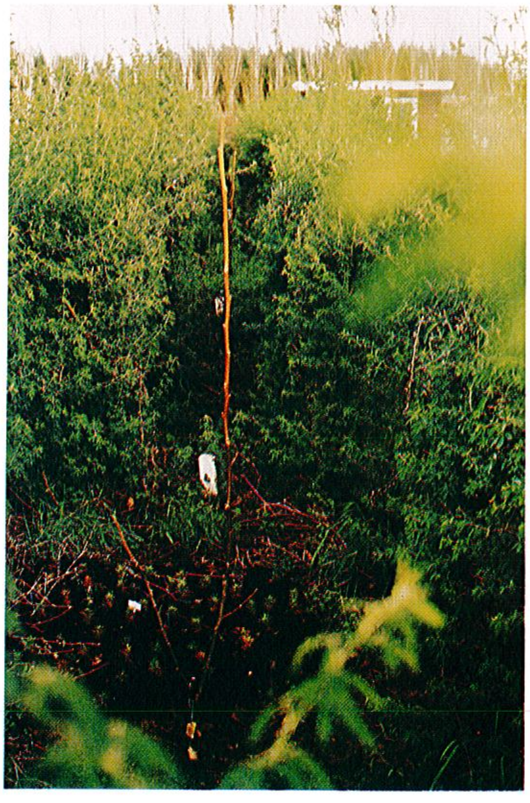


Plate 22
Tree lucerne (Chamaecytisus palmensis) is the main multipurpose tree being researched in New Zealand. This photograph shows tree lucerne being used as a shelter for a young black walnut tree.

3. Preliminary conclusions

The major findings from a preliminary analysis of the model, as presented in the 1982 Forest Research Institute Report, are:

i) site and processing decisions can have more influence on profitability than silvicultural decisions

ii) steepness of land and distance to the mill both greatly influence profitability

iii) size of log, size of defect core and sawing patterns are also important in determining profitability

iv) high final stockings produce more timber per hectare than low final stockings, but value per hectare is higher for low final stockings (Plate 20)

v) branch size is increased by heavy thinnings to low final-crop densities. However, the increase in log size obtained by having low final-crop densities more than compensated for having large branches

vi) pruning depresses growth, but this loss of volume is more than compensated for by having a small knotty core (Plate 21). Therefore, it is recommended that trees are pruned heavily. Signs of over-pruning are deaths and a proliferation of epicormic shoots.

These findings have important implications for management. I quote from the 1982 Forest Research Institute Report:

"The results will challenge not only current practices but also where our forests should be located"; and

"The optimum silviculture is that which involves wide initial spacing and heavy early thinning and pruning to a low final crop stocking; practices which provide opportunities for agroforestry".

Knowles (1983) used the SILMOD model to compare the volumes and present-net-worth of stands of *Pinus radiata* with final-crop stockings of 100, 200 and 400 trees per hectare, grown in conjunction with understorey pasture. He found that final-crop stockings of 100 trees per hectare gave the lowest timber yields but were more profitable than the other treatments. Knowles concluded that financial returns from grazing stock under trees would further improve the profitability of the lower density of trees.

Research by Ministry of Agriculture and Fisheries

The Ministry of Agriculture and Fisheries is studying wide-spaced pine with grazing in a number of research trials. The most comprehensive trial is at Tikitere, on a 93 hectare site 20 km east of Rotorua (Plate 19). Tiketere is a co-operative venture between the Ministry of Agriculture and Fisheries and the Forest Research Institute. The Ministry of Agriculture and Fisheries researchers are measuring pasture and livestock performances at Tikitere under a range of stockings (0, 50, 100, 200 and 400 trees per hectare). The radiata pine are now 10 years old, and much valuable data about the relationship between tree density and agricultural production is being obtained.

Table 2 presents data from the Tikitere trial (Percival and Knowles, 1983) on the effect of density of 8 year old radiata pine on livestock carrying capacity. The data shows that the carrying capacity is reduced by the density of trees, and that the carrying capacity is already greatly reduced by age eight years with 200 or more trees per hectare.

TABLE 2: Livestock carrying capacity (% of open pasture) under various densities of eight year old radiata pine at Tikitere, New Zealand (adapted Percival and Knowles, 1983).

Trees per hectare	Livestock carrying capacity (% of open pasture)
50	92
100	78
200	61
400	35

Table 3 presents data (Percival and Knowles, 1983) on the effects of age of radiata pine at 100 trees per hectare on livestock carrying capacity. The data show that the carrying capacity declines steadily over the growing cycle of the tree. A similar trend occurred for other densities. The dip in carrying capacity at age 6 corresponds with thinning and pruning and shows that debris significantly reduced the carrying capacity.

TABLE 3: Livestock carrying capacity (% of open pasture) for various ages of radiata pine at 100 trees per hectare at Tikitere, New Zealand (adapted Percival and Knowles, 1983).

Age of trees (years)	Livestock carrying capacity (% of open pasture)
3	95
6	67
8	78
13	73
18	45
23	26

FODDER TREES

FODDER TREE RESEARCH

Background

Research into fodder trees in New Zealand has concentrated on tree lucerne (Davies, 1982a). Tree lucerne is more productive than other fodder species tested by Joan Radcliffe (1982). Work is still in the early stages, but there is growing interest and new studies are commencing.

Potential Benefits of Tree Lucerne

Davies (1982a) states that the potential uses of tree lucerne are many and varied. He groups the uses into six types:

1. Animal grazing systems
   Davies suggests that tree lucerne has the potential to improve the health of stock. A mixture of normal pasture (bulk and roughage) and tree lucerne (protein) should produce healthier animals and consequently higher quality meat.

2. Agroforestry
   In exposed sites where establishment of trees is difficult, tree lucerne could provide valuable shelter for young seedlings. Subsequently, the legume would be useful in improving soil fertility in association with pasture and stock.

3. Shelter for horticulture
   Tree lucerne can be hedged and will provide perennial shelter around valuable tree, shrub and herb crops (Plate 22). It has the advantages of fast growth and desirable permeability. Its blossom is attractive to bees which would help to sustain a bee population and improve pollination of the crop being sheltered.

4. Mixed cropping

   Tree lucerne can be used as a break crop to restore farmland. The crop could be either offered as green feed to stock, harvested for producing dry stock food or harvested as a seed crop.

5. Conservation

   Tree lucerne has the ability to grow well on harsh sites. It therefore has the potential to help control wind erosion on sandy soils.

6. Biomass production

   The rapid growth of tree lucerne suggests that the species may have potential as an energy source. Its suitability for pulping has not been evaluated, although it is regarded by some as an excellent firewood.

Current Research

Doug Davies of the Crop Research Division of the Department of Scientific and Industrial Research at Lincoln is one of the main researchers studying tree lucerne in New Zealand. His research is concentrating on two main areas:

1. Establishment

   To determine suitable establishment methods, various techniques with cuttings and seed have been tested. The performance of various types of containers has also been tested. A technique with seed in Finnish paper-pots has been successful. Timing of planting and optimum spacings in the field have been evaluated (Davies, 1982b).

2. Management

A number of management techniques are being studied in a series of trials. These trials aim to answer questions such as:

i) how severely should tree lucerne be grazed?

ii) how can grazing of tree lucerne be incorporated with farm management? and

iii) how far apart should rows be planted where tree lucerne is to act as a nurse shelter for tree crops such as walnut seedlings?

A trial established in 1983 on a farm on the Banks Peninsula (near Christchurch) is significant because, for the first time in New Zealand, management methods will be tested on a farm scale. Doug Davies will study establishment and management of trees, and Dennis Poppi from the Department of Animal Science at Lincoln College will study their effect upon animals.

Blocks of tree lucerne for grazing will be separated by double rows of tree lucerne that will act as shelter.

Electric fencing will be used to manage grazing. Small areas will be grazed heavily for a day or two before moving the fence to the next section.

ACKNOWLEDGEMENTS

The opportunity to visit New Zealand under the Australia-New Zealand Forest officer Exchange Scheme was greatly appreciated. I wish to thank all those who gave time and assistance for my study tour, especially Leith Knowles of the Forest Research Institute, Roturua, who arranged the itinerary.

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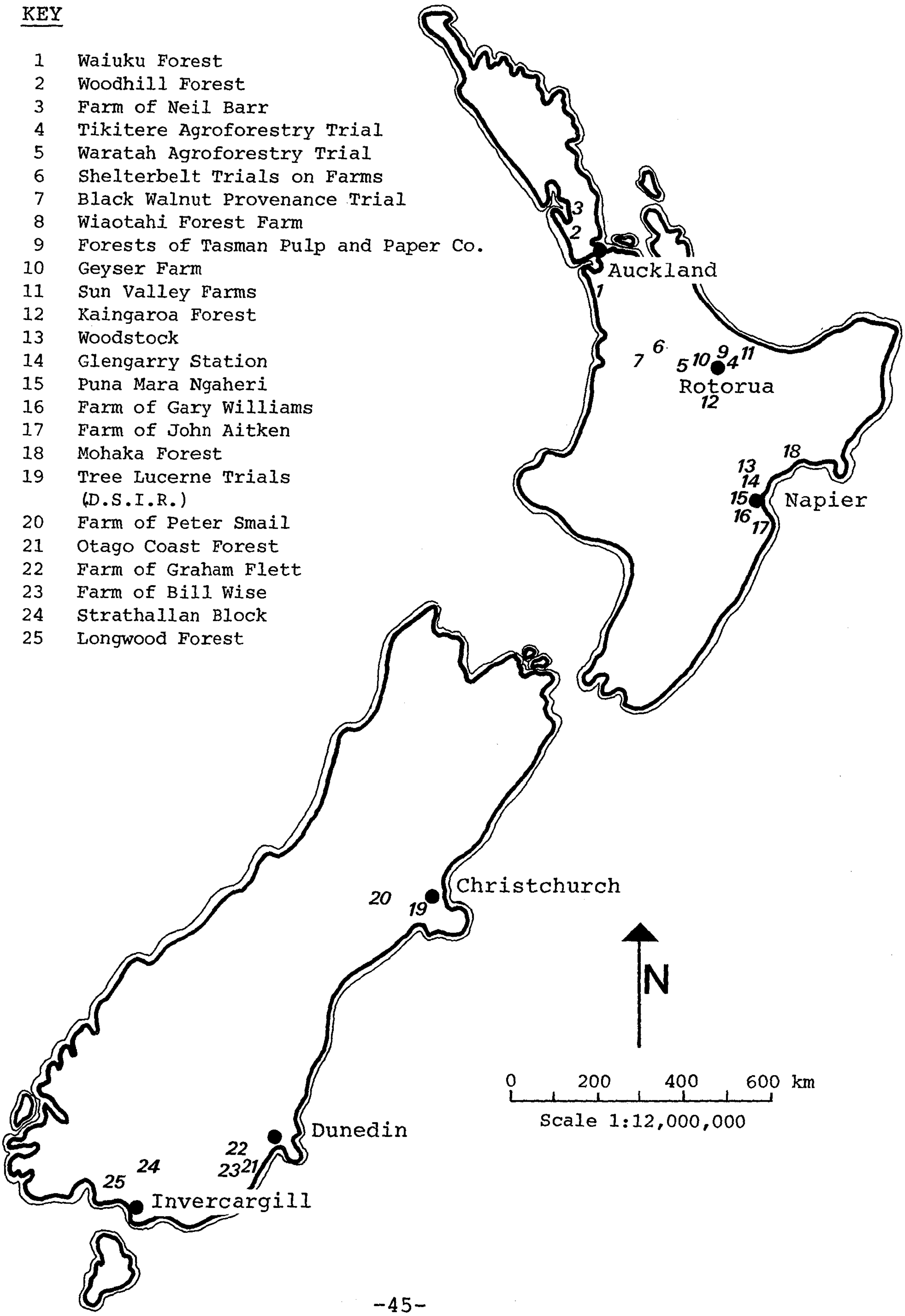
APPENDIX 1

Map Showing Location of Places Visited

KEY

1 Waiuku Forest
2 Woodhill Forest
3 Farm of Neil Barr
4 Tikitere Agroforestry Trial
5 Waratah Agroforestry Trial
6 Shelterbelt Trials on Farms
7 Black Walnut Provenance Trial
8 Wiaotahi Forest Farm
9 Forests of Tasman Pulp and Paper Co.
10 Geyser Farm
11 Sun Valley Farms
12 Kaingaroa Forest
13 Woodstock
14 Glengarry Station
15 Puna Mara Ngaheri
16 Farm of Gary Williams
17 Farm of John Aitken
18 Mohaka Forest
19 Tree Lucerne Trials (D.S.I.R.)
20 Farm of Peter Smail
21 Otago Coast Forest
22 Farm of Graham Flett
23 Farm of Bill Wise
24 Strathallan Block
25 Longwood Forest



APPENDIX 2

List of people either mentioned in this report or talked to on the tour:

John	Aitken	Farmer, "Hau Ora", Havelock North
Patrick	Aldwell	Forest Research Institute (Economics Group) Rotorua
Gordon	Baker	Forest Research Institute, Rangiora
Neil	Barr	Farmer, Kaukapakapa
Peter	Bolton	New Zealand Forest Service, Rotorua
Harry	Bunn	Forest Research Institute, Rotorua
Graham	Cameron	Farm Manager, Glengary Station, via Napier
John	Cawston	New Zealand Forest Service (Extension), Rotorua
Steve	Croskery	New Zealand Forest Service, Napier
Ian	Curry	New Zealand Forest Service, Waiuku Forest
Doug	Davies	Department of Scientific and Industrial Research, Lincoln
Joe	Dennis	New Zealand Forest Service (Extension), Napier
John	Edmonds	New Zealand Forest Service (Extension), Dunedin
Graham	Flett	Farmer, "Skilbister", Tablehill, R.D.2., Milton
Barry	Keating	New Zealand Forest Service, Napier
John	Kinninmonth	Forest Research Institute (Conversion Planning Group), Rotorua
Brian	Gorrie	Farm Manager, Waiotahi Forests Ltd., via Opotiki
Roger	Handcock	New Zealand Forest Service, Dunedin
Ken	Harris	Farm Manager, "Woodstock", via Napier

APPENDIX 2 cont.

Martin	Hawke	Ministry of Agriculture and Fisheries, Rotorua
Andrew	Hindmarsh	Farm Manager, Puna Mara Ngaheri Ltd., via Napier
Leith	Knowles	Forest Research Institute (Exotic Forest Management Group), Rotorua
Alan	Koehler	Forest Research Institute (Exotic Forest Management Group), Rotorua
Patrick	Milne	Forest Research Institute, Rangiora
Ian	Nicholas	Forest Research Institute, Rotorua
Dennis	Poppi	Department of Animal Science, Lincoln College
Joan	Radcliffe	Lincoln College, Lincoln
Alan	Rusk	New Zealand Forest Service, Otago Coast Forest
Peter	Smail	Farmer, "Lynton", Hororata
Mark	Smorti	New Zealand Forest Service, Kumau
Hamish	Sturrock	Lincoln College, Lincoln
Cedrick	Terlesk	Forest Research Institute, Rotorua
Jeff	Tombleson	Forest Research Institute (Exotic Forest Management Group), Rotorua
Rob	Webster	New Zealand Forest Service, Auckland
Graham	West	Forest Research Institute (Exotic Forest Management Group), Rotorua
Ian	Whiteside	Forest Research Institute, Rotorua
Gary	Williams	Farmer, Taradale, via Napier
Ian	Williams	New Zealand Forest Service, Otautau
Nigel	Williams	Forest Research Institute, Rotorua
Andy	Wiltshire	New Zealand Forest Service, Tuatapere
Bill	Wise	Farmer, Pukekoma, R.D. 2, Balclutha
Bill	Wray	Forester, Tasman Pulp and Paper Co. Ltd., Paengaroa.

APPENDIX 3

Common and scientific names of plants mentioned in this report.

Sydney blue gum	*Eucalyptus saligna*
Alpine ash	*Eucalyptus delegatensis*
Southern mahogany	*Eucalyptus botryoides*
Brown barrel	*Eucalyptus fastigata*
Mountain ash	*Eucalyptus regnans*
Cypress pine	*Cypressus macrocarpa*
Tasmanian blackwood	*Acacia melanoxylon*
Black walnut	*Juglans nigra*
Radiata pine	*Pinus radiata*
Tree lucerne	*Chamaecytisus palmensis*
Maku lotus	*Lotus pedunculatus* var. *maku*