FARM FORESTRY

A study of aspects of farm forestry in New Zealand, Denmark, Sweden, Finland and California

By Peter J Swain.

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Foreword

Peter Swain was awarded an Ernest Cook Fellowship in Rural Development by the Arkleton Trust in 1986. The award was made to enable him to examine the opportunities for integrating woodland production with agriculture, with particular reference to agroforestry and development work being carried out in the temperate areas of Europe and New Zealand.

The Rural Development Fellowships are awarded in order to enable any 'practically orientated professional' involved at first hand in rural development or rural education to study alternative approaches to the problems which they encounter in their daily work, and to reflect on their personal and institutional effectiveness. Peter, when awarded the fellowship was Principal Surveyor in the Land and Water Service of the Agricultural Development and Advisory Service (ADAS) with the Welsh Office Agriculture Department at Aberystwyth. He is now a Regional Land Management Adviser with the (re-organized) ADAS. He is shortly to take part in the UK/Australia Civil Service Exchange Scheme and will be working from February 1988 with the Forestry and Land Resources branch of the Department of Primary Industries and Energy in Canberra.

Diversification of rural areas and farms has been a subject close to the Trust's interests since its inception, as a study of its publications over the past decade will affirm. The idea of farm and rural diversification, and integration of action at local level, have however only very recently become of interest and concern to many of the key Agencies involved in rural development. Our attitudes and policies are only now beginning to change, and the process is still very patchy!

Farm forestry is a most interesting, and sometimes controversial, part of the diversification issue. New schemes are about to be announced in the UK. We continue to hope that the problems facing farm tenants and crofters with respect to afforestation are shortly to be seriously tackled. Peter Swain makes the key point that *farm* forestry is quite unlike forestry as we in the UK know and practice it. It requires *radical* changes in attitudes, support schemes and legislative frameworks. In looking to the necessary reforms we can, as ever, learn from other countries. Peter brings practical examples from New Zealand, Scandinavia and North America to enlighten this learning process.

The Trust very much welcomes this useful and important study, and once again thanks the Ernest Cook Trust for making it possible.

John Bryden
Programme Director
The Arkleton Trust

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Preface

By the year 2000 up to 1 million hectares of agricultural land could be surplus to food production requirements in Great Britain. Yet at the same time Britain is unlikely to produce more than 20 per cent of its requirements for timber and wood products. One option open to policy makers is to recast the incentives for agriculture and forestry in order to redress this apparent imbalance of land use.

Current forestry practice is largely concerned with the planting of softwoods on poor quality land, notably the wetter west and the northern hills and mountains. Planting is undertaken by the state, and by individuals who have been primarily motivated by taxation incentives. Forestry is largely completely separate from farming. The talk of integration relates to the one sided gain by agriculture from forest access roads, fencing and shelter given by trees to livestock. There are very few examples of integrated farm forestry businesses, even on the traditional landed estates, agriculture and timber production are often quite separate enterprises.

Forestry is criticized by environmentalists for causing damage to the landscape and wildlife habitats, and by rural communities for its poor contribution to the rural fabric and the local economy.

A new approach is now under consideration. Government has announced its intention to introduce a scheme in 1988 to give further encouragement for farmers to plant trees. It will provide an annual income for farmers during the first 20-40 years, during the establishment period, in addition to the planting grants that are already available.

This new approach has considerable implications for the agricultural and forestry service industries. Advisory services will need to equip themselves for the new challenge. As the first point of contact for the majority of farmers in England and Wales it is highly appropriate for ADAS to build on its existing expertise in order to be able to give technical advice on silvicultural practice, and perhaps even more importantly, to provide advice on the management and financial implications of diversifying the farm business.

Quite naturally forestry research has concentrated on the exploitation of conifers on poor land, but the new situation demands radical thinking. There is much discussion of forestry moving 'down the hill' and onto the better quality farmland that is used for growing crops and rearing livestock that is in surplus.

This raises many questions. How can policy makers create the right conditions to make it a feasible proposition? How can farm forestry contribute to the prosperity of the rural community and to building a new countryside for people to enjoy and for wildlife to prosper? How can farmers exploit this long-term crop and integrate it with their farming operations? How can the diverse forestry and agricultural advisory services adapt to meet the farmers' need for integrated advice?

The Ernest Cook Fellowship provided me with a unique opportunity to learn from the experience of other countries in farm forestry. New Zealand was an obvious choice as it leads the world in the development of techniques for wide spaced trees undergrazed by cattle and sheep; a truly integrated form of farm forestry. Denmark is at the forefront of shelterbelt design with a Government programme for implementation. Sweden and Finland were picked because of their tradition of farm woodlots, for their systems of marketing and co-operatives. A visit to California provided an insight into the ecology and management of native oaks.

These approaches to farm forestry have evolved in accordance with very different circumstances to those at home, and it would be quite inappropriate to directly extrapolate their systems to the UK, especially after a short three month study. Nevertheless there are challenges to our current practices and philosophies, with pointers for the future. More research and policy evaluation are required, and it is hoped that this report, and the issues raised, will contribute to that process. In each section I have separated my findings from my personal comments and views. These comments are often subjective and speculative; they do not necessarily reflect the views of ADAS or the Welsh Office.

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Acknowledgements

A study tour to foreign lands inevitably involves a lot of people with a lot of hard work. I am indebted to the large number of individuals, and the list runs to several hundreds, who so willingly gave up their time to help with my programme; in suggesting contacts, arranging appointments and so patiently explaining their fields of interest.

Special mention must be made of those key people who took on the organization of tours within their respective countries:

Leith Knowles and his team at the Forest Research Institute, Rotorua for their infectious enthusiasm and organization of my study of agroforestry in New Zealand.

Joe McBride and colleagues at Berkeley University for their exchange of views about the ecology and management of oak woodlands in California and Wales, and for such generous hospitality.

Chr Als of Hedeselskabet for a thorough exposition of the Danish Government's shelterbelt programme.

Vikar Salvestad in Sweden, unbelievably retired yet still active at the County Board of Agriculture.

Karl Iver Kumm of the Swedish University of Agricultural Sciences in Uppsala for full coverage of farm forestry in Sweden.

Anders Arnell of the University of Umea for the brief glimpses of the delightful Baltic island of Gotland and the uplands of Jamtland.

Ilpo Tikkanen of the University of Helsinki for a meticulously planned tour of Southern Finland.

At home I must record my gratitude to ADAS for providing me with time and encouragement, and to my colleagues at Aberystwyth for shouldering the extra work resulting from my frequent absences from the office.

Last, but not least, thanks are due to the Arkleton Trust for awarding me the Ernest Cook Fellowship that made it all possible.

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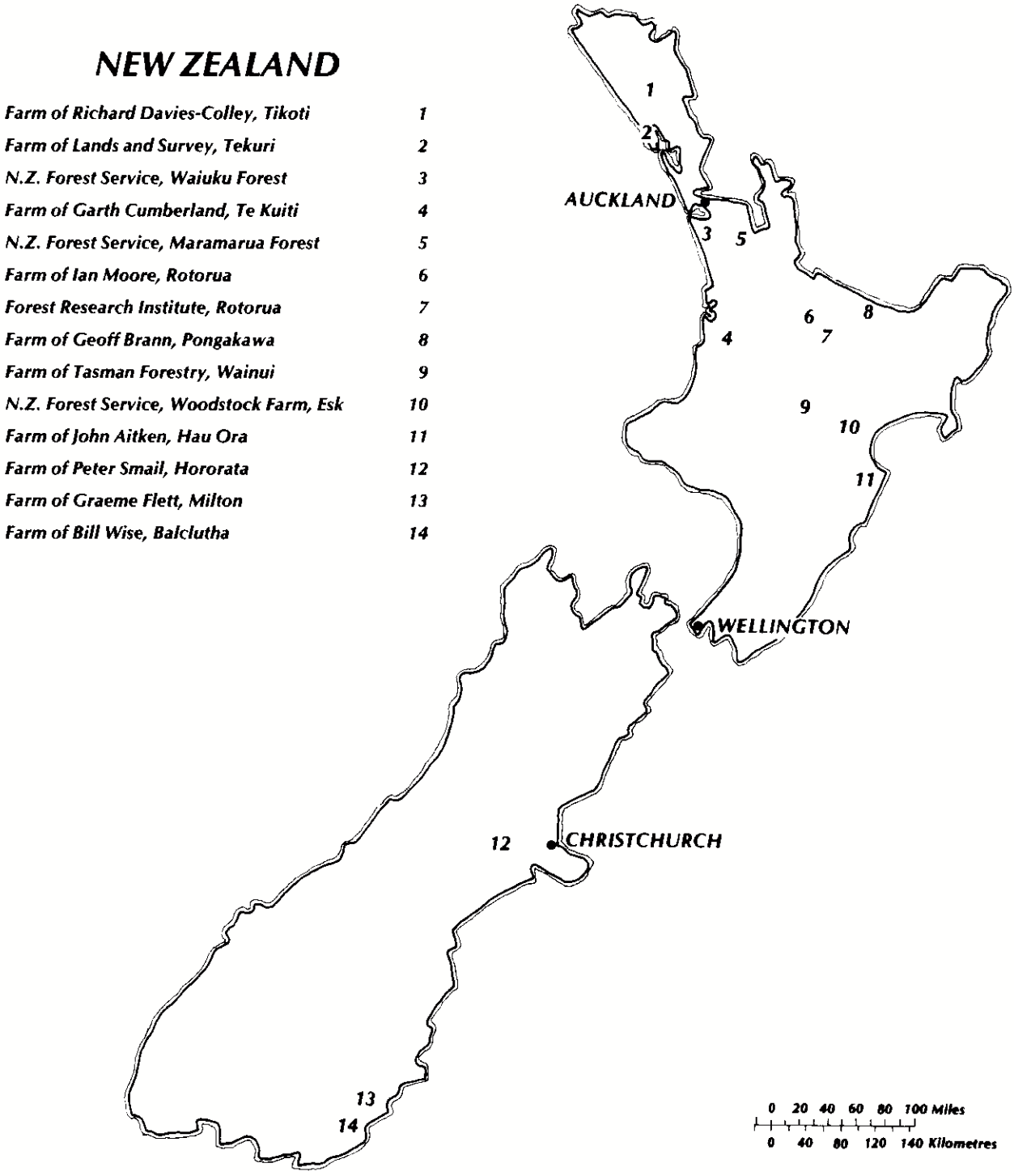
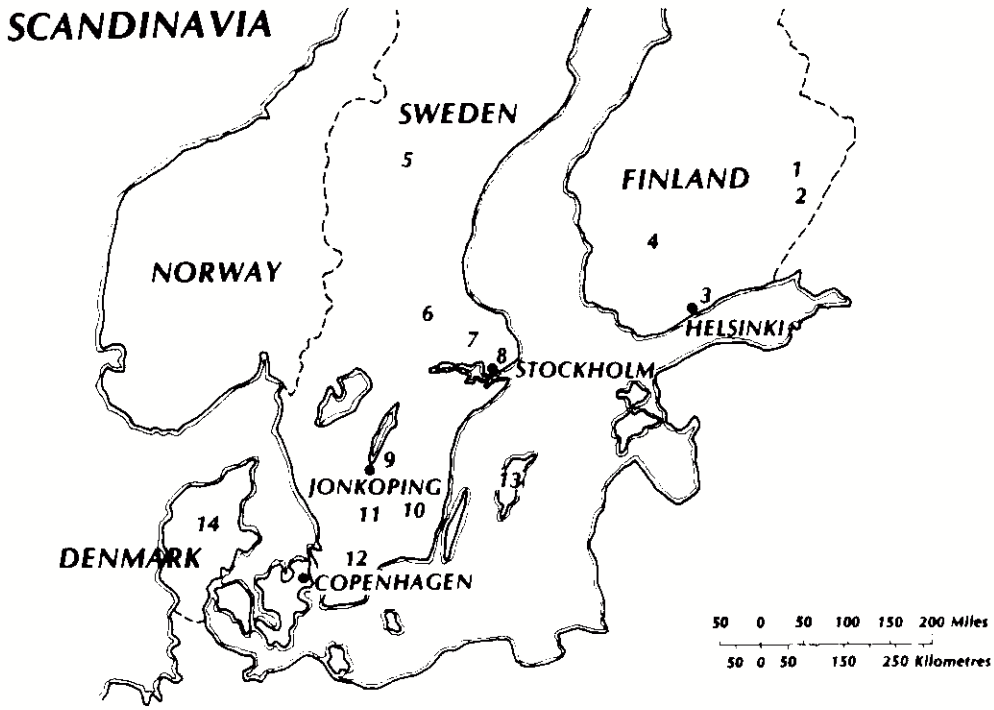


Figure 1: Locations included in the Report – New Zealand.



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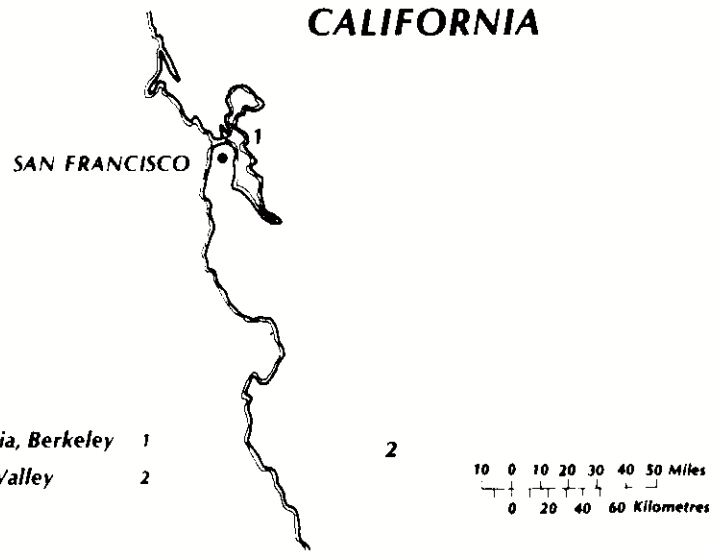

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Figure 2: Locations included in the Report – Scandinavia and California.

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Objectives, Summary and Conclusions

This report describes a three months study of farm forestry in New Zealand, Denmark, Sweden, Finland and California. It was undertaken in 1986-87 under a Fellowship awarded by the Arkleton Trust. *The objective* was to study and evaluate the experiences of several countries in the integration of agricultural and forestry enterprises within single businesses, with a view to applications in the United Kingdom. Several aspects were considered in detail:

1. New techniques being developed for agroforestry, e.g. tree pastures and short term coppicing.

2. Opportunities for forest grazing.

3. Integration of functions, e.g. livestock shelter, timber production, game management, fuel for farm use, and home grown fencing materials.

4. Integration of resources and services, e.g. use of farm labour for woodland planting or management during slack periods in the farming year.

5. Environmental conservation (landscape and wildlife) pressures and techniques to ameliorate the impact of farm forestry.

6. Farm shelterbelts – design and management.

7. Socio-economic implications for farm businesses and effects on the rural economy.

8. Government forestry policy, incentives to private land owners and the integration of forestry and agricultural policies.

9. Farm woodlands and forestry advisory services in the public and private sectors.

The visits to New Zealand and Scandinavia provided evidence that farm forestry is a practical and viable proposition in Britain, providing that the necessary adjustments can be made to the financial structures and incentives. It would be wrong to assume that existing forestry and agricultural technologies can be simply welded together. Farm scale forestry is quite different from large-scale afforestation. Constraints and opportunities change so it is necessary to think through the fundamental ingredients of both enterprises and design new recipes to meet the new challenge. While the UK is on the verge of making a tentative start with the Farm Forestry Scheme, it is important to learn from the successes of countries that have a tradition of farm forestry, and others that have evolved novel systems.

A short visit to California demonstrated the ecological value of oak woodland and the problems of managing non-commercial native broadleaved trees that are subject to undergrazing by livestock.

This chapter summarizes the main findings of the study tour with an eye to suitable applications in the UK.

1.1 New Zealand – Agroforestry

The forestry practice currently adopted by commercial forestry in New Zealand is the 'Direct Sawlog' regime, which is geared to the production of high quality clearwood (knot free timber) from Radiata pine (*Pinus radiata*). The regime involves low density planting of some 1200 trees per hectare which are quickly thinned and intensively managed to produce valuable final crops of quality sawlog timber, after short rotations of 25-35 years. The system lends itself to forest grazing and a silvopastoral type of agroforestry (wide spaced trees undergrazed by livestock) for many reasons:

1. Radiata is quick growing. The top leader grows above browzing height in just two or three years. Rotations are short.

2. Radiata is relatively unpalatable to livestock.

3. Pruning prolongs the penetration of solar radiation to the understorey pasture.

4. Research indicates that the trend will be towards even lower density tree planting and final crops (100-150 trees per hectare).

5. The intensive management, required for producing high quality timber, increases local employment and financial returns.

6. The superb growing conditions in New Zealand encourage a vigorous understorey which can be effectively controlled by grazing.

7. Grazing livestock prevent ground vegetation from obscuring access or creating a fire risk. Livestock also assist the breakdown of slash (pruning and thinning debris).

8. Nutrient cycling benefits the agricultural and forestry elements.

Government policy

The New Zealand agricultural and forestry industries are geared to the export trade. Therefore they must strive to be competitive on the world market. Agriculture and forestry are largely unsupported by state aid. The current

policy of the New Zealand Government in allowing market forces to decide land use is the acid test of a free market economy. It is hard to visualize a similar situation arising in the EC. If agriculture continues to receive substantial support it follows that forestry as an alternative crop will also need some degree of financial support in order to compete as a land use in the UK.

Reasons why farmers plant trees

An analysis of the survey of farmer intentions and opinions carried out by Lincoln College in 1985-6 makes interesting reading. Over half the farmers surveyed who had planted, or intended to plant trees, were motivated by the need for shelterbelts. The concept of quality timber production from shelterbelts is an admirable attempt to accept farmer opinion and to develop a system to combine the function of shelter with a financial return.

Shelter is also provided with agroforestry plantations. The system adopted by Peter Smail (see case studies – section 2.7) comprises a central agroforestry block of trees accessible from surrounding fields. Here the plantation fulfils the role of a well ventilated livestock house; the roof is provided by a half closed canopy supported by the pruned trunks, and perimeter walls are formed with one or two unpruned or fan-pruned rows of trees.

These approaches should be tried in Britain.

Socio-economics

The three elements of pasture husbandry, stock rearing and silvicultural management require a higher combined labour input than agriculture or forestry alone. This provides extra employment opportunities for the farmer and his family. Many skilled operations such as planting and pruning are carried out by New Zealand farming families to good effect. Economists in New Zealand consider that agroforestry is likely to be more profitable than either farming or forestry when the level of farming returns is low. With higher farming returns and low tree densities agroforestry is considered able to compete with farming in some circumstances but the margins either way are comparatively small.

Where the system scores is in the combination of the regular income from agriculture with the long-term return from forestry. It also provides a gentle transition from agriculture to farm forestry without a significant drop in agricultural production during the early years. Farm based timber conversion enterprises offer an additional avenue for employment and income.

Joint ventures

New Zealand farmers have the basic land resource but often lack the finance and skills to undertake agroforestry. Private investors and timber processing companies have access to these other resources, and are often prepared to invest in the tree planting in return for a share of the final crop. The Forest Rights Registration Act 1983 gives long term legal security to both parties who sign joint venture agreements. The concept is promulgated by several consultants.

Such a system is worth pursuing in the UK. Wealthy individuals invest in private forestry to secure taxation advantages. An alternative policy to steer private investors to farm based forestry through joint ventures should be considered.*

Forest grazing

The grazing of state forests is now an accepted practice to control vigorous weeds such as pampas, gorse and broom. Grazing improves access, reduces the fire hazard, cuts the need for chemical herbicides and provides a financial return via the grazing animal as well as releasing the trees from weed competition. Fencing is electrified and the quality of grazing is enhanced with the legume 'Maku lotus' (*Lotus pedunculatus Var. Maku*).

With the increase in environmental objections to chemicals this biological system is worth pursuing in the U.K. For farmers it has the potential for reducing tree establishment costs and gaining some livestock production through the utilization of the forage. The offer of low cost or free grazing to farmers adjoining forest land could sweeten relations between agricultural and forestry sectors. There is a need for further research into this technique with particular attention to the susceptibility of tree species to browzing damage.

Timberbelts

The new system of two-row shelterbelts aimed at giving shelter for livestock or crops, and at the same time providing a long-term harvest of quality timber is an exciting development. Typically a slow growing species such as *Cryptomeria japonica* is used on the windward side to provide low level shelter whilst to leeward a fast growing species, typically Radiata pine, is pruned to produce quality timber. The crowns of the Radiata complement the slower growing species in providing a continuous permeable screen. The system should be tried and evaluated in the UK.

Environmental issues

The environmental movement is not so well developed in New Zealand and agroforestry exponents do not give much thought to environmental conservation. The grid pattern planting does not lead to an 'orchard-like' countryside as may be supposed, and quickly develops a 'tweed-like' appearance which is not at all unpleasant, providing care is taken to avoid skyline planting where high pruned trees jar the eye. Planting in wide-spaced rows gives a startling appearance to the countryside and can not be advocated in the UK without professional landscaping advice. An evaluation of the implications of agroforestry for wildlife has not been carried out in New Zealand. It is interesting to speculate that agroforestry would provide a more diverse and species rich habitat than exotic trees or pasture alone. Agroforestry systems should be evaluated in terms of wildlife and landscape as part of any research programme in the UK.

*Since the preparation of this report the Financial Budget 1988 took forestry out of the taxation net in the U.K.

Extension services

Agricultural and forestry extension services are quite separate and although there is co-operation at a local level there is limited interest in agroforestry by the Ministry of Agriculture's advisory staff. A number of farmers met on the study tour indicated that they wanted integrated advice – see also the section on extension services in Scandinavia page 14.

The agroforestry discussion groups operated by the New Zealand Forest Service (NZFS) in Dunedin provide a useful model for promoting innovative farm forestry in the UK, and should be adopted by ADAS.

Financial and practical aspects of agroforestry

It would be quite wrong to think Britain could adopt the New Zealand models without a fundamental review and understanding of all the components and their interrelationships. Of prime importance is financial modelling, because the system will stand or fall on economic factors. The recent work by the Hill Farming Research Organization (now part of Macaulay Institute) and others need refinement and updating as new information becomes available. R & D is in progress on a number of sites in Britain to assess the performance of the pasture and tree components. There is a need to research the most promising management regimes, and market niches for the products. At present researchers have protected trees from grazing animals so £1 or so per tree is added for protection with growth tubes. What are the alternatives, and what happens when the growth tubes break down after 5-6 years? Some New Zealand farmers graze very soon after planting; evidence from Scandinavia and elsewhere suggests that some trees (e.g. pines and spruce) are quite resistant to browzing damage and bark stripping. For sensitive trees widespread rows protected by temporary fencing may be an answer.

Agroforestry components

The choice of trees, pasture and livestock need careful research. Requirements for short rotation, high value timber that can benefit from an open grown pruning regime, and yet be resistant to damage by livestock, call for a fundamental review of suitable tree species. There is no single obvious candidate, such as Radiata pine, in the UK.

Shade tolerant pasture components will be required for forest grazing and later stages of tree rotations in farm based agroforestry. The legume *Lotus peduculatus* (cf. Maku) used in New Zealand, and other likely contenders should be evaluated.

The New Zealand experience indicates that dairy cows and ewes with lambs cause more damage to trees than dry ewes, store lambs or beef cattle. The training methods adopted by the New Zealand Forest Service for livestock is worthy of evaluation (see forest grazing in Chapter 2). The factors influencing bark stripping and foliage browzing are not understood. Opinions range from nutrient deficiencies, fibre requirement, boredom or curiosity. Research is needed. The experience of Tasman Forestry in deer farming under agroforestry conditions (see NZ Agroforestry Case Studies – section 2.5) is worth exploring. Even the trophy hunting outlet should not be quickly dismissed.

Agroforestry management implications

New Zealand agroforestry brings together the management skills required for livestock, pasture and growing trees. Successful managers are those who can effectively balance the often competing requirements of all three elements. The system is a series of 'trade-offs' which relies on constant supervision, monitoring and quick reactions. Agroforestry is suited to the family farm because of the close supervision available, but it is not generally advocated for more than 25 per cent of the farm.

Most practicing farmers utilize their poorer land, slopes and banks for their agroforestry enterprises, prefering to retain their flat high quality land for more intensive agricultural production.

1.2 Denmark – Shelterbelts

Government support

The importance of shelterbelts has long been recognized in central and western Jutland for the stabilization of drifting sandy soils and the creation of a microclimate to favour plant growth.

A new programme of government support was introduced in 1976. 'Hedeselskabet', the Danish Land Development Service, is responsible for administering the current subsidized planting programme. The main thrust is directed to collective schemes, whereby belts are planned over a large district. The aim is to provide a comprehensive shelter effect over the whole district. Hedeselskabet advisers oversee the planning, and all stages of clearance, planting, beating-up and subsequent weeding during establishment.

Following the satisfactory establishment of a shelterbelt the farmer is invoiced for 50 per cent of a fixed standard cost of establishment which includes labour and plant materials.

Effects of shelter

Hedeselskabet consider that yields of crops such as maize, potatoes and grass will increase by 7 per cent with an integrated system of belts, after taking into account the loss of land occupied by the trees.

Planning and design

Comprehensive district planting schemes are planned to optimize shelter effects. They also facilitate mechanization and economies of scale. The current design is aimed at producing a permeable long-term structure. This is achieved by planting three rows of a mixture comprising permanent trees, nurse trees and shrubs. Hedeselskabet's success is largely attributable to the complete service that

they provide, and their direct responsibility for all stages of implementation.

The Danish design is a compromise between the single row shelter hedge commonly used by horticulturalists and the wider belts used by livestock farmers. It has direct application in lowland Britain and provides a practical alternative to thorn hedges that have become obsolete in many arable areas.

Environmental issues

Wildlife and amenity aspects are recognized by the planting of native hardwoods, although the use of some exotic shrubs look rather out of place in a rural environment. In central Jutland shelterbelts have a major impact on the countryside and are generally recognized as one of agriculture's most significant contributions to the landscape. In parts of South-east England there is very little tree cover and hedgerows have been drastically reduced. Such landscapes could benefit from this comprehensive approach to improve the appearance of the countryside yet at the same time enhance agricultural production by soil stabilization and reduction of moisture losses.

Research and development

Trial plots to test different mixtures of trees and shrubs under a range of conditions have been established by Hedeselskabet. The results will be of direct interest to farmers and advisers in the UK.

1.3 Sweden and Finland – Farm Forestry

Sweden and Finland are considered together because many aspects of their farming and forestry enterprises are similar, and it is interesting to reflect on their separate approaches to current issues.

Timber is an extremely important natural resource. Sixty-five per cent of the land area of Finland and 57 per cent of Sweden is occupied by production forests, whilst the proportions of agricultural land are 10 per cent and 12 per cent respectively. The main tree species are Scots pine and Norway spruce. Birch is the predominant hardwood. Rotations vary from 70 years in the south to 150 years or more in the far north. Both countries are exporters of timber and have long-standing problems of surplus agricultural production.

It is necessary to look back in history to understand the present structure of farm forestry. The two enterprises were not brought together - they have evolved together since man settled in the countryside and cleared woodland areas for growing food and rearing livestock. Private ownership now accounts for 50 per cent of Sweden's, and 64 per cent of Finland's, woodland, excluding the land owned by large companies. Farming and forestry are integral parts of forest farms, but the traditional attitude is for farmers to give prime attention to their agricultural enterprise and regard the woodland as a reserve of capital to be realized when investment is required in the farm business.

Policy objectives

A major policy objective for both Governments is to increase the utilization of woodland. The present rate of cutting is well below the natural growth increment. Consequently the national stocks of timber have risen to a level probably not equalled since the last Ice Age. The Swedish Government has taken the extreme action of introducing legislation to require every forest owner to manage his woodland in a productive manner, and to have a Forest Management Plan. Finland has adopted a timber production programme - 'Forest 2000 Programme' - which provides guidelines on the means of increasing cutting by 30 per cent over and above present levels, by the year 2010.

Extension services

In both countries the state provides an advisory service for forest owners. In Sweden this is a direct function of the Board of Forestry, whilst in Finland ground level advice is given by local forest management associations which are semi-independent of the state, yet funded by local taxation levied on forestry.

Forest management plans

Sweden and Finland set great store in the provision of forest management plans for individual holdings. Indeed, in Sweden all owners are required to have such a plan by the year 1993. The plans include a schedule of the timber resources on the holding and a set of prescriptions for future management.

The plans were valued by all the owners met on the tour, and give useful pointers to the service that advisers should offer in the UK. A major challenge to the Scandinavian advisory services is how to reach the non-resident owner who obtains his income from outside forestry and agriculture. The introduction of farm forestry holiday training courses recently operated by the District Board at Tampere in Finland is an interesting concept, with application for part-time, retired or hobby farmers in the U.K. The bringing together under one roof of extension service advisers from forestry and agriculture services demonstrates a practical approach at Tampere towards encouraging co-operation between the two sectors. This should be considered in the UK.

Socio-economics

The average size of forest farms in Sweden and Finland is well below that required to provide a family with a reasonable standard of living. In some instances families have moved away to seek industrial employment but a large number remain. A common practice is for farmers to seek employment off the farm to bolster their incomes, but some interesting new initiatives are being mounted to explore farm based solutions. 'Forestry 87 – Jonkoping County' is an example whereby stimulation and some assistance by the County Board of Forestry is aimed at encouraging people to find their own solutions. Calculations show that despite large-scale technology, it is

financially advantageous for woodland owners to carry out most silvicultural management operations themselves rather than employ a contractor. Training is offered to forest farmers on a group basis, but it is the group members who identify their training and advisory needs.

Small-scale technology

In recent years there have been big advances in large-scale machinery for forestry operations. Complete harvesters now account for an increasing proportion of timber cutting by the state and forestry companies. However, a second tier of small-scale technology is developing for the forest farmer. The Royal College of Forestry at Garpenberg, Sweden has a special Small-scale Technology Unit that closely co-operates with industry in the development of small purpose-made machinery and attachments for the ubiquitous farm tractor. Woodland owners in the UK may well wish to consider the option of carrying out silvicultural operations themselves rather than use a contractor. Much of the Scandinavian technology will have direct application at home. Working horses are little used now in Scandinavia and there is no case for promoting their use in the UK.

Energy forestry

The Swedish University of Agricultural Sciences has a well advanced R & D programme for energy forestry based on short rotation willows grown on good quality farm land. Extensive field trials are now being conducted in southern Sweden and results will be available in 1988. The Swede's calculate that, given current energy prices and the high levels of production achieved under experimental conditions, energy forestry can just compete with the profit levels achieved from a barley crop. British scientists and researchers will wish to continue to keep abreast of work in Sweden and elsewhere.

Environmental conservation

Farm forestry in Scandinavia is essentially small in scale. The sub-compartments of trees are much smaller than in the state and company forests. Large clearcuts are avoided and the appearance of the countryside is greatly enhanced by the intimate mixture of crops, woodlands and lakes, with interest being provided by sympathetically designed farmsteads and other buildings. It follows that farm forestry in the UK would have a much more acceptable impact on the environment than the large-scale afforestation of the uplands. Because the forests of Finland and Sweden have never been cleared for agriculture their wildlife is well established.

The environmental implications of planting trees on productive farmland needs to be assessed.

Chemical weed control is virtually banned in many parts of Sweden and is constrained in Finland. This is promoting some interest in forest grazing as a biological weed control system.

'Everyman's right'

The Swedish public enjoy considerable rights of access to, and derive much pleasure from, the countryside. People have the right to walk in fields and woods, pick flowers, mushrooms and berries, and to go boating and bathing in lakes and seas.

This right is jealously guarded by the public as part of their heritage and it provides a firm basis for recreation in the countryside, and appears to work without causing much conflict.

Without a firm historical base it would be virtually impossible to introduce such a code into another society.

Forest grazing

The grazing of animals in the forests of Sweden and Finland was a traditional part of forest farming. With the promotion of silvicultural management came the objections of timber growers to forest grazing because of the perceived damage to trees. As regulations now prevent the use of herbicides, some research is being undertaken in Sweden into controlled grazing for the suppression of weed species.

Birch as a commercial crop

There is a considerable interest in birch as a commercial crop in Finland. For many years it has been utilized for ply and particle board facings but, with the new techniques for short-fibred pulp, it is even more versatile. Improved cultivars are being developed and planted in Finland and Sweden.

In view of its relatively short rotation and general hardiness, this tree might have application for farm forestry in the UK. It is a good tree for wildlife and the landscape, and is worthy of full evaluation.

1.4 California – Oak Woodland

Regeneration of oaks

The lack of regeneration of oaks, particularly Valley and Blue oaks, is recognized as a serious problem in California. The causes are still not fully understood but they are believed to be a combination of browzing animals and other influences such as fire, weather patterns and wildlife. Similar problems occur in the livestock rearing areas of Britain. Given the very long lifespan of most oak species, it is perhaps an appropriate natural process for regeneration to be uncertain and spasmodic. Although farm livestock is generally acknowledged to be a prime factor in suppressing regeneration, further research is needed to understand all of the natural processes.

Wildlife use for oaks

Oaks have a very high number of associated species of wildlife. Some Californian species such as deer, Black Bear, Grey Squirrel, Wild Turkey, Wood Duck and Acorn Woodpecker are considered wholly dependent on acorns.

Land use change

The main reasons for the clearance of broadleaved woodland and conversion to other uses has been rangeland modification for agricultural development, and urban expansion. Recent surveys have revealed that residential and commercial development are currently the main causes. Relaxed planning legislation enables people to buy small plots of lightly wooded rangeland for building individual houses. This leads to a change in character of the woodland and uncertain implications for wildlife.

Recreational hunting

The scattered oaks considerably enhance the game holding capacity of hardwood rangeland in California. Many ranchers value hunting as a recreational resource, and well managed hunting can provide a substantial income if all the circumstances are right. This provides a financial incentive for landowners to adopt sympathetic management practices.

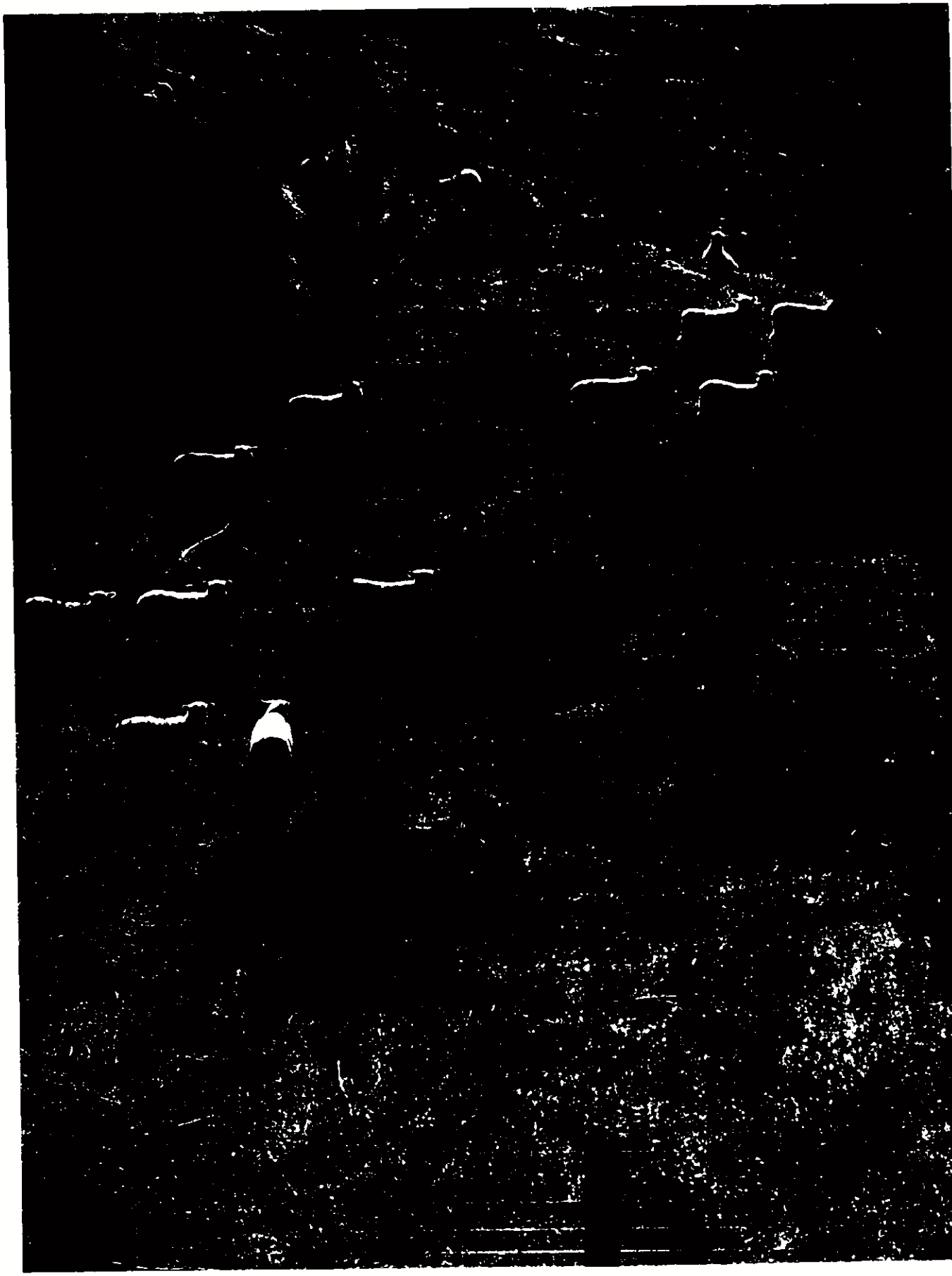
Influence of oaks on pasture production

The traditional practice of ranchers has been to thin rangeland oaks in order to enhance pasture growth. It is now considered that a low density of oaks has little impact on the amount of forage produced. Indeed in some circumstances it can lead to increased production. The reasons for this enhancement are not fully understood and further research is justified to resolve the phenomenon because of the implications for agriculture.

Opportunities for integrated management

The university based agricultural and forestry extension service advisers are encouraging landowners to adopt multiple land use management practices. Hardwood rangeland is capable of fulfilling the objectives of low quality wood production, wildlife conservation, game management, recreational hunting, amenity and soil stabilization as well as grazing for livestock. Advice from extension services includes the regeneration of stands and other management practices.

Similar parallels can be drawn in the UK where there are ample opportunities for multiple land use. This is recognized by ADAS and merits further development.



● *Wide spaced Monterey Pine (*Pinus radiata*) can yield high quality timber and the pasture provides grazing through most of the rotation* [New Zealand]

2

New Zealand – Agroforestry

2.1 Introduction

New Zealand is a young country with a land area similar to Great Britain, yet with a population of less than Wales. Land clearance for agriculture started in earnest during the 1800s and is only now drawing to a close. Extensive areas of native forest still remain but it is the exotic crops of Radiata pine (*Pinus radiata*) that dominate commercial forestry. Approximately one million hectares of Radiata have been planted since the Second World War. Whilst a great deal of this planting is a separate forestry enterprise, a significant number of farmers are growing Radiata on their holdings as a long-term crop. Away from its native California, with its natural checks and balances, Radiata pine has an outstanding performance in New Zealand. In North Island it is quite common for growth rates to average 25-32 cubic metres per hectare per year with rotations lasting 25-35 years.

Farm forestry in New Zealand developed from the need for windbreaks to shelter stock and prevent soil erosion, the exploitation of mature trees through land clearing and later the growing of trees as a cash crop. The more intimate integration of timber production and agriculture or 'agroforestry' as a conscious management practice has developed over the last two decades.

Agroforestry developed largely as a consequence of the 'direct sawlog regime' introduced into New Zealand forestry in the early 1970s. The regime involves low density planting of 1200 plants per hectare followed by successive pruning and thinning operations in favour of a final crop of 250 stems per hectare, all pruned to a height of 6 metres. The objective is to produce very high quality knot free timber for the export trade. The regime lends itself well to undergrazing by livestock especially on the free draining pumice soils of North Island. Agroforestry systems are being developed in New Zealand to suit commercial forestry interests, and small-scale timber growing as a farm enterprise. Three distinct systems comprising forest grazing, trees on pasture (silvopasture) and the production of quality timber from shelterbelts have evolved.

The author completed a four-week study of agroforestry in New Zealand during November-December 1986, which included attendance at the Agroforestry Symposium at the Forest Research Institute, Rotorua, and visits to a number of farms and forests in both North and South Islands. Accurate figures about the extent of agroforestry are not available. The New Zealand Forest Service estimates that there are approximately 30,000 hectares of 'trees with pasture' on farms and about 70,000 hectares of forests have managed grazing.

2.2 Government Policy and Financial Support for Agroforestry

Policy

In 1985, three New Zealand Government departments, namely the NZ Forest Service, Lands and Survey and the Ministry of Agriculture [MAF] formulated a joint agroforestry policy to:

1. Ensure that landowners are made aware of the potential contribution agroforestry can make to land use diversification.

2. Encourage integrated land use on lands of the Crown to increase overall productivity and product diversification.

3. Ensure that the policy environment does not constrain the best use of resources in agroforestry.

4. Identify the major constraints on the production and marketing of agroforestry products and design research programmes in those areas of higher pay off.

5. Seek 'equal opportunity' for agroforestry under town and country planning procedures.

The Government is now pursuing a policy of free market forces and has stripped the subsidies and grants from agriculture and forestry. It is intended that taxation shall also have a neutral effect in terms of one investment versus another (David Butcher MP). In this way the present socialist Government intends that land use be decided on the basis of commercial viability; agroforestry must stand or fall on its own merits.

Financial support

1. Private forestry was promoted by the Government's Forestry Encouragement Scheme until 1985 when it was cancelled in favour of the free market forces philosophy outlined above. The scheme paid 45 per cent of all establishment and tending costs for trees grown for timber production. For plantings that had a protective function such as erosion control the rate of payment was 66.6 per cent of costs.

2. Financial assistance for tree planting to counteract soil erosion (wind and water) is still available in some areas from local Catchment Boards.

Comment

Farmers in New Zealand are hard pressed financially because of the withdrawal of state support, and low commodity prices on the world market. With this incentive to

explore other enterprises such as farm forestry, which has also been stripped of subsidy, the pattern of land use that emerges will provide a unique pointer to the working of free market forces.

2.3 Why Farm Forestry?

Chris Morey reported some of the results of the 1985-6 Lincoln College survey of New Zealand farmer intention and opinions at the FRI Agroforestry Symposium on 27 November 1986.[1] The survey included a section on farm forestry (amenity trees excluded). Of the 3,700 dairy sheep, beef and arable farmers who were sent the questionnaire, 1,907 returned satisfactorily completed forms. Farms less than 20 hectares in area were not sampled.

Results of 1985-6 survey

A. *Planting practice and motivation*

	Past Planting Rates	Intentions
Shelterbelts	54-57%	54-57%
Woodlots	30-33%	28-31%
Agroforestry	7-8%	12-13%

Shelterbelts were most popular on sheep and beef 'fattening and breeding' farms and in the South Island high country. Agroforestry was most popular on 'hard hill country' followed by 'hill country' and 'high country'.

The uses for forest trees on farms rated most highly by respondents were, in descending order of importance:

shelter for stock,
shelter for house,
landscape and aesthetics,
best land use for steep and/or low productive land,
erosion control.

Still important, but less so, were the economic motivations:

wood for own use,
increases in farm value,
profit from sale.

The most important reasons for not planting were:

displaces agriculture,
lack of finance,
inadequate returns,
returns too far in the future.

Reasons judged unimportant were:

lack of skilled labour,
lack of agroforestry and forestry information,
district scheme (planning constraints).

B. *Marketing methods*

The methods of marketing farm grown wood judged overall as most effective were:

negotiate with regular or most likely buyer,
seek best individual deal at time of next sale.

These were followed, in order of decreasing effectiveness, by:

farmer co-operative,
tender of auction,
joint venture.

The option of farm foresters processing their own timber was not offered for rating on the questionnaire, unfortunately. Thus, respondents showed a marked preference for traditional methods.

C. *Sources of forestry information*

The sources of forestry information were rated, in descending order of importance:

magazines,
NZ Forest Service extension officers,
neighbours and friends,
Farm Forestry Association,
catchment boards.

Respondents were neutral about MAF farm advisers and rated the Forest Owners Association and Private Consultants as unimportant.

Comment

Given the high popularity of shelterbelts and the importance of shelter as a use for forest trees, there is potential for developing systems to exploit multiple functions of timber production and shelter, particularly if all of the initial establishment costs do not have to be set against the financial returns.

From the importance attributed by those establishing agroforestry to make the best use of steep or poor land, it would seem that it is generally the poorer areas of these farms that are favoured for planting. It is vital that policy makers and research scientists evaluate farmer attitudes and preferences when considering new initiatives.

2.4 Agroforestry – 'Trees on Pasture'

Most farms in New Zealand have land of variable productivity. Farmers and advisers advocate planting trees on the least productive areas, but they must be suitable for the trees to be grown, for their management, timber extraction and marketing.

The goal for agroforestry is to achieve the optimum level of timber and animal production from farmland. Because of the degree of inflexibility inherent in the system it is

generally recognized that farms should not devote more than about 25 per cent of their land to agroforestry and the remainder should remain as open pastures. Silvopastoral management embraces the three elements of silviculture, animal husbandry and pasture management. Exponents of the system stress the need for managers who can successfully bring together these elements and sensitively balance the competing demands that inevitably arise. Subsequent management decisions are an inter-related series of 'trade offs' to achieve an optimum balance. During early tree establishment, the trees must be given priority and this is one of the important reasons why the farmer must have a large reservoir of open pasture to facilitate flexibility in management.

Because of the high premium paid for knot free timber (clearwood) the *silvicultural objective* is usually to produce high quality pruned 6 metre butt logs.

The following stumpage timber prices offered by a merchant in South Island in 1986 illustrate the value of clearwood:

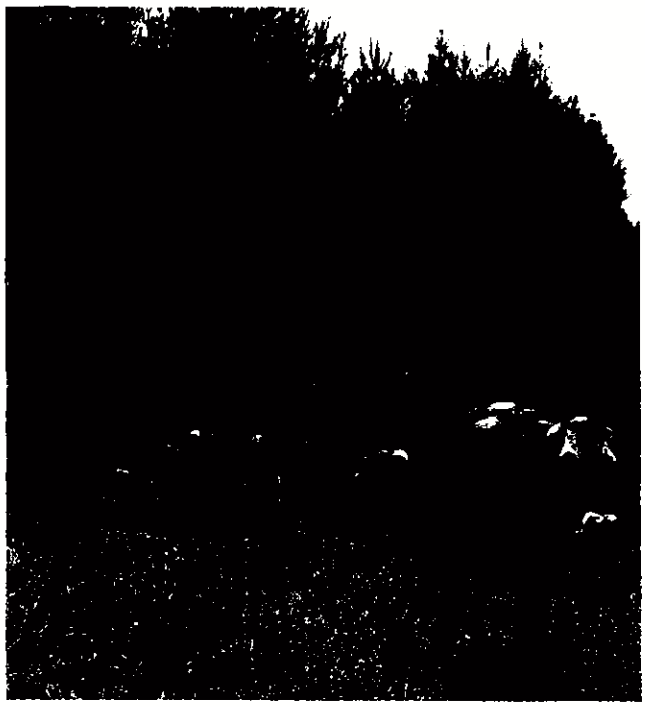
Pruned logs over 60 cm diameter	= NZ $67/m^3
Pruned logs between 36-60 cm	= NZ $53/m^3
Pruned logs under 36 cm	= NZ $32/m^3
Unpruned lightly branched logs	= NZ $18.50/m^3
Unpruned heavily branched logs	= NZ $8/m^3

[1986 Exchange rate approx £1 = NZ $2.5]

In order to produce large diameter butt logs, the aim is to thin to a final crop of 100-200 stems per hectare. The tree crop rotation is 25-30 years. With the lower stocking rate of 100 stems per hectare a significant amount of pasture is available until the crop is around 20 years old, but with 200 stems per hectare most production occurs in the first 10-15 years.

Current practices for growing Radiata pine are described below, based on MAF Farm Production and Practice notes 'Forestry on Farms' prepared jointly by FRI and MAF staff.[2]

Establishment of trees: Trees are best planted on well established pasture to reduce the potential problems with weeds such as gorse and broom.



● *Trees can be grown in rows, convenient if temporary fencing is required during the establishment period* [New Zealand]

Pasture management: Before planting, the land is grazed hard to provide a short sward. Herbicide is then sprayed in 0.8 m spots for individual trees or in 0.8 m wide strips 1-4 weeks before planting (paraquat, glyphosate and atrazine are commonly used).

Weed control: It is essential, after planting, to control woody perennial weeds such as gorse, bracken and blackberry otherwise subsequent grazing will be severely reduced.

Planting density and arrangements: Good quality 1-1½ year old seedlings are planted 4-5 times the planned final tree density to allow for selection of the best trees and occasional damage by stock. If cuttings are used the ratio can be reduced by 50 per cent. Trees near gateways, troughs, stock 'camps' on high ground or places where fodder is fed inevitably suffer damage, and it is preferable to leave such areas unplanted.

Final Density (trees/ha)	Planting Density (trees/ha)		Initial spacing (metres)			Average final spacing (metres)
	Seedlings	Cuttings	Between Rows		Between Trees	
100	500	250	10	×	2	10 × 10
150	750	375	7	×	1.9	7 × 9.5
200	1,000	500	7	×	1.4	7 × 7

Source: NZ Forest Service/MAF

Radiata pine cuttings from high quality genetic stock have more consistent form than seedling plants. Research has shown that in most situations a final density of 100-150 stems per hectare will give the highest overall return on the money invested. Crops around 200 stems per hectare may well have a higher value at harvesting but the loss in grazing is significant.

Early grazing: Once the effect of the pre-planting herbicide wears off, competition from the pasture can be quite severe. The aim is to utilize the pasture by stock as soon as practicable without incurring excessive browzing damage to the seedlings. This is where opinions and practice vary enormously as there is a conflict of interest between normal agricultural and silvicultural practice. At one extreme farmers simply shut the gate until the trees have grown adequately to come to no harm, e.g. 4-5 years advocated by John Aitken. At the other extreme, managers allow light grazing soon after planting.

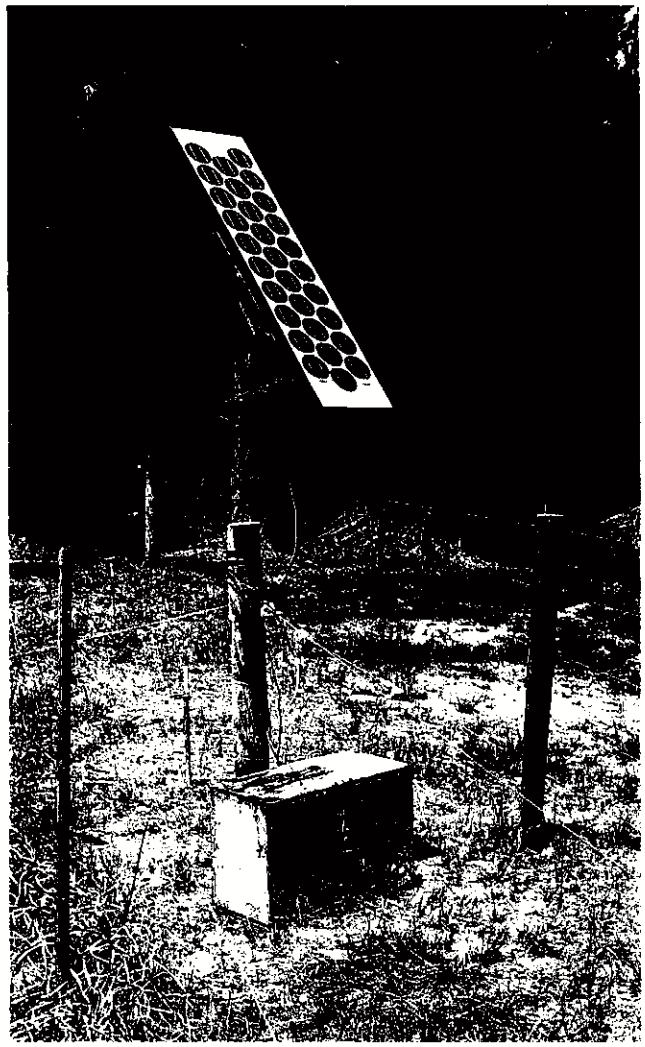
The Forest Research Institute advises that the best results have been obtained by excluding livestock for 6-8 months after planting followed by light stocking (2-3 per hectare) with weaned lambs or dry ewes. In this way trees have a chance to become established, and very light browzing damage can be tolerated. It is generally accepted that dry ewes and lambs cause less damage than hoggets, and that beef cattle do less harm than dairy cows. Goats and deer (particularly Red Deer) cannot be grazed until the trees are well grown and the bark is hardened (8-9 years). Sheep are generally preferred for grazing younger plantations, but cattle are better at utilizing forage growing in the slash produced from thinning and pruning operations. There is some evidence of abortion problems with cows grazing Radiata pine and it is recommended that cows are excluded for the last two months of pregnancy.

It is considered essential that the trees are closely monitored for damage and stock must be removed if damage occurs to 10 per cent or more trees. In practice, stock that are accustomed to agroforestry grazing cause less damage than other stock, and a premium is sometimes paid for 'acclimatized' stock. Some managers on large estates have a policy of stock 'training' whereby stock are introduced to semi-mature plantations and through diet restrictions are forced to eat pine needles. It is reported that this leads to a lasting reluctance by the stock to browze vulnerable young trees (see section 2.9, Forest grazing and weed control).

An alternative is to protect the young trees with individual guards or fencing.

Hay or silage cropping: Where the terrain is suitable, hay or silage may be made in preference to grazing during the first two years of establishment. Inter-row spacing of at least 7 metres is required for machinery access. Fertilizer application will be needed to compensate for crop removal.

Fencing: Adequate perimeter fencing to regulate grazing and prevent 'break-ins' is essential.



● *In remote areas solar energizers power up to 11km of electric fences used for internal and perimeter forest fencing* [New Zealand]

Animal pests: Populations of hares, rabbits, possums and goats have to be controlled to prevent damage.

Stock management: It is considered that periodic grazing gives higher feed utilization than set stocking up to about the tenth year in a plantation of 200 stems per hectare (about year 16 at 100 stems per hectare), and it is feasible to carry livestock through the whole year. Beyond that, occasional grazings (4-5 per annum) appear to give better utilization.

Care is needed during lambing, where there is a large amount of slash, as there is a risk of mis-mothering.

Livestock stocking rates: As the trees get bigger, the livestock carrying capacity is reduced. The effects of tree density and tree age on livestock carrying capacity in the Tikitere Forest Farm research are shown in figure 3. The livestock numbers are all expressed relative to those carried on open pasture without any trees. The New Zealand site index for Tikitere is 32 (the expected mean top height of a stand of Radiata pine measured in metres 20 years after planting). For sites with a lower index all lines move to the right.

Livestock performance: In general terms livestock growth rates decrease with increasing tree densities. At 200 stems per hectare and above these reductions are significant, resulting in approximately 1 kg of wool less per ewe, and 2 kg lower lamb weaning heights. Wool from experimental plots has not been down-graded when sold at auction so quality seems to be unaffected. Trials to date indicate lambing percentage is not affected by tree density. Although the effects of tree densities of 100 stems per hectare or less have been small, as these trees mature some reduction in livestock performance is expected. Where livestock spend a relatively small proportion of its time under trees, any effects will be of minor importance.

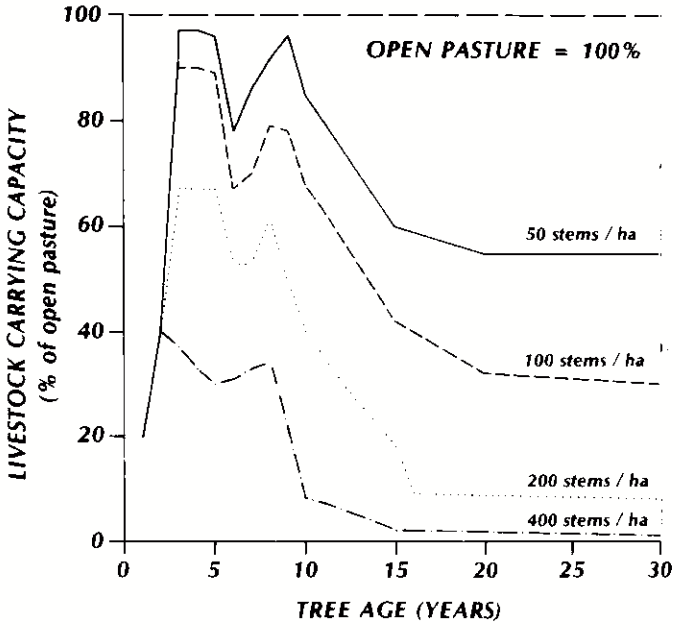


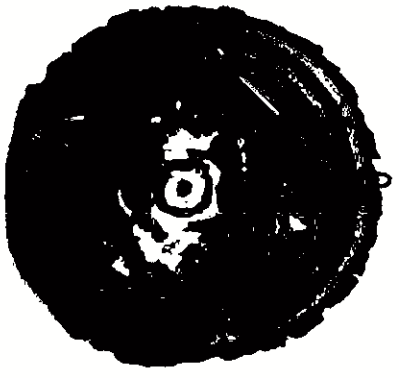
Figure 3: Effects of tree age and density on livestock carying capacity in the Tikitere Forest Farming Research Area. (Radiata Pine on Pasture.)
Source: Ministry of Agriculture/NZFS Forest Research Institute 1984.

Shelter: The harsher the climate the more beneficial are the effects of shelter.

Fertilizers: Maintenance fertilizer is only advocated when justified on agricultural grounds as trees will not usually have a requirement for NPK fertilizers on agricultural land that has been farmed previously.

Pruning: To achieve high value 6 metre butt logs, pruning is carried out to ensure that the maximum clearwood is produced over the defect core (residual knots). Open grown trees tend to have larger branches and close attention is needed to minimize the size of the defect core, which should not exceed 18 centimetres in diameter. Variable height pruning is often carried out using pre-set callipers in order that each tree can be pruned on merit. In practice farmers who carry out this operation often undertake pruning about every 9-10 months, in order to achieve a balance between the need for minimizing the defect core and the desirability of maintaining a good crown on the tree for light interception and growth. Regular pruning reduces large slash, allows maximum light penetration to the pasture whilst maintaining a consistent defect core.

● *Pruning is essential for clear-wood production* [New Zealand]



● Pinus radiata *is quick to occlude pruning scars* [New Zealand]

NEW ZEALAND

Thinning: Poor quality or damaged trees are thinned as early as possible to permit the remainder to grow more freely and reduce the amount of slash. It is common practice to cull about half of the trees at year 3-4. Subsequent thinnings are usually done in conjunction with each pruning.

Profitability: Calculations in New Zealand indicate that agroforestry is likely to be more profitable than either farming or forestry when the level of farming returns is low. With higher farming returns, agroforestry at low tree densities can compete with farming in some circumstances, but the margins either way are comparatively small.

● *Jeff Tombleson of the Forest Research Institute advocates two row timber belts for shelter, and quality timber. Here is an 8 year old belt of* Pinus radiata and Cryptomeria japonica [New Zealand]

Comment

Agroforestry allows the uninterrupted utilization of solar radiation. It combines long term capital accumulation with a regular annual income. The New Zealand system utilizes the grazing animal to assist with suppression of ground vegetation that would otherwise compete with the tree crop. However a high standard of management is essential to strike the right balance between agricultural and silvicultural requirements.

There are many wide ranging views about tree damage in newly planted areas, where young trees are not protected from grazing livestock. The subject has been studied by many in New Zealand but the results are inconclusive. Some farmers allow early grazing of their woodlots and incur a very low level of browzing damage whilst others have had bad experiences. When trees are assessed for their suitability for agroforestry, their resistance to browzing and bark stripping damage will be a critical factor. Individual tree protection may make the system uneconomic.

The New Zealand experience is often quoted as a way forward for farm forestry in the UK. Because of the risk that some researchers and policy advisers may simply extrapolate the technology to other countries it is worthwhile listing the head start that New Zealand enjoys:

1. Radiata pine is very fast growing with half the rotation length of many softwoods in Europe.

2. Radiata has inherent resistance to bark stripping and browzing damage.

3. Competing returns from agriculture are low because they are geared to world commodity prices.

4. The quality clearwood product is also being grown by commercial large-scale forestry, and a market is being developed. The clearwood regime suits agroforestry well and allows utilization of solar radiation and nutrients for an extended period.

5. Radiata has been well researched for traditional forestry in New Zealand. It is convenient that this species also suits agroforestry.

Agroforestry must not be dismissed in the UK because it does not have these advantages, but a great deal of R & D will be required before it can be advocated as a viable system. Although agroforestry provides agriculture with a gentle transition to farm forestry it suffers the political disadvantage of failing to significantly cut surplus food production during the early years of a rotation.

Nevertheless agroforestry is an extremely efficient form of land use, and long term research may well produce a technology for the vertical integration of agriculture and forestry.

2.5 Agroforestry – Case Studies

Richard Davies-Colley – Tikoti, Northland

Tikoti is a family run farm extending to 300 hectares. About 60 per cent of the farm has some form of tree planting. Richard, his wife and sons Peter, David and Tony are all interested in trees. They have completely integrated farm forestry with agriculture over the 23 years that the family has owned the holding. Tony has now moved away and has his own sawmill business. Peter runs the farm business and David takes charge of the silvicultural operations and is developing a home sawmilling operation. Richard and his wife still take an active interest in the family agroforestry enterprises but also have a business interest with a local retail nursery.

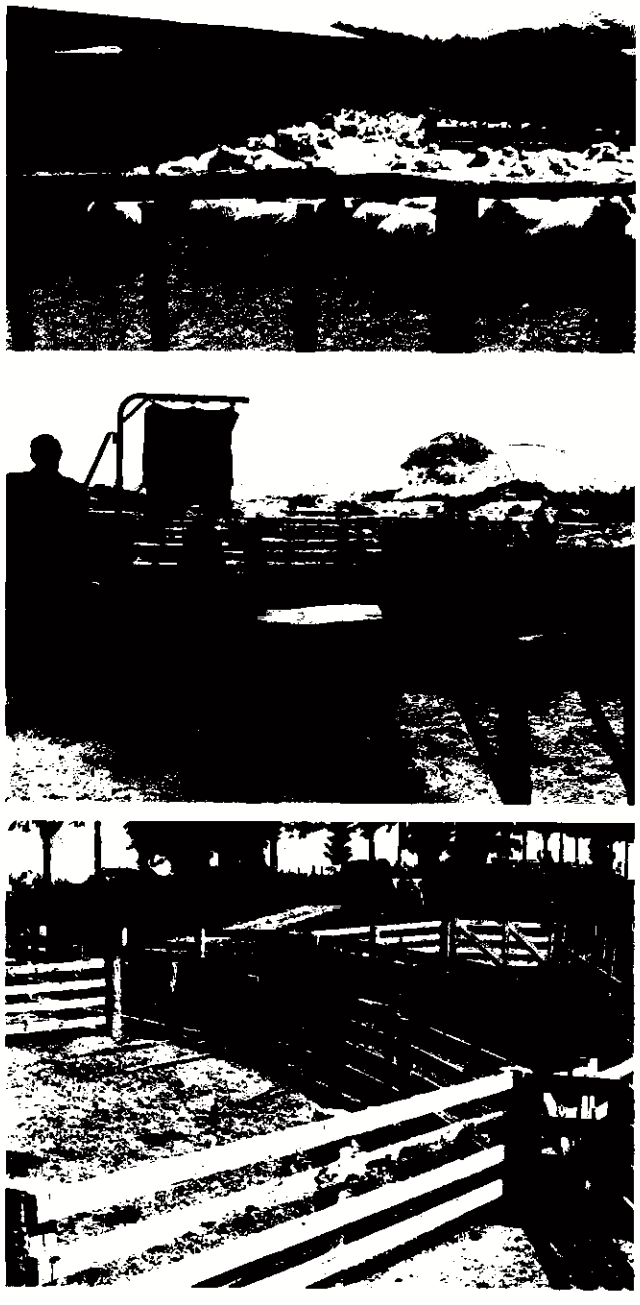
Agricultural enterprises: A flock of 1,000 Romney ewes is kept for fat lamb production and 300 Friesian bulls are reared for the export meat market. Open pasture is managed to maintain ryegrass and white clover with minimum fertilizer input. Bulls and sheep are strip grazed with front and back electric fences.

Silvicultural enterprises: Richard started tree planting on the farm with poplars to aid soil stabilization and prevent soil erosion in some of the gulleys, all with grant aid from the Catchment Board. In addition, the trees provide timber, shade for stock, shelter, add to the amenity of the farm and even the pruning operations can be timed to provide fodder for stock during dry periods.

Blocks of Radiata pine and other species were planted later as conventional woodlots. Grazing with hoggets was practised, from soon after planting, because hand releasing was not feasible. No difficulty was found in correcting the light browzing damage during thinnings, and all final crop trees are pruned to at least 6 metres. The objective is now to extend the rotation so that very large trees are produced, and to capitalize on the extra clearwood produced over the defect core. In future low density planting will be adopted, with commensurate greater control over grazing to prevent damage.

Timber conversion and timber products: Now that early plantings are yielding useful thinnings, a sawmilling and processing enterprise is being developed. Because it can add four times to the stumpage value of trees by doing this work on the farm (based on a modest 50 per cent recovery rate in the timber conversion process), the family sees this as an ideal way of generating more income from the farm and providing extra employment for itself. Timber currently valued at NZ $50 per cubic metre at stump is worth NZ $400 per cubic metre as finished sawn wood. The farm is able to undercut the prices of local millers by 30 per cent. Early thinnings produce fencing posts and timber for the farm. The timber conversion enterprise was started in earnest by David two years ago with a second-hand sawbench, and now a large shed is planned to accommodate a bench saw, a docking saw, a multiple re-cut saw and a 4-sided planer. The unit is to be designed for one man operation with casual help as needed. Other developments into finished products, such as fencing and garden planter tubs, are planned – all with a view to maximizing income and employment on the farm.

Perhaps the ultimate in the utilization of home-produced timber is the bungalow that the family is constructing for Peter on the farm. Virtually all the timber is home-produced even down to the white poplar faced kitchen units and the macrocarpa floors as well as the Radiata pine for constructional timber, exterior cladding and the cattle grid at the drive entrance.



● *Livestock rearing, wood lots and a modest timber conversion enterprise provide full employment for Richard Davies-Colley and his two sons. Home grown timber is used for buildings and fencing* [New Zealand]

John Aitken – Hau Ora, Havelock North, Napier

John Aitken manages his 400 hectare holding on agroforestry lines. As a business colleague of John Groome and Associates (Forestry Consultants) he is responsible for promoting joint ventures in farm forestry.

Hau Ora is a hill farm capable of supporting 5 sheep per hectare on the poorer dry land, and 15 per hectare on the better pasture. John pursues agroforestry on strict pre-determined land use and management criteria. Tree planting is zoned onto the poor quality farmland; the flatter productive areas are left in open pasture. Stock comprise 2000 sheep and 300 cattle. John and his wife manage the farm themselves and silvicultural operations are carried out by a contractor. Forty per cent of the land has been planted and this will be increased to 60 per cent. John's motive is to pursue a more profitable land use on poor quality farmland which is expected to become less and less viable because of rising costs and falling agricultural returns.

Trees are planted at a high density of 1,500 per hectare. Livestock is totally excluded for 4 years (until first pruning), as John is convinced that early browzing damage can cause the rotation to be extended by at least 5 years with disastrous results for the financial budget. Final crop trees are selected and pruned to 6 metres on strictly predetermined growth criteria, aimed at producing a final crop of 100 stems per hectare with a diameter of up to 75 centimetres over a 12 centimetre defect core.

Joint ventures: John is employed part-time by John Groome and Associates and is actively promoting 'joint ventures' in the locality. The consultancy is co-ordinating joint ventures between a lumber growing and processing company and local farmers. In such joint ventures the landowner provides the land, fences, pays the rates and landowning overheads whilst the investor finances the planting and silvicultural operations. Both parties share the proceeds and the split is dependent on their financial inputs. All the planned financial inputs throughout the rotation are capitalized, including a charge on the land at 5 per cent of its market value. Whilst the farmer has the option to undertake the silviculture, in practice contractors are often used and the split of proceeds often ends up two-thirds in favour of the investor.

John's target is to achieve a farm forest area of 6,000 hectares in a 15 mile circle. He considers that this would then justify a sawmill which could also be run as a joint venture between the landowners and the investment company (landowners could use their maturing forests as collateral for obtaining finance). To date 700 hectares have been planted by three landowners, and more is in the pipeline. Another option of 'buying in' existing forests is being considered to speed up the justification of a sawmill. In this way it is intended to set up a 'family forest' of 20 or so co-operating farmers.

Geoff and Gill Brann, Pongakawa, Bay of Plenty

The Branns' own and manage a 205 hectare hill farm in the Bay of Plenty. The land is fairly steep but there are flat valley bottoms and ridge tops. The 1.5 metre rainfall, light ash soil and long warm growing season provide ideal conditions for grass and trees. The stock comprises a flock of 1,800 Romney ewes, 300 deer (250 Red and 50 Wapiti), and about 120 dairy cows from a nearby farm are outwintered. Surplus grass is sold for silage. The Branns consider the deer enterprise to be more profitable than the sheep or cattle because of the high price paid by the export trade for venison and velvet, and the low labour requirement compared with cattle. Although fencing costs are high, at NZ $8-10 per metre for 2 metre high perimeter fencing, economies are made by using electrified internal fencing.

Labour: With the exception of shearing, all work on the farm, including silviculture is done by the family. Geoff (full-time), his wife Gill (half-time), their son (third-time) and Geoff's father (third-time on constructional work) manage the holding as a family business.

Silviculture: Since they came to the farm in 1963, the Branns have planted 80 hectares of trees which are mainly managed as agroforestry. Radiata pine is a large component but many other tree species have been tried including various Eucalypts, Tasmanian blackwood, Lusitania cypress, English walnut and Douglas fir. Planting is restricted to sloping sites that are less suitable for agricultural field operations. Blocks are kept small, and 3-5 hectares are planted each year.

Initially plantings were at traditional close spacings but work is now minimized by planting at final spacings. Only very high quality stock is purchased and great care is taken over planting and establishment. The Branns have experienced more damage to plants derived from cuttings than seedlings, but if trees do not survive the Branns are not too concerned because of the extra grazing made available.

Grazing management: When the planting stock was derived from Radiata pine seedlings, lambs could be carefully introduced 6 months after planting, and ewes sometime within the year. After one and a half years the old pasture would generally be back under control. With pine plants derived from cuttings, there has been much more damage and their current practice is to 'mob-stock' young plantations with ewes (1500 ewes on 3 hectares) for about 2 hours daily. Extensive use is made of internal electric fencing.

Older blocks provide useful cover for fawning deer and much needed shade in the summer.

Implications for the family: Planting is spread to ensure that the silvicultural operations can be financed by the agricultural enterprise income. Despite planting over one third of the farm with trees there has been no drop in agricultural output although this may well change as the tree crops mature.

The Branns three children are paid for planting and pruning. In this way, money stays in the family and the children are involved in the enterprise.

A simple portable sawmill and timber treatment plant was purchased 6 years ago which has provided further employment for the family and a ready supply of timber for farm use.

The environment: Geoff and Gill have a keen interest in providing a legacy of trees and a pleasant environment for future generations. This is typified by the retention of 8 hectares of native bush, and a small plantation of walnuts destined for a 100 year rotation.

Land and Survey Department, Tekuri, Dargaville

'Lands and Survey' is the Government department that has the responsibility for developing native bush land to provide agricultural holdings for settlers and returned servicemen. This programme of work is drawing to a close and some new initiatives are being explored.

At Tekuri, Lands and Survey has kept its estate in hand and have a resident manager who lives on the block. The original objective was to plant 9,000 hectares with Radiata pine but in 1979 planting was suspended to allow staff to catch up with silvicultural operations.

Early planting: Early plantings were at the conventional 1,200 stems per hectare, which were progressively thinned to a final crop density of 100-150 stems per hectare with 4 lifts of pruning to 6 metres. Sheep grazed plantations within 6 months of planting, and browzing damage was not found to be serious. Ridge tops, field gateways and 'camp sites' suffered more damage but this was confined to an acceptably small area. 'Mob' stocking using 700-800 hoggets for a week in a 20 hectare paddock was found to be most satisfactory. Cattle were not introduced until the fourth year.

Current planting: The new regime is to plant a much lower density of 300 quality plants per hectare derived from cuttings taken from high quality genetic stock. Trees are initially spaced 3 metres apart in rows of 10 metre centres. Planting is in shallow pits created by removing the turf 2 spades wide × 2 spades long. The cost is high at NZ $0.50 per tree compared with NZ $0.14 for conventional planting, but is found to reduce weed competition and help to reduce browzing damage. The crop is thinned to about 100 stems per hectare.

Browzing damage is much more critical with the lower ratio of planting to final crop. Plantations are only lightly grazed by sheep and great care is taken with monitoring for the first 2 years until the leaders are above browzing height. However, browzing damage has not been found to be significant enough to justify individual tree protection, or row protection with electric fencing. It is thought that wet weather promotes more damage – perhaps the stock are looking for higher dry matter fodder. Parent tree stock of cuttings can affect the palatability of young plants, e.g. 8-12 month old parent tree stock provides cuttings that produce less palatable young trees than cuttings from 2-3 year old trees.

The environment: Initially the wide spaced rows stand out in the landscape as a series of straight lines, more prominent than the closer spaced lines of high density conventional forestry. However after the stands have been thinned to their final density this effect largely disappears. During the later stages of the rotation the stands take on a 'tweedy mixture' mottled appearance derived from the pines and the ground vegetation.

Tasman Forestry, Wainui, Taupo

Tasman Forestry is a large forestry company owning commercial forests and sawmills in New Zealand and overseas. In 1978 it was decided to establish a deer farm on 1,000 hectares of company land at Wainui. The farm consists of 320 hectares of grassland, 380 hectares of Radiata pine planted on grassland and a further 300 hectares of Radiata pine planted on native scrub. Density, nine years after planting, is about 160-170 stems per hectare which will reduce to 120 for the final crop. Experiments are being undertaken with low density planting of 20 stems per hectare where trees are individually guarded (2.5 metres high for Red deer) to permit early grazing. The high cost of establishment has yet to be fully evaluated.

Establishment of the deer enterprise: One of the reasons for the choice of Wainui was because of the possibility of capitalizing on the native population of Sitka and Red deer. In March 1978 the farm had 44 deer. Thereafter an extensive programme of wild deer capture was undertaken on several company owned forests, which was complemented by the purchase of 100 Red deer hinds.

The farm holds 2,500 deer on 400 hectares of which 30 per cent is open pasture and the remainder agroforestry.

Sitka deer: Early experiments with Sitka deer were a disaster because of high losses through the stress-related disease MCF (Malignant Catarrhal Fever). Introduction of the survivors to 4 year old Radiata pine plantations prevented further losses. The herd thrived and multiplied to the present size of 300. The deer did not browze the bark but 'antler-thrashing' caused damage to a few small diameter trees. All progeny are retained – hinds for breeding and stags for venison or potential trophy heads. Experience shows that Sitka can utilize poor quality pasture.

Red deer: To avoid bark stripping Red deer are not introduced to Radiata pine until the trees are at least 8 years old, after which the trees come to little harm. Substantial advantages have been found in farming deer on agroforestry compared with open pasture:

1. The trees provide shelter and 'calving niches' for hinds, significantly reducing stress.

2. Calving percentages increase. Figures for 1985-6 show an increase from 80 per cent to 96 per cent calving, recorded at weaning.

3. Deer require less supplementary feed during the winter; they maintain condition better and fawns have a heavier weight at weaning.

Len Crofskey, the manager, is enthusiastic about the economics of deer production. Deer require 9.8 kg dry matter for every 1 kg carcass gain compared with 30 kg and 20 kg feed dry matter required respectively by sheep and cattle for 1 kg gain. This, coupled with current end-product values, makes deer farming a very attractive proposition:

Table of comparative value of carcass meat [1986]

Beef	NZ $1.40kg
Lamb	NZ $1.30 kg
Venison	NZ $7.00 kg

Based on studies in Hungary where deer hunting is big business, a trophy shooting enterprise is being developed at Wainui. The first season has just been completed with 10 Sitka stags shot at a charge of NZ $1400 for each head. The trophy value of stags represents six times the meat value. The shooting is marketed by a specialist travel agency which offer 'certainty of a kill' to clients as part of an overall hunting package for wealthy tourists. It is planned to extend the trophy enterprise to Red stags, Wapiti stags and wild pigs.

Garth Cumberland, Te Kuite, King Country

Te Kuite is a farm of some 330 hectares, with light volcanic ash soil on undulating uplands, and an annual rainfall of about 2 metres. The farm maintains 4,000 stock units (1 ewe = 1 stock unit), comprising mainly sheep but also goats through the winter, and cattle that are purchased to utilize the spring flush of grass. Winters are cold by North Island's standards, with 5-6°C frosts quite common but there is little snow. The agricultural management follows a low input system and 'autumn saved pasture' is grazed during the short winter instead of hay or silage.

Garth manages the farm himself, as well as several other business interests, with the help of a contract worker who lives on the holding and carries out most of the silvicultural operations. Approximately 38 hectares of trees have been planted since the farm was purchased in 1974; the main planting, comprising 5 paddocks of 7 hectares, took place between 1975 and 1979. The principal species is Radiata pine, but alternative species including *Eucalyptus delagatensis* and *Eucalyptus fraxinoides* are also successfully grown. The agroforestry enterprise has been adopted for the following reasons:

1. It diversifies the investment.

2. Farm profits can be invested in trees with a tax saving.

3. It provides shelter especially for newly shorn sheep and goats.

4. It aesthetically enhances the farm working environment.

5. It is very interesting to pioneer new technology.

Garth has a philosophy of learning by experience and quickly reduced his tree planting density from the conventional 1,000 stems per hectare to 600 stems per hectare in order to facilitate agroforestry management. He now advocates planting no more than 300 stems per hectare of high quality genetic stock aiming at a final stocking of 100 stems per hectare by the fourth year. All final crop trees are pruned to 6 metres. An experiment of pruning to 9 metres (at an extra cost of NZ $2 per tree) at year 10 revealed that as much light penetrated the pasture as with 6 metre pruning in 7 year old trees. The economics of this extra high pruning have yet to be evaluated.

Garth does not practice very early grazing because of the risk of tree damage. When the trees are 18 months old (1.2 metres high) grazing is carried out with lambs. Adult sheep and cattle are introduced at year 2 (height 2.2 metres). Goats are not introduced to the pines until year 6 because of the high risk of damage. On the positive side, goats do assist with the breakdown of slash by browzing the bark and needles. Pasture suffers during the early establishment phase and clover has proved to be difficult to re-establish once grazing commences. Garth considers that about a quarter or one-third of a hill or upland farm could be usefully managed as agroforestry. His initial rate of planting could not be maintained because of the progressive build up of silvicultural operations required.

Thinnings are now providing timber for farm use and Garth gained enormous personal satisfaction from using home produced weather boarding for an extension to his home.

The environment: When the holding was purchased in 1974 there was hardly a tree on the farm. A conscious effort has been made to enhance the landscape with tree planting. Mixtures have been introduced and in recent years amenity planting has been undertaken near the house to screen it from the road and provide a visual backcloth to set off the ornamental garden.

2.6 Timberbelts – Quality Timber from Shelterbelts

Shelterbelts have been planted extensively in New Zealand, particularly in exposed areas such as the Canterbury Plain, since the 1850-60s. Many are poorly managed and the timber often has very low value because it is heavily branched, with poor form. The Forest Research Institute has been investigating whether the timber quality can be improved without shelter benefits being lost. The objective of growing trees for shelter is to provide a tall semi-porous

screen that filters the wind thereby reducing its speed and its consequent chill factor without causing turbulence. This demands a structure of branches at low and high levels but conflicts with silvicultural requirements required for knot free timber. The FRI have evolved two alternative strategies to overcome this dilemma:

a. Two-row system whereby a single line of Radiata pine is grown for timber and a supplementary row of slower growing trees provides 'in fill' shelter at a lower level to cover the bare butts of the pines.

b. Single rows of one species such as Radiata pine where alternate trees are pruned to 6 metres. Intermediate trees are fan pruned to provide low cover.

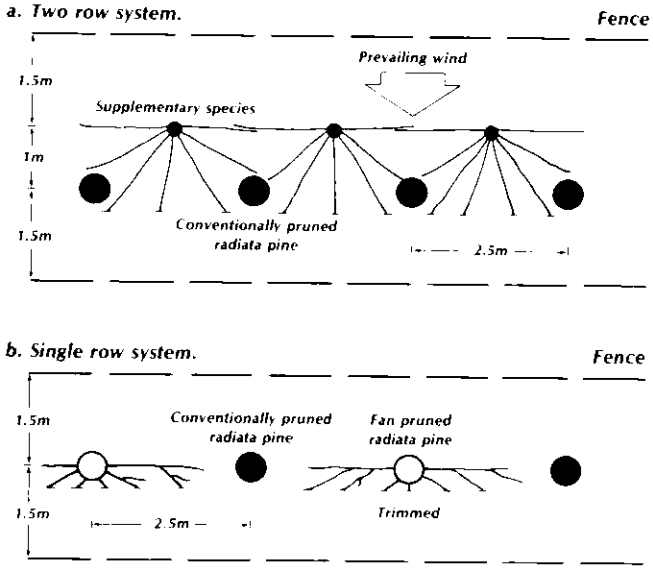


Figure 4: Alternative strategies for producing high quality timber from narrow shelter belts.
Source: NZFS Forest Research Institute 1985.

An early trial at Waikite based on the 2-row system of Radiata pine and a slower growing conifer produced a crop in 22 years of pruned Radiata trees with a diameter of more than 60 centimetres and a height of 30 metres. After all logging costs, transport etc a net revenue of NZ $30,000 per kilometre of shelterbelt was produced. It has been estimated that this would represent a return of at least 10 per cent on initial investment (Tombleson, 1986).

Extensive trials are now being undertaken to evaluate and prove these concepts. The report of the Working Party for the National Research Advisory Council and National Water and Soil Conservation Authority recommended that studies are needed to determine the best shelterbelt structure and to devise suitable tending schedules, with related study of the effects of tending on shelter values. Co-operation has not been forthcoming from MAF and the shelter aspects are not being evaluated. In practice many farmers have adopted 2- or 3-row belts for shelter in livestock areas such as Canterbury Plain. Single row shelter hedges are more popular for horticultural crops.

Comment

This development has considerable potential in Britain, and research into quality timber production from efficient shelterbelts could pay handsome dividends. It is a pity that the shelter aspects are not being monitored or taken into account in New Zealand, as it is clear from the survey of attitudes that farmers place high importance on shelter. It will be difficult to 'sell' the concept of multi-functional belts to farmers unless both functions are properly researched.

2.7 Timberbelts – Case Studies

Peter Smail, Hororata, Christchurch

Hororata is a 573 hectare farm of light land on the flat Canterbury Plain. The rainfall is 700 millimetres per year and it is 240 metres above sea level. The farm is subject to high winds which cause problems of soil erosion, and exposure for stock and crops. 5,000 stock units are kept including 3,500 ewes but no cattle.

High priority is given to the establishment and management of shelterbelts on the farm and Peter is recognized as a leading exponent on the subject.

● *Peter Smail's priority is to provide shelter for his livestock – timber production is a bonus* [New Zealand]

Background: Peter purchased the farm by ballot in 1953 when it largely comprised native bush. It was quickly realized that prevailing north-westerly winds and snow and rain laden southerlies were a major cause of livestock losses. With Catchment Board grants, shelterbelts have been planted and Peter has developed two types of belts to cater for the different wind conditions.

Snow protection: A small number of wide dense belts on an east-west axis protect stock from the bitter snow laden southerly winds in winter. Protection is also given by high

density woodlots with unpruned or fan-pruned exterior trees to form completely sheltered 'stock yards' during bad winter weather. Pruning slash provides useful cover after shearing and a microclimate for grass growth. Before this shelter was available Peter lost 300 lambs in one winter. Indeed in 1985-6 his neighbour lost 150 sheep because he lacked adequate shelter.

Prevailing wind protection: Peter Smail helped to pioneer the 2-row 'timberbelt' concept, and now has a total of 30 kilometres on the holding. Radiata pine is grown in one row as a fast growing shelter tree and a second row of slower growing trees such as *Cedrus deodara*, and *Cupressus macrocarpa* provides low level shelter on the windward side. The belts are trimmed with the aim of maintaining 60 per cent porosity to reduce wind speed without causing turbulence. A contractor carries out mechanical trimming to a height of 14 metres, at an approximately cost of NZ $400 per year for the farm.

Priority is given to management of the belts for shelter but, where possible, the Radiata is pruned to maximize its timber value. With a rotation of 25-30 years for the Radiata it is anticipated that 2 or 3 crops can be grown besides the secondary shelter row, before it too needs replacement.

Research: Field monitoring carried out by MAF in 1981-2 indicated an extra 60 per cent of dry matter production from pasture for up to 8 times the tree height into the field. Trials the following year did not corroborate these findings but climatic conditions were unusual. Unfortunately the work has not continued.

Ian Moore, Rotorua

Ian Moore has adopted a radical new agroforestry technique on his dairy farm. Because of the risk of bark stripping by cows (considered much worse than beef cattle) and young heifers, forest grazing was not a favoured option. Until 1983 forestry took the form of fenced woodlots on the steeper or poorer land. With Forest Research Institute advice a new concept was adopted; to grow Radiata pine in wide-spaced rows or 'timberbelts'.

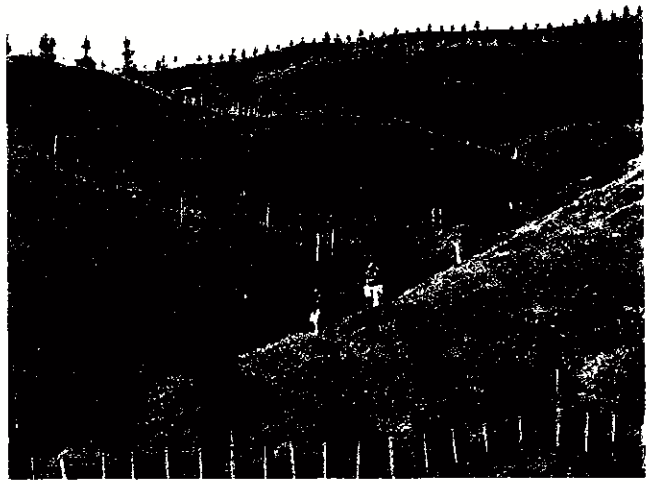
To date 7 kilometres of timberbelts have been planted.

The timberbelts are set at 40 metres apart, and as near as possible on a north-south axis to minimize effects of shading. Radiata transplants are planted at final spacing of 2.5 metres along the row giving a density of 100 stems per hectare. The timberbelts are electric fenced each side to totally separate stock from the trees in order to prevent damage.

Shelter: Where shelter is required two alternative strategies are adopted:

1. underplant the Radiata pine with a second row of slower growing species, or

2. prune alternate trees and 'fan prune' the remainder.



● *At Ian Moore's Farm timber belts form paddocks for his dairy herd, and a cash crop for the future* [New Zealand]

Pasture management: Reduction of grass production is anticipated in the later years of the rotation but high pruning will assist light penetration. Pruning debris will be contained within the electric fencing lines, but it may be proved necessary to collect and burn slash. The widely spaced timberbelts effectively form boundaries to paddocks which can be adjusted in size to suit the size of the dairy herd and to facilitate good pasture management.

Financial aspects: Based on 1986 levels the cost of establishment per kilometre of timberbelt were:

	Flat country NZ $	**Hill Country** NZ $
Fencing costs (single side)		
Materials	400	1200
Labour	80	160
400 Radiata pine plants	160	160
Planting	160	160
Source: NZFS	$800	$1680

On a holding of 200 hectares, with belts spaced at 80 metres apart, an annual harvest of 1 kilometre of timberbelt could be achieved. It is envisaged that a 25 year rotation of 1 kilometre planting and harvesting each year would require a labour input of five weeks per year for preparation, fencing, planting and pruning.

The rotation is predicted by NZFS to provide an annual yield of 400 stems per hectare. After growing, harvesting and transport costs have been deducted (but of course not discounted) this could return up to NZ $85,000 per annum.

2.8 Agroforestry Discussion Groups

John Edmonds, NZFS Extension Officer co-ordinates three agroforestry discussion groups in the Dunedin area. Many members have hardly missed a meeting since its inception some two years ago. They value the groups for the spread of technical information and their collective discussion about new technology.[5] The farms lie in isolated rural situations and the social aspects of the meetings are enjoyed by the families.

Comment

The operation of farm discussion groups is a successful agricultural extension service technique used in Britain and New Zealand, although not generally utilized for promoting agroforestry. The obvious enthusiasm of the three farmers visited in the Dunedin area demonstrates the mutual benefit to the adviser and agroforesters alike. It provides a vehicle for dissemination of new ideas, stimulates healthy competition and feedback for the adviser. This would be a useful concept for promoting agroforestry in the UK if sufficient interested farmers could be co-ordinated within a locality.

Bill Wise, Balclutha, Dunedin

Bill Wise, and his wife Barbara, started farming at Balclutha in 1958 and their son Denis now helps on the farm. The holding extends to 155 hectares, including about 42 hectares of trees. The livestock comprise 1,350 Romney ewes and 350 hoggets. A recent purchase of 83 hectares of land adjoining has strained family finances following the downturn in agricultural prosperity. The agricultural enterprise is barely breaking even and it is the revenue from the farm woodlots that is providing disposable income for the family.

Trees are grown for profit and to utilize steep sided scrub covered valleys that are unsuitable for agriculture. For several years 2 hectares per annum were planted with family labour, grant aided by the Forestry Encouragement Scheme. Because silvicultural operations do not have to be carried out at a precise time they could be fitted in with the farmwork. Even Bill's daughter was employed on pruning operations during university vacations.

With an eye to the environment, some natural vegetation, such as mature 'cabbage' trees are retained. Although Radiata pine is the main crop grown, other species such as *Eucalyptus nitans* and *Cupressus macrocorpa* have been planted to provide variety and interest. In a time of severe drought poplar prunings fed 1,500 sheep for a week.

Bill is an enthusiastic member of the agroforestry discussion group chaired by John Edmonds, NZFS.

Graeme Flett, Skilbister, Dunedin

The Fletts' farm comprises some 1,500 hectares and is stocked with 5,400 Perendale ewes and 200 beef cows. 230 hectares of trees have been planted, Graeme's son works full-time on the farm and his other son Warwick is employed on silvicultural operations.

The rate of tree planting tends to be cyclical and is constrained by backlogs of management operations from previous planting. Now that blocks are approaching maturity it is anticipated that income will be in the order of NZ $150,000 per year, at least equivalent to the total income from agricultural operations.

Silvicultural management regime: The current practice is to plant Radiata pine in groups of 3 at 10 metre × 10 metre spacing. Thinning provides a final density of 100 per hectare. Pruning commences at year 4, following which annual pruning is carried out until 6 metres is reached. Multinodel stock is preferred because the small branches are easier to prune.

Grazing is started when the trees are 1.5 metre high. The small amount of browzing damage is tolerated as there is little impact on tree growth. Earlier conventional woodlots are grazed during the winter.

Graeme is also an enthusiastic member of his agroforestry group.

2.9 Forest Grazing and Weed Control

Forest grazing, as a weed control measure, is being researched and practiced by the NZ Forest Service on state-owned forest lands.[6] The 'direct sawlog' regime (see introduction) unfortunately provides good growing conditions for forest weeds. Low planting densities, early thinnings and pruning allows more light to reach the forest floor for a longer part of the rotation. Many weeds such as pampas grass, gorse, broom and bracken grow extremely vigorously in the very favourable conditions of New Zealand.

Chemical control is expensive and often requires repeated application. Forest managers have turned to farm livestock as a means of weed control and it is estimated that some 70,000 hectares of commercial forestry are now systematically grazed by cattle and sheep. The

● *Maku lotus (*Lotus pedunculatus Var maku*) is sown to enhance forest grazing. Its vigorous growth enables it to climb through pruning and thinning slash* [New Zealand]

NZFS takes the lead, and managers are developing special livestock training techniques whereby cattle and sheep are discouraged from browzing foliage. The understorey vegetation is often enriched with legumes such as *Lotus pendunculatus var Maku* to enhance the nutrient value of the grazing. Such systems are described in some detail in the three examples included in this section.

Comment

Forest grazing is an efficient biological weed control system with potential for application in the UK. Foresters in New Zealand had the same distrust of farm animals as do foresters elsewhere; but with the punitive cost of controlling weeds by chemicals they turned to controlled grazing as an alternative management tool. In practice cattle and sheep cause little damage to the tree crop and managers are now enthusiastically developing new techniques for better utilization of the understorey and livestock management.

Forestry on better quality farmland in the UK, as a result of new policies stemming from agricultural surplus problems, will bring new weed control problems. Given the financial and environmental cost of chemical control, grazing techniques should be evaluated in the UK.

New Zealand Forest Service, Maramarua

In partnership with the state department 'Lands and Survey', the NZFS have introduced grazing into their 5,690 hectare forestry estate at Maramarua. The initial objective was to control pampas grass (*Cortaderia selloana* and *C. jubata*) which was originally introduced to New Zealand as a fodder and windbreak crop. The pampas quickly spread and is now a serious forest weed that quickly grows to a height of 3-4 metres and smothers new plantations. It results in difficult site access for silvicultural operations, creates a fire hazard and competes for water and nutrients as well as suppressing tree growth.

A new operation was started in 1978. This took the form of aerial spraying with a chemical that would kill the pampas grass but not damage the trees. Costs climbed to NZ $480 per hectare by 1983, and a cheaper means of pampas control had to be found. Nearly out of desperation, grazing by cattle was tried and found very successful.

Silvicultural regime: Radiata pine is planted at 1,250 per hectare which is progressively thinned to 250 stems per hectare at year 9. The normal rotation is 25-30 years.

Grazing regime: Forest blocks are sub-divided into suitably sized paddocks, linked by internal corridors to clear pasture areas to facilitate stock management. Beef store cattle are used as the grazing animal. Hereford cross steers are preferred, because their white face markings facilitate with mustering in the forest. Electric fencing is used extensively and where mains power is not available solar energizers are utilized.

● *Cattle grazing (left of fence) at Maramaru Forest controls vigorous weeds such as pampas grass* [New Zealand]

To improve stock feed, immediately after planting in September, areas are aerially oversown with the legume *Lotus pendunculatus*, cultivar 'Maku' at a rate of 2 kilograms of seed per hectare bulked up with 15 kilograms per hectare of reverted superphosphate. On most sites the fertilizer is not really required for the lotus, it has simply been used as a 'carrier' for the seed.

Stock is introduced to graze the blocks when the trees are 2 years old and the Maku lotus is well established. Stock forage and graze the Maku lotus and pampas mixture, and in this way pampas is controlled. There is little damage to tree stocks. Trampling of young trees round water holes and bedding down sites is a minor problem.

The stock in July 1986 comprised:

150	Cows
1200	Steers
5	Bulls
1355	

The total area fenced is 1,115 hectares. The total area oversown with Maku lotus is 1084 hectares.

Benefits of Maku lotus to the forest are:

a. The removal of pampas improves tree growth.

b. Control of pampas from spreading.

c. Reduced fire hazard.

d. Better access for tending, so reducing costs.

e. Nutritional return through the animal.

NEW ZEALAND

New Zealand Forest Service, Waiuku

The NZFS was given the task of establishing a forest on the light sandy soils at Waiku to prevent soil erosion. Approximately 1000 hectares of Radiata pine have been planted, and much of the area is coming into the second rotation. Pampas became an invasive weed. Grazing experiments were undertaken and Maku lotus was used to enrich the poor quality pasture. The views of Ian Currie, the manager are worth recording. He lists the advantages of Maku lotus:

a. It has a high food value for stock.

b. It is shade tolerant and will grow under trees.

c. It will grow in low fertility soils with a low pH.

d. It fixes nitrogen, increasing soil fertility and tree growth (being evaluated).

e. It is not eaten by rabbits because of its tannin content which also prevents bloating of stock.

f. It has a high resistance to attack by pests.

g. The plant spreads by means of horizontal rhizomes.

On the minus side Maku lotus does compete for water and nutrients and could cause stress for trees during drought conditions.

Maku lotus establishment: Inoculated seed (with bacteria specific to Maku lotus) is sown by air over mature stands of trees in the autumn, just prior to harvesting. A seed rate of 3 kilograms per hectare, with fertilizer added as a filler is adopted. To enhance germination, livestock are introduced either immediately prior to, or after sowing. Logging and restocking with Radiata is then undertaken. Maku lotus takes between 18 months and 2 years to establish itself during which time little grazing is permitted. The plants grow vigorously through the slash and intermingle with forest weeds such as pampas.

Stock management: In-calf dairy cows, heifers, young steers, 3 year old steers and sheep have been grazed at Waiuku. Ian Currie's practical experience in stockmanship illustrates the need for managing each type of stock according to its grazing characteristics in the forest.

Dairy cows only graze in the forest for 4-6 weeks during the dry period in May to July. This annual grazing does not give the desired weed control as the cows are reluctant to forage (Friesians are better than Jersey cows). Subdivision of the compartments and feeding within the forest improves the intensity of grazing. Dairy cows are susceptible to abortion, and the retention of afterbirth following calving if they browze the needles from standing trees or pruning slash.

Young steers or *heifers* have caused damage by bark stripping and Ian advocates the exclusion of young stock from plantations until the trees are 12 years old when the bark is hardened.

Sheep require more expensive fencing. Electric fencing must have 3 strands (2 strands for cattle) with the bottom wire relatively close to the ground, thus causing problems with shorts to the ground vegetation. Providing the understorey vegetation is not too large or vigorous, sheep can be used effectively. Unlike cattle they do not effectively graze a block with thinning and pruning slash present. 'Perendales' are the good foragers, but difficult to handle. Care is necessary during the spring sap flow as severe bark stripping can result once the sheep get a liking for it. Ian also finds that young trees with leaders at browzing height are susceptible to sheep damage.

Beef cattle are most suitable for forest grazing and Ian Currie lists the following factors:

a. They can be grazed in the forest all year round on a rotational basis providing adequate feed is available.

b. They are not adversely affected by browzing Radiata pine foliage.

c. They are good foragers and are stronger so they are able to effectively graze a block containing pruning and thinning slash, and vigorous weeds such as pampas.

Training: Ian advocates training stock before it is allowed into the forest grazing regime. The following steps are listed:

1. Prior to arriving on the forest they should be electric fence trained.

2. After arrival they should be allowed to settle in either an unplanted holding paddock or under mature trees.

   This settling process includes getting used to the peculiarities of the forest environment such as the noise of trees above or crackling sticks underfoot.

3. Once settled, stock must be taught that Radiata foliage and bark are unpalatable and not to be browzed. This is done by putting them into a stand of unpruned 3½-5 year old trees with leaders above browzing height.

   Early browzing of Radiata foliage and bark from branches that are later pruned off establishes a preference for other palatable plants and a dislike for Radiata.

It may be necessary for stock to graze two or three of these blocks before dislike of foliage and bark is enforced. From then on it has been found that virtually no browzing damage occurs, even when stock is grazed amongst one

year old or newly planted trees. At Waiuku they do not yet have the confidence to advocate grazing amongst trees younger than 1½-2 years old, although trials are currently underway.

Tree damage at Waiuku has mainly resulted from trampling near gateways and troughs, or from displacement on slopes. This usually occurs when an area is grazed for the first time and is negligible once a pattern of cattle tracks has been established. On some slopes grazing has to be kept to a minimum or delayed until the trees are strong.

New Zealand Forest Service, Woodstock Forest Farm, Napier

Woodstock Forest Farm is jointly managed by the New Zealand Forest Service and the Department of Lands and Survey with the objective of developing and demonstrating the optimum mix of agriculture and forestry on a hill farm.

Farm details: The farm extends to 2,351 hectares at an altitude ranging from 460 metres to 1,170 metres above sea level. The rainfall is between 1,500 and 1,800 millimetres per year. The project manager is assisted by four permanent staff members. Shearing and fencing is done by contractors and silvicultural work is by NZFS staff.

The stock comprises:

11,500 Perendale sheep
4,200 Hoggets
1,020 Wethers
170 Rams

265 Cows – Hereford and Hereford × Aberdeen Angus
280 Steers and heifers
10 Bulls

Lambing and calving percentages are 84 and 82 respectively.

In planning the development of Woodstock, four basic land uses have been allocated:

	Current Area	Proposed Final Area
(a) Open farmland	1,106 ha	538 ha
(b) Forest grazing	532 ha	1,100 ha
(c) Rough grazing	332 ha	332 ha
(d) Reserve	382 ha	382 ha
Total	2,352 ha	2,352 ha

Woodstock farmstead has been sited in an agricultural unit of 340 hectares in the centre of the block. It is well sheltered, easy contoured country with a carrying capacity of 15 livestock units per hectare (1 ewe = 1 livestock unit). Development in this area includes the farm buildings and stock handling facilities. The main aim is to provide a clear base to enable the maximum utilization of the forest grazing areas.

Silvicultural management: Trees are planted into closely grazed pasture. After planting, grazing is stopped for about 20 months until the tree leaders have grown above browzing height. Trees are released from grass competition by spot spraying before and after planting.

Early planting on Woodstock were at 1,500 stems per hectare at 3.6 × 1.8 metres spacing. In the winter of 1984 a series of spacings were tried. Trees planted in groups of 5 from seed orchard trees, or in groups of 3 when grown from cuttings, at 10 metre centres seem most promising. These planting rates represent 500 per hectare and 300 per hectare respectively. Setting out the groups is found to be a little more difficult than planting in rows. However, tree selection for pruning and thinning is simplified. Pruning and thinning debris will be concentrated within the groups leaving most of the pasture free of debris.

Pruning and thinning schedules are still under development with the main aim of maximizing profitability.

Current indications are:

1. that pasture production and availability is maximized:
   - with trees planted wide apart;
   - with early and severe pruning and thinning to minimize shading and debris build-up;
   - with low final tree crop stockings.

2. that profitability is maximized:
   - with fewer trees planted, pruned and thinned;
   - with severe, early pruning to minimize defect cores;
   - at final tree crop stockings of about 100 per hectare;
   - by harvesting at year 26.

Grazing management: Before planting, perimeter and internal fences are made completely stockproof so that grazing can be properly controlled. At present, stock is completely excluded for nearly two years to prevent damage, but experiments are planned to introduce weaned lambs earlier. Cattle are excluded for 4-5 years to prevent bark stripping problems.

Utilization of pastures planted with trees is being recorded for comparison against the carrying capacity of open pasture. Results to date have been encouraging and, if the agroforestry compartments follow predictions, they will offer at least 50 per cent of the open pasture grazing potential over the 25 year rotation.

2.10 Joint Ventures

Farmers in New Zealand have the basic land resource but often lack finance and skills to undertake agroforestry. On the other hand there are two sources of capital available for investment in farm forestry:

a. The city dweller or businessman who hankers for a rural interest or a tax haven.

b. The company with money to invest as part of a portfolio or a direct interest in ensuring a future supply of timber for a processing mill or wholesale market.

Benefits

Joint ventures provide benefits for both parties.[7] But, as with all contracts, particularly long term ones, the agreement must be exhaustively researched, extensively documented and equitably based. This is even more important because personalities may change and objectives may shift or contractual interest sold during the time of the agreement.

Government involvement

The 1981 New Zealand Forestry Conference recommended that greater emphasis should be placed on the role of the small grower in increasing the nation's forest estate during the 1980s. It was hoped that small growers should account for planting 30 to 40 per cent of all new forests by 1990.

The Government provided legislation to give long term legal security under the Forest Rights Registration Act 1983, and technical advice and assistance through NZFS in setting up joint ventures. The 1983 Act provides an effective method of registering on the title of the land. A right is given by a landowner to an investor to grow and harvest trees. The right once given is independent of the landownership which may change from time to time. Such joint ventures are not a form of leasing. In a joint venture the owner retains occupation of his land and, depending on the terms of the agreement, may utilize grazing, fencing materials or other rights such as water supply access.

Current schemes

Two alternative methods are used to calculate each party's contribution:[8]

1. Pre-establishment calculations – determining the inputs in advance, from model calculations.

2. Calculation at harvest – determining the share of profits at the end of the venture by recording the inputs at the time they occur throughout the rotation.

In each case the total inputs of the landowner and the investor are compounded to determine the share of profits that each partner will receive. The first method has been favoured by many because:

a. they are easier to calculate and do not rely on keeping accounts;
b. division of proceeds is certain from the outset;
c. both parties will have incentive to save on costs;
d. frequent reviews and consequential disputes are avoided.

On the other hand parties may wish to build into the agreement some provision for adjustment should a major change occur, like the alteration of planting grants.

Features of a joint venture agreement

1. *Length of contract:* often related to a single crop rotation, bearing in mind the marketing objective and personal objectives such as tax efficiency.

2. *Calculating other benefits to the farmer:* benefits such as grazing will be a bonus to the agricultural enterprise, but are often left out of the calculations because of the similar benefit to the forestry enterprise in the breakdown of slash and nutrient, e.g. from animal manure.

3. *Management provisions:*
   a. A Management Plan is essential and should be administered by a manager or consultant with farmer involvement.
   b. Insurance.
   c. Forest damage.
   d. Default – arrangements for indemnity and arbitration.
   e. Grant and revenue taxation – distribution and allocation.
   f. Leasehold/mortgages – must be carefully studied.
   g. End crop – if not sold on open market independent valuation may be necessary.

Comment

Joint ventures provide a useful method of bringing the resources of land, finance and skills together with marketing opportunities. With agroforestry, the farmer will be able to continue grazing after tree establishment and still derive agricultural income until the canopy closes, whilst maintaining a share in the value of the timber crop. This will lead to the creation of a considerable capital sum that can be allocated for long term provisions including tax efficient arrangements for succession.

In practice the rental charge for the land resource equates to between a quarter and a third of the total inputs. For the desirable 50:50 share of the value of the final crop the farmer must make a significant contribution towards the establishment or management of the tree crop.

2.11 Planning Control

The Town and Country Planning Act 1977 requires local authorities to prepare District Schemes aimed at guiding and regulating land use. The discretion lies with each local authority as to how they treat forestry but substantial new planting can be subject to planning control if it infringes on other public interests. The Ministry of Works and Development have carried out a National Land Resource Survey classifying land according to its capability for agriculture and forestry. This information is used as a key document in drawing up local District Schemes.

In areas with high quality farmland there can be a presumption under District Schemes against large scale forestry on the better quality land. Government departments such as MAF, NZFS and Lands and Survey are often consulted during the compilation of the District Schemes, and give evidence at public hearings in cases of dispute. Agroforestry is not usually caught by planning controls even if there is a presumption against forestry in an area, providing it can be argued that the forestry enterprise will allow agricultural production, i.e. by grazing. Similarly most District Schemes do not limit farm woodlots on areas of less than 20 hectares per property. As market forces would make it uneconomic to grow trees on very high quality and versatile agricultural land the 'threat' to agriculture does not materialize. Accordingly the planning system does not form an obstacle to farm forestry investment. In practice the detailed requirements set out in District Schemes, whereby full details of planting, timber extraction etc. for new plantations must be notified to the local authority, are largely ignored.

Comment

Market forces effectively decide the land use division between agriculture and forestry and there seems little reason to mirror this in local authority bureaucracy. The growing environmental lobby may well pressure local authorities to regulate land use for other reasons. It can be argued that significant afforestation should have some independent assessment, perhaps through the planning system, if this can be sensitively tuned. However, agroforestry is small in scale and there is no evidence to show that this type of scrutiny could be justified.

2.12 Environmental Issues

Background

Most pastoral farms in New Zealand are on land cleared from native scrub and woodland in relatively recent times. Indeed some of the farms visited had only been cleared literally two or three decades ago, and the process has not yet finished. Many farms were cleared completely without regard for the landscape and wildlife. Although there are considerable areas of native woodland left in New Zealand it is not so intimately mixed with farmland as in the UK. Consequently there is now a small but significant reaction by enlightened farmers to put something back into the landscape and a growing pride in maintaining remnant areas of native vegetation.

Farmers attitudes

Most farmers met wanted more from their agroforestry than maximum financial return from Radiata pine. Although this species was invariably the principal crop other trees including Eucalypts, Macrocarpa, Douglas fir and Walnut are commonly planted for amenity and diversification of interest.

Advisory services

The New Zealand Forest Service (NZFS) does not have a responsibility for providing advice on the conservation and management of natural and semi-natural woodland. This is carried out by a separate government agency.

Whilst the NZFS staff met on the study tour were conscious of environmental issues it was clear that the pressures were not at the same level as in the UK. The general impression gained was that forestry, including agroforestry, should be considered and promoted on its financial merits alone. For example, the great thrust of research and advice is concerned with the single exotic species Radiata pine, because of its outstanding performance and profitability.

Comment

When existing natural vegetation is cleared to make way for agroforestry then there is a loss of wildlife. But more often the trees are superimposed on improved grassland or poorer quality unimproved pasture. Because another tier is added to the vegetation, and the ground vegetation is often never completely shaded out, it is reasonable to suppose that the wildlife implications are not so severe as with conventional plantation forestry. Given a mosaic of open pasture and trees, agroforestry may well benefit some wildlife and lead to the diversification of species.

Shelterbelts produce a particular landscape by compartmentalizing the land and reducing the sensation of openness. *En masse* they give a unique character to the landscape. For example, the tightly enclosed kiwi fruit orchards in the Bay of Plenty are similar to the hop gardens of Kent, whilst the extensive landscape of the Canterbury Plain in South Island with regularly spaced coniferous belts is quite different from the open undulating Canterbury Plain of Wiltshire.

Timberbelts which are grown for timber produce a strange appearance because they are commonly pruned to a height of 6 metres. However when they are grown as shelterbelt with a supplementary species, or a second row of the same species, only 50 per cent of the trees are pruned so the 'lollipop' appearance is diguised.

Silvopastoral areas have considerable impact on the visual environment which is quite different from large-scale afforestation.

The following personal impressions of agroforestry were gained during the study tour.

Positive factors:

a. Plantations are small in scale.

b. Agroforestry gives variation in size, shape, density, age and, to some extent, species.

c. Plantations often follow contours and natural features because farmers tend to plant poorer land and steep slopes.

d. New Zealand farmers have a 'feel' for the landscape, because it is their home environment and often leave native trees, thus providing variation for the eye.

e. Because the density of trees is low, the ground vegetation and the trees produce a visual mixture that is more interesting than a monoculture of trees or grass.

f. Provision of interest and contrast.

Negative factors:

a. Pruning produces a highly unnatural tree shape which is more exposed to the eye in low density agroforestry. Skyline planting can produce an obtrusive row of 'lollipops'.

b. Plantations in areas of scrub and other semi-natural vegetation displace landscape features and wildlife habitats.

c. Plantations can provide unwelcome contrast and subdivision of some open landscapes.

d. New techniques of straight wide-spaced rows produce an unnatural striped appearance, but this largely disappears at later thinnings.

Because of the importance of environmental issues in the UK, attention must be paid to wildlife and amenity values in the development of a new system. The impression gained in New Zealand is that, providing attention is paid to skyline planting and the avoidance or amelioration of planting in rows, then agroforestry can blend with the landscape and, in some cases, enhance it. Research by ecologists is needed to evaluate the impact of agroforestry on flora and fauna.

2.13 Agroforestry Research

The Forest Research Institute (FRI) was established in Rotorua in 1947 as the research arm of the New Zealand Forest Service (NZFS), and has grown to cover all the main areas of forest and forest-product research. FRI staff now total 480 and the current budget is NZ $26 million (1986). With the corporatization of NZFS, FRI is to be re-formed as a research co-operative designed to seek broader based funding and to encourage a wider range of interests to have a direct say in management. FRI research into agroforestry began in 1970. The FRI Agroforestry Project Team was established in 1983 and, with assistance from MAF, has added the agroforestry component (physical and economic) to a series of computer-based models of Radiata pine. Forest grazing with *Maku lotus*, and timber production from shelterbelts are also being evaluated.

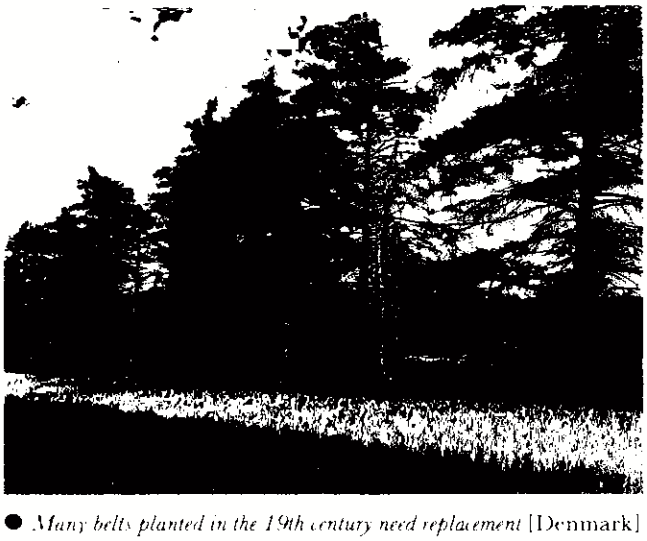
● *Shelter belts are planted to reduce soil erosion in arable areas of Jutland* [Denmark]

3

Denmark – Farm Shelterbelts

3.1 Background and Government Support

The importance of shelterbelts has long been recognized in Middle and Western Jutland for the stabilization of drifting sandy soils and the alteration of the microclimate to favour plant growth. Government support for shelterbelts dates back to 1868 and the belts planted over the next hundred years played a major role in developing the countryside and facilitating modern agricultural cropping.



● *Many belts planted in the 19th century need replacement* [Denmark]

Early design concentrated on the planting of single rows of softwood species, typically Sitka spruce, in lines 100 metres or so apart. In recent years these belts have become overmature or affected by disease, and a new programme of Government support was introduced in 1976. 'Hedeselskabet', the Danish Land Development Service, was made responsible for administering the current subsidized planting programme. Although grants are still available for individual schemes (50 per cent of the cost of plants), the main thrust is directed to collective schemes whereby belts are planned over a large district involving a number of farms. Each scheme must be for at least 20 kilometres of 3-rowed shelterbelts. The plan must show a systematic planning of the belts to give a comprehensive shelter effect over the district. Each year farmer representatives of local counties plan a programme, often in conjunction with the local Hedeselskabet adviser. In the past, planting programmes were carried through by 'Planting Guilds' of co-operating farmers but currently most of the planting work is planned and carried out by Hedeselskabet itself. Each of the 20 outstationed advisers from Hedeselskabet is responsible for planting some 40-50 kilometres of belts each year, resulting in an annual programme of 900 kilometres per year. 250 workers are directly employed on the programme during the planting season.

The programmes are completely voluntary and no pressure is applied on farmers to co-operate; however most farmers need no convincing of the value of shelterbelts and are keen to join (over 80 per cent of farmers co-operate with most schemes). Advisers consider that this is the most effective method of operation as they can oversee the planning, all stages of clearance, planting, beating-up, and subsequent weeding during establishment.

Individual contracts are drawn up between the Hedeselskabet and the farmers concerned. The department undertakes the site preparation and silvicultural work including three years of weeding, whilst the farmer undertakes to fence against livestock and cope with some damage to adjoining crops by the heavy machinery used in the operations. After three years the farmer is sent a leaflet describing what can go wrong with new planting schemes and is invited to write to the head office at Hedeselskabet to confirm that the work has been satisfactorily completed. Any subsequent remedial work costs less than 1 per cent of the budget for the programme, and is recognized as excellent 'PR'. Following the satisfactory establishment of the belt the farmer is invoiced for 50 per cent of a fixed standard cost of establishment which includes labour and plant materials.

3.2 Effects of Shelter

Figure 5 summarizes the perceived advantages of shelterbelts.[1] Closest to the shelterbelt, the wind velocity is reduced to 35-40 per cent of the free wind velocity, and the downwind shelter can be measured to a distance of about 30 times the height of the hedge. Water evaporation is reduced by up to 40 per cent in the lee of the belt whilst day air and soil temperatures are raised by about 1°C. Mr Chr Als, who heads the Hedeselskabet shelterbelt team, considers that yields of crops such as maize, potatoes and grass will increase by 7 per cent with an integrated system of belts, even after taking into account the loss of land occupied by the trees.

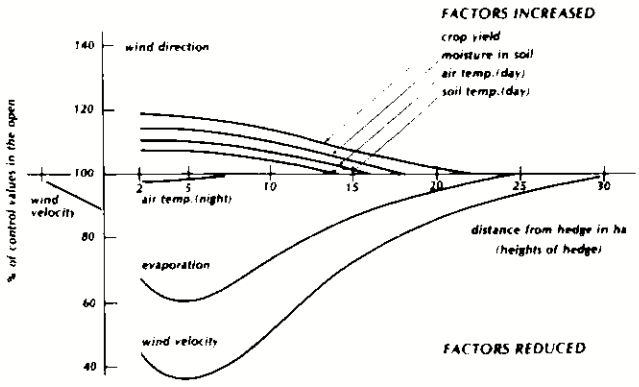


Figure 5: The effects of shelter. *Source, Hedeselskabet 1976*

3.3 Planning and Design

Hedeselskabet staff stress the value of comprehensive planting plans and claim to reduce the sea wind velocity by 50 per cent in areas where planting is well planned. District plans are also designed to provide economy of scale for planting and subsequent management during the three year establishment period.

● *Trials are being conducted by Hedeselskabet to find the best combination of trees and shrubs - here is a 6 year old "Coastal mix" of* Rosa rugosa, Salix cinerea, Pinus mugo, Malus sargentii and Quercus robur [Denmark]

The optimum spacing for shelterbelts is considered to be 200-400 metres apart to enable reasonably large enclosures to be formed, commensurate with effective shelter provisions. Ideally, the work should be phased over several decades to ensure continuity, and allow for eventual replacement. Planting is arranged to provide tall long-lived belts of trees that will be a permanent part of the landscape. Because planting is planned on a collective, rather than an individual farm basis, it is possible to make more use of farm boundaries for siting belts and reduce the amount of planting within individual holdings that may inhibit flexibility of cropping.

The objective is to provide tall, durable hedges that will provide reduction of wind speed over the maximum areas without causing turbulence. Hedeselskabet aim for a porosity of 40-50 per cent and, in practice, plants 3-row belts of mixed deciduous trees and shrubs. Rows are spaced 1.2-1.5 metres apart and the plants are at 1 metre intervals down the row.

Three categories of plants are used:

1. Fast growing nurse trees such as grey alder *(Alnus incana)* to give protection for the permanent trees and to provide shelter during the early years of establishment (after four or five years).

2. Long-lived and medium to tall species such as oak *(Quercus robur)*, elm *(Ulmus glabra)*, and rowan *(Sorbus aucuparia)*. They form the eventual core of the belt at the expense of the nurse trees.

3. Shade tolerant bushy shrubs, which help with initial weed suppression, later provide low level shelter.

3.4 Choice of Species

Tree and shrub species are chosen to match the site conditions and to suit other requirements in addition to shelter. No attempts are made to grow timber quality trees and the only output is some firewood from thinnings and the removal of belts at the end of their rotation. Indeed the growth requirement of well branched trees to provide the maximum filtration of wind is recognized to be quite contrary to the knot-free objectives of quality timber production. Hedeselskabet acknowledge this by producing separate strains of plants in their nursery for shelterbelts and for commercial forestry. Three species of main crop trees are always planted. One is always oak – others are often maple, elm, ash, cherry or beech. Among the shrubs hawthorn *(Crataegus monogyna)*, lilac *(Syringa vulgaris)*, Snowy mespilus *(Amelanchier spicata)*, grey willow *(Salix cinerea)*, and alpine currant *(Ribes alpinum)* are common. Grey alder *(Alnus incana)* and black alder *(Alnus glutinosa)* are often used as nurse trees. There are always at least 14 species planted in a belt, chosen from a list of more than 50 species.

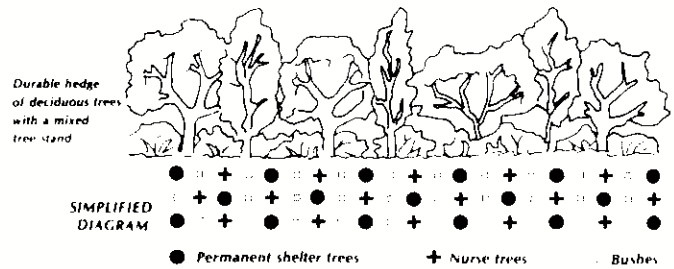


Figure 6: A typical mixture of trees and shrubs in a Danish shelter belt.
Source Hedeselskabet 1976.

3.5 Environmental Issues

Hedeselskabet undertakes 90 per cent of all shelterbelt planting in Jutland. It raises its own plant material and takes care to utilize local or closely related genetic stock. Wildlife and amenity implications are recognized by the planting of native hardwoods together with some exotic flowering shrubs such as lilac *(Syringa vulgaris)*. Farmers and advisers seem well aware of the importance of shelterbelts to the amenity of the farmed countryside. The benefits for bee keeping and game rearing are also recognized. Regulations, such as the prevention of planting within 100 metres of ancient monuments and within 10 metres of streams, help to safeguard other features in the countryside. These shelterbelts are so highly esteemed that they are considered agriculture's most positive contribution to the environment.

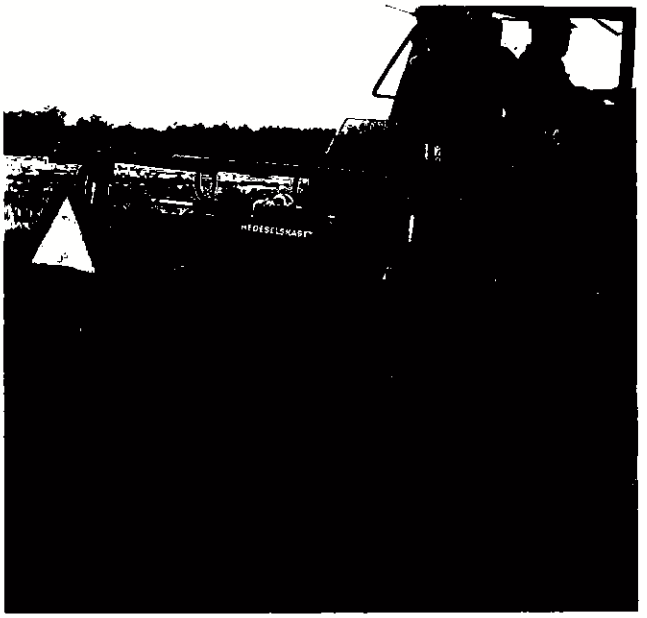
3.6 Planting and Establishment Techniques

Many new belts are direct replacements of older shelter hedges. To avoid disease problems the stumps and roots are usually removed during site preparation. A planting bed is then prepared by ploughing. Planting is often by tractor-drawn machines and mechanical cultivation is used to reduce weed competition – at present pre-planting herbicides are not used. Fertilizer is not separately applied unless the soil is poor. Farmers are encouraged to include the belts when adjoining crops are fertilized.

● *A semi-mature 18-year old belt with uniform density from top to bottom reduces wind velocity without causing turbulence* [Denmark]

Inter-row cultivation is used in the first two years to suppress weeds. Five passes are required in the first year, and hand hoeing down the rows is carried out as necessary. Beating-up is undertaken in the second planting season if the plant failure rate is significant. In years two and three chemical weed control with Atrazine or similar is applied with a view to handing over the belt to the farmer at the end of the third year.

Subsequent management includes the pruning or removal of nurse trees, and the side trimming of belts to reduce encroachment on farmland and promote bushy growth.



● *Inter-row cultivators are used for weeding during the establishment of new belts* [Denmark]

3.7 Research and Development

In 1981 trial plots were established by Hedeselskabet on several sites to test 10 different mixtures under a range of conditions. Results will be available in due course.

Comments

To some extent the large number of different species used in each planting scheme is insurance against failure of one or two components. The earlier practice of growing single species in one or several rows produced failures, e.g. the fast die back of willow *sp.* and Lombardy poplar *(Populus nigra var Italica)*.

This system is designed for crop protection in the lowlands and may well have application in eastern England where soil erosion is a problem. Three-row shelterbelts provide a sensible alternative to the re-introduction of hedgerows which no longer have a livestock retention function. When planned on a district basis considerable landscape improvement can be achieved with great benefit to wildlife. The land taken up by the belt can be kept to a low level by the adoption of a planned cycle of trimming.

● *Farm forestry is small in compartment size. Conifers can look attractive, if not grown as an extensive even-aged monoculture* [Sweden]

4

Sweden – Farm Forestry

4.1 Introduction

Sweden is over 80 per cent self sufficient in food, with some commodities now in surplus. Lakes, waterways and wetlands total 11 million hectares whilst arable land, which is mainly situated in the south, is not quite 3 million hectares. Fifty-seven per cent of the land surface, totalling 23.4 million hectares, is covered by forest.

The proportion of growing stock consists of 47 per cent Norway spruce *(Picea abies)*, 38 per cent Scots pine *(Pinus silvestris)*, 10 per cent birch *(Betula pubescens and B. pendula)* and 5 per cent other deciduous trees. Lodgepole pine *(Pinus contorta)* is now being planted in northern Sweden.

In the extreme south the rotation lasts about 70 years, by which time the trees are, on average 30 metres high and have a diameter of 30 centimetres. Corresponding figures for the far north are about 140 years, 15 metres and 20 centimetres.

Of the woodland area 26 per cent is owned by public bodies, 25 per cent by forest companies and 49 per cent by private persons. Most of the public forests are concentrated in central Sweden, whilst private ownership is predominant in southern Sweden and distributed amongst about 240,000 holdings.[2] On half of these holdings, forestry is conducted in combination with farming. The average area of production forest land per holding is approximately 45 hectares, but it is generally accepted that over 100 hectares of productive forestry is required to provide a family with a basic livelihood in southern Sweden, and considerably more in the north.

In the past two hundred years Sweden has developed from a purely agrarian society to an industrialized nation. Today, only 4 per cent of the working population is engaged in agriculture and forestry.

The standard harvesting practice is to clear cut even aged stands. In recent years 210,000 hectares have been clear cut annually. Of this area, 70 per cent has been replanted and the rest allowed to regenerate naturally. Of the 450 million plants set each year, just over half are bare rooted and the rest are potted in peat. Between 1,500 and 3,000 plants are set per hectare. Where natural regeneration is practiced 75-125 pine trees per hectare are left on the clear cut area and the ground is scarified mechanically where conditions permit. When the stand reaches a height of 2-3 metres, a pre-commercial thinning is carried out. Up to 4 commercial thinnings are taken during the rotation. Local authority regulations often prevent the use of herbicides for weed and broadleaved coppice control. About 140,000 hectares are fertilized each year, mainly by aircraft and approximately 20,000 hectares are drained annually. Attempts are being made to make more use of biomass arising from forest residues, which is also claimed to improve forest hygiene.

The forestry sector employs 200,000 people full-time or part-time, of the 4.4 million national labour force. In the north, and in the interior of central Sweden, forestry is particularly important because of the lack of alternative employment opportunities. Forestry products amount to 18 per cent of Sweden's exports but, because forest product imports are very low, the forestry sector accounts for over half of the country's net exports.

Some current issues

1. The growing stock of timber on forest lands has risen throughout the 20th century. Annual growth is around 85 million cubic metres whilst the drain (felling and natural mortality) is currently only about 65 million cubic metres. The Government wishes to close this gap because the excessive proportion of mature timber reduces the rate of return. In 1973 the Government Commission of Inquiry about forestry policy recorded that 30 per cent of Sweden's forestry yields less than a 4 per cent increment for this reason.

2. Privately owned forest land lies in the more productive south of Sweden and it is owned by about a quarter of a million individuals. Forest holdings are mostly small. More than half of them are less than 25 hectares and the woodland is often scattered. 30 per cent of forest owners live away from their land in cities and towns. Many of these holdings are not capable of providing a livelihood and the income of the owners is often entirely derived from other sources. These holdings are regarded as nostalgic recreational resources visited by their owners for hunting, berry picking etc. The owners often lack motivation to undertake commercial management.

3. Agricultural surplus has been a problem in Sweden for over a decade. Of the 3 million hectares of arable land about 0.5 million hectares are now in surplus and this is estimated to increase to about 1 million hectares by the turn of the century (Karl Iver Kumm, 1987). Surplus grain is given a 40 per cent subsidy for export onto the world market, and policy makers struggle for long term solutions. Current measures are the payment for set-aside to fallow agricultural land. There are proposals for introducing tree planting grants on arable land and the argument continues as to whether the Government or the farming industry should finance the programme.

4. Traditionally many farmers have viewed their woodland as something that is 'just there' and to be exploited by felling as and when capital investment is required for the agricultural enterprises, such as a new cattle shed or a land drainage scheme. Most

owners have an affection for their woodland but are unaware of the opportunities and advantages of positive woodland management.

5. Environmental interests conflict with modern forestry technology, e.g:

   a. Clear cutting temporarily degrades the amenity of critical areas, such as the environs of skiing resorts in Jamtland.

   b. Modern forestry reduces the quantity of mature trees with lichen, essential winter food for reindeer that are traditionally husbanded by the Lapps in northern and central Sweden.

   c. The cessation of farming in the more remote areas allows scrub to develop on former grazing land. This in turn reduces recreational access and degrades some traditional landscape and wildlife features.

4.2 Government Policy and Implementation

Both agriculture and forestry are tightly controlled and directed by the State. For instance a private individual cannot simply buy a farm and start up in business. He has to obtain consent from the County Board and 'prove' that he is suitably qualified. In effect, the price of land is regulated by the State and investment purchases by absentee landlords is not allowed. Similarly, consent has to be obtained to plant trees on arable land, and until recently, this was unlikely to be granted despite long-standing agricultural surplus problems.

Forestry legislation started in the 17th century when Sweden was the largest exporter of timber in Europe. In 1908 Parliament made a law to prevent forest companies from buying more land and has virtually frozen the structure of ownership to this day.

The *Forestry Act 1979* introduced a new forest policy for Sweden, aimed at directing the proper utilization of forest land. The Act stipulates that forestry and forest land shall, through suitable utilization of the timber production capacity of the land, be cared for so as to produce a valuable timber yield over a long period of time. This care must give consideration to nature conservation and other public interests.

The Forestry Act[3] requires:

- after final felling, new trees must be regenerated or planted;
- dense new and young forest must be thinned;
- some proportion of the forest which is ready for final felling must be felled;
- special measures are to be taken to combat insect damage;
- there must be a forestry plan for every forestry property;
- final felling of some forest land is subject to rationing.

The legislation provides a framework and requires the National Forestry Board to draw up quite detailed regulations. For example, if the forest is so sparse or so poor that the production capacity of the land is not being fully exploited the owner is required to fell the forest and replace it with new stands. At present, appeals against County Board decisions are handled administratively by the National Board of Forestry and, ultimately, by Parliament.

The Association of Swedish Forest Owners is content with the main principles of the Act but does not want the detailed regulations and quotes inflexible planting densities set out in rules of the National Board of Forestry. The Association is opposed to these measures and is lobbying for an independent appeals procedure.

The Broadleaved Deciduous Forestry Act 1984[4] aims to promote the sound management of deciduous woodland. Consent is required for felling which is often subject to conditions requiring replanting with broadleaves.

Administration

Government forestry policy, under the umbrella of the Department of Agriculture, is administered by the National Board of Forestry at Jonkoping, and 24 County Forest boards. The County Boards are responsible for extension services and the implementation of forestry legislation, the distribution of grants and the development of forestry plans.

Fiscal policies

Government grants concentrate mainly on long-term improvements such as forest roads and drainage, and on those areas of land where production conditions and economic factors are the poorest. Grant is not normally paid on the cost of re-establishing forests after clear felling.

Taxation on both income and capital is directed towards individuals on an ability to pay basis. The national portion of income tax is progressive whilst the local portion varies from one municipality to another. Income tax on woodland is only due when income arises from harvested timber. Thus yield in the form of increment on trees does not result in taxation.

One of the most important income tax concessions is the facility for postponing payment on timber sales for up to 10 years, with the facility for off-setting certain expenditure associated with the holding. In effect, this is to the advantage of resident forest farmers who can get taxation exemptions for expenditure on a variety of items ranging from land improvement to central heating in the farm-

house. Non-resident forest owners who have income from other sources have no opportunity of off-setting forestry revenue, and heavy taxation can be a discouragement to commercial management.

The assessment of taxable capital in forestry is based on the value (termed taxation value) of forest land and growing trees according to a valuation procedure carried out every 5 years. Taxable capital, is however, only 30 per cent of this taxation value and there are allowable charges on the land. In 1983 Capital taxation was levied on capital assets exceeding SEK 400,000 (£40,000) at rates ranging between 1.5 and 3 per cent.

General forest inventory

Swedish legislation dated 25 May 1983 requires every forest owner to have an up-to-date manangement plan for his forest holding. The plan must include statements of the need for silvicultural measures, suitable areas for felling etc. As a pre-requisite of these specific management plans the Swedish Parliament decided that a general forest inventory should be conducted. This is aimed at providing an information base for privately owned forest land to facilitate operational planning by the Forestry Board. It is also intended to constitute a basis for the forest management planning of privately owned property. Mapping is to a scale of 1:10000 or 1:20000. Data recorded includes:

Area: Compartments are identified by mapping co-ordinates.

Land class: Is an essential component as it indicates whether the land is suitable for forestry.

Vegetation type: (Optional) Vegetation provides an indicator for silvicultural operations such as scarification, and for other land use interests such as nature conservation.

Site quality class: This provides long term management information.

Terrain class: (Optional) Useful for planning logging operations.

Age:

Cutting class:

Growing stock: Used to determine maintenance measures, particularly thinning.

Tree species:

Distribution: Indicates which regeneration treatments are suitable and priorities for thinning and final crop.

Diameter: (Optional) Used for thinning assessment and certain property valuations and taxation assessment.

Verbal description: To provide any additional commentary.

Maintenance needs: Essential for silvicultural planning.

Degree of priority: Because many owners will be faced with a backlog of maintenance, priorities are clearly needed.

Subsidies: Where situations arise that qualify for subsidies then basic data for eligibility assessment is provided.

Mapping is carried out by trained Board of Forestry technicians, who rely heavily on aerial photography interpretation.

Forest management plans

Forest management plans are offered to owners soon after a General Forestry Inventory has been prepared for an area. The service is available from County Forestry Boards or private sources such as Forest Owners Associations. One such association, Sodra Skogsagarna, charges SEK 65 per hectare (£6.50) which is competitive with the County Board and other sources.

By 1993 the law requires all forest owners to have a 10 year management plan, although for holdings of less than 20 hectares the plan can be less detailed.

Comment

It remains to be seen how successful the Government's attempt to regulate forestry through legislation will be. Already there are signs of disquiet from the owners organizations about the detailed regulations drawn up by the Board of Forestry and the need for an independent arbitration service. The concept and practice of a National Forest Inventory followed by individual management plans seem an excellent basis for sensible land management.

4.3 Woodland Management Activity by Forest Owners

Surveys by the National Federation of Forest Owners indicates that, in recent years, the proportion of woodland management carried out by Association members and their families, as opposed to contractors, has increased.

To some extent these results are surprising because certain factors mitigate against this trend, e.g. increased mechanization in harvesting the final crop, the large proportion of owners who live away from their land and the uneven age structure of owners (22 per cent of forest farmers are over 67 years of age).

Agricultural surplus problems and the small size of individual farm units limit the contribution that agricultural enterprises can make towards increasing profitable activity on such holdings.

From the 1850s to the Second World War it was usual for private owners to farm in summer, and use the same horses and equipment in the forest during the winter.

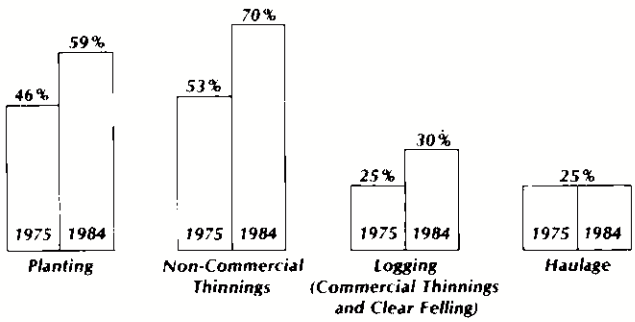
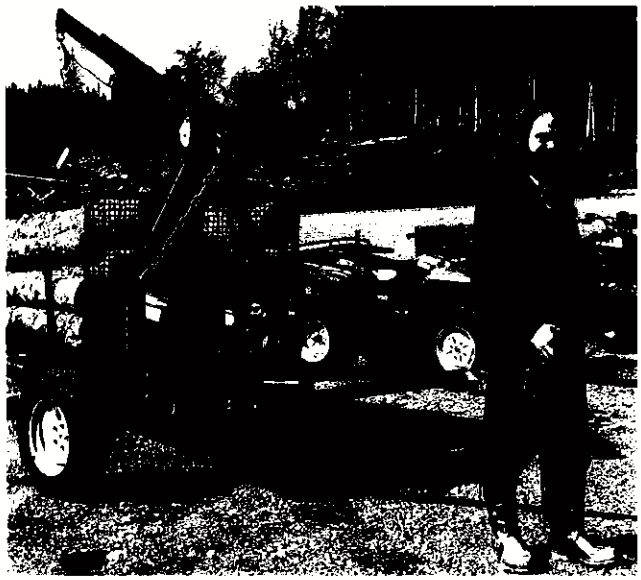


Figure 7: The proportion of woodland management undertaken by Forest Owners Association members.
Source: National Federation of Forest Owners 1987.

Since the war further industrialization caused migration to the cities. Today, of the 240,000 forest holdings less than 10,000 owners obtain over 50 per cent of their income from forestry and farming.



● *The Royal College of Forestry at Garpenberg has a Small Scale Technology Unit to develop farm based techniques for silvicultural management* [Sweden]

Many authorities and advisers consider that greater possibilities lie in the forestry side of forest farming. Because of economic problems government will not provide all the financial solutions. One answer is for owners to go back to the traditional relationship between farming and forestry but use modern technology and methods. Firstly owners can increase timber extraction to match the growth rate and, secondly, the owner can undertake more silvicultural work himself. In recognition of this, and spurred by the large amount of thinning required for the large areas planted in the 1950s, a research group for Small Scale Forestry was established at the Royal College of Forestry, Garpenberg. The group has an important role in the design of machines and working methods suited to the special needs of small-scale forestry. Figure 8 illustrates the regional variations in methods used for haulage and the categories of management employed in felling.

Two distinct streams of technology are now developing, to meet the needs of large scale forestry and the private woodland owner. The complete harvesters associated with contractors and 'company forests' have their place for large scale work but smaller machines, often based on the farm tractor, have a role in working small compartments on farms. On difficult terrain, or where there is a risk of damaging growing trees, small scale technology has considerable advantages.

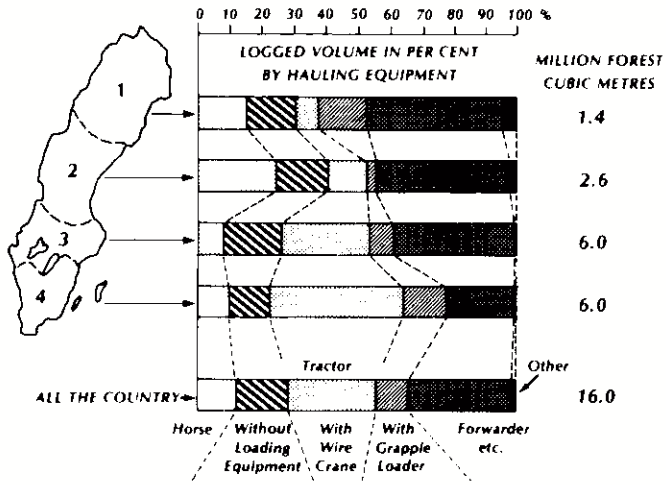


Figure 8: Regional variation in equipment used for timber haulage to the roadside.
Source: Royal College of Forestry

During the 1950s thinnings accounted for 50 per cent of the total harvesting volume, while today it is only 20 per cent. With the national need to increase thinnings, the research group argues that small-scale technology has advantages over large forestry machines, in that it results in less damage and wastes less land with strip roads. Various types of 'mini-skidders' and self propelled trailers with grapple loaders are being tested and developed at Garpenberg. Other equipment based on the farm tractor is being developed.

Only 1.5 per cent of timber extraction in Sweden is carried out by horses (Lars Hedman, 1987).[5] There are 25,000-30,000 haulage horses in the country and it is estimated that about half are used in logging. Advantages are that they cause no damage to young stands when extracting thinnings, and they can work in difficult terrain. But the work of hand-loading timber and managing horses is hard. In the words of Lars Hedman – 'young people do not like the hard work and the old people are not strong enough'. Costs of extraction can increase by up to 50 per cent when horses are used and, because of weight problems, there is unlikely to be an easy way of mechanizing the loading operations. Horses and mini-skidders have the advantage of reducing the number of access roads required and can even lead to lower pick-up costs for the forwarder.

Comment

Horses have a very limited place with the committed

enthusiast but have very few advantages over small-scale machinery such as the mini-skidder or tractor mounted winch. The optimism voiced by some advisers in Britain about the introduction of the horses seems quite misplaced. On the other hand the new 'iron horses' show considerable promise for small scale operators. An interim range of machinery such as tractor mounted harvesters and loaders is more appropriate for small scale contractors or forest owners who undertake work on neighbours land.

4.4 Forest Owners' Associations and Marketing

The 12 forest owners' associations in Sweden have some 80,000 members with a total of 5 million hectares of forest land. The associations were formed to improve the financial yield of forestry operations among their members, and today they are a major force in marketing. Most have their own sawmills, and some associations have pulp mills and other processing plants.

The associations are constituted as co-operatives whose members jointly own the company through their contribution payments. Their primary functions are summaried:

1. Provide a market for timber in competition with other private sector markets.
2. Undertake timber conversion and processing.
3. Offer a technical service to members.
4. Provide a contracting service for silvicultural management operations.

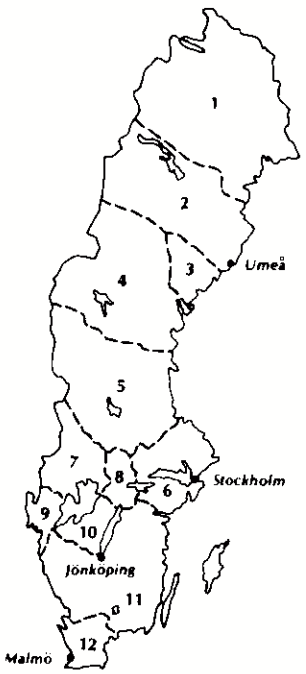
The National Federation of Forest Owners' Associations is the parent body that deals with major policy issues and negotiations with Government about all aspects of forestry support and regulation. It also plays a major role in negotiating prices with the pulp and processing industry.

Sodra Skogsagarna

The largest association is Sodra Skogsagarna in southern Sweden. This is a major co-operative of 22,000 members with 1.2 million hectares of productive forest. The annual timber trade is 7 million cubic metres with sales of SEK 2,244 million (over £200 million) and a workforce of 1,139. Its sister industrial company has 3 pulp mills, 3 paper plants and 8 sawmills.

In 1979 the collapse in timber prices caused a financial crisis and members withdrew support. The Swedish Government acquired a 40 per cent shareholding in the industrial company but, in 1984, an upturn in the market enabled the company to repurchase the Government's share with interest.

Forest owners are free to join or leave the association. It is funded by a 4 per cent levy of all timber sold to the



Association 1983	No. of members	Total holdings in 1000 hectares	Timber purchases in 1000m³ (solid measure under bark)
1 Norrbottens läns Forest Owners' Association	5,587*	410	401
2 Västerbotten Forest Owners	9,097*	530	575
3 Örnsköldsvik Forest Owners'	2,902	220	314
4 Norrskog	13,399	984	1,790
5 Mellanskog Forest Owners' Association	12,529	868	2,415
6 Mälarskog	8,590	569	1,600
7 Värmland Forest Owners*	1,323	110	650
8 Örebro Forest Owners*	444	22	150
9 Västra Forest Owners*	452	22	236
10 Skaraborg Forest Owners*	1,114	51	491
11 Södra Forest Owners'	20,959	1,068	6,570
12 Skane Forest Owners'	1,733	74	551

* Commenced operations in the autumn of 1982

Figure 9: The structure of Forest Owners Associations in Sweden.
Source: The Association of Forest Owners 1983.

association. Members are also able to invest money with the co-operative. Interest is paid, and in this way members are able to build up an increasing financial stake in the association.

Firm published timber prices are available from the association, and members are free to sell to the co-operative or look elsewhere. Many members have loyalty to the co-operative and are often prepared to accept their set prices rather than constantly 'shop around'.

● *Sodra Skogsägarna, a farm-forestry association in Southern Sweden, co-ordinates local contractors as a service to members. Here a machine is scarifying the ground prior to replanting* [Sweden]

Comment

The associations provide an extremely useful support for farm forestry businesses. In effect they underpin the market timber prices, yet at the same time have to keep a commercial cutting edge in order to compete with other buyers. Their advisory services co-operate with, and sometimes compete with, similar services offered by the County Boards of Forestry. Although this leads to some duplication of effort, again, it sharpens efficiency by healthy competition.

4.5 Socio Economics and Rural Development

The industrialization of the Swedish agrarian society has resulted in the depopulation of rural areas and the migration of workers to the urban and industrial areas of southern Sweden. New policies are now being developed for the remaining sparsely populated areas to create prosperity, employment opportunities, good service facilities and a satisfactory environment. Local Authorities, County Administrative Boards, the Delegation for Development of Sparsely Populated Areas and others have initiated local development projects in such areas. Various forms of government grants to sparsely populated areas have been available since the end of the 1960s, which have gradually been reinforced and co-ordinated. Government support has been decentralized to make it more responsive to local needs. Local small-scale production systems are encouraged and it is recognized that many individuals will need a combination of occupational activities to make a living. Local co-operation is becoming more common as people join forces in village associations and co-operatives.

A number of projects are under way to stimulate local initiatives and local interest in development. Although some over-view and co-ordination is given, the emphasis is directed to assistance and stimulation of local people to share responsibility for development.

Many owners of farm forestry holdings face problems of low income and limited employment opportunities. Current initiatives by local authorities and County Boards' seek to help farmers maximize employment opportunities on their land and develop alternative strategies for raising their income.

'Forestry 87' – Jonkoping County

An example of the local socio-economic initiatives in Sweden is 'Forestry 87 – Jonkoping County'.[6] Here the County Board of Forestry have instigated a scheme to improve woodlands in the county with support from virtually the entire farm forestry industry. Jonkoping county has a large rural population with 10 per cent employed in agriculture and forestry. Special training courses in socio-economics and rural development have been held for county administrative staff.

It is recognized that a lot of work remains to be done in the forests. For example some 800,000 cubic metres of timber are thinned annually from the woods, but in the county the correct rate should be around 1,100,000 cubic metres. More planting, clearing and pruning will give greater quantities of timber as well as better quality, while employment opportunities could be increased by some 600 man years (County Board of Forestry, 1987).

Two trial sites have been chosen to test new initiatives in the parishes of Aker and Alseda. Site details are tabulated below.

Vikar Salvestad and his team from the County Board have tried to estimate what additional jobs would result from the forest management plans that have been drawn up. They have also calculated what benefit self-employment provides when a wage of SEK 500/day (£50/day) is compared with contractors costs. An analysis of a questionnaire to the farmers concerned reveals:

- The trial sites have an efficiency of around 70 per cent compared with proposals in the relevant forestry management plans (100 per cent).

Trial site	Privately owned woodland	No. of woodland holdings	Average area of woodland per holding	No. of woodland holdings with more than 2 ha arable land	Average area of arable land per holding
Alseda	9,690 ha	211	46 ha	93	18 ha
Aker	9,675 ha	203	48 ha	90	10 ha

Parish	Persons living on holding in %	Persons living up to 30 kms from holding in %	Persons living more than 30 kms from holding in %	Total
Alseda	55	34	11	100
Aker	58	30	12	100

● *Details of holdings included in "Forestry 87 – Johnkoping County"* Source: Vikar Salvestad

- Self-employment can be increased from the present level of 45 per cent, up to 75 per cent.

- It is deduced that forest farmers can carry out planting, clearing, thinning, and even in some cases felling at a cheaper rate than contractors.

- These results lead to the conclusion that increased efficiency and self-employment could provide the County with additional jobs totalling 600 man years.

Development opportunities are recognized to include:

- Increased efficiency

- Increased self-employment

- New ranges of timber products

- Small sawmills

- Tree nurseries

Action programme: New methods of tackling problems have been developed following the survey conducted in Alseda and Aker. The programme includes:

1. Selection of 'model farms' as a base for courses.

2. The provision of courses dealing with matters selected by participants.

3. The grouping of courses based on participants' backgrounds, e.g. part-time farmers or non residents.

4. To utilize information gained for a countrywide programme.

Comment

Projects such as 'Forestry 87 – Jonkoping County' are a commendable local initiative aimed at improving the livelihood of forest farmers. The mixture of stimulation and assistance provided by the County Board of Forestry aimed at encouraging people to help themselves is a useful approach to rural socio-economic problems. However, some participants in the project expressed disappointment that training courses had not been run. It will be interesting to see an evaulation of the project when it is completed, and it may be that understaffing of the project at working officer level will not enable the full potential benefits to be achieved.

4.6 Forest Farms – Case Studies

Bert-Ola and Linnea Hugosson, Skillingaryd

Bert-Ola and Linnea own 102 hectares of commercial woodland and 7 hectares of farmland in southern Sweden. Bert-Ola is a design engineer and Linnea a free lance reporter. Neither depend on the holding for their primary income and the farmland is let. However they have a keen interest in their woodland and are eager to develop their knowledge and skills in silviculture. They belong to a study-circle of 13 part-time forest farmers who were brought together in the project 'Forestry 87' organized by Jonkoping County Board of Forestry. Examples of subjects that they wish to pursue are farm-forestry economics, thinning, drainage, environmental conservation (a particular interest of Linnea) and road building.

Bert-Ola and Linnea undertake all replanting and some thinnings themselves, while additional thinning and final cropping is by contractor. They are pleased to have a 10 year Forest Management Plan prepared by the County Board, and are members of the local farm-forestry co-operative although they do not market all their timber with them. Timber is sold standing but forest residue is chipped by a contractor and used on the farm for fuelling the 29 Kilowatts domestic heating boiler.

Lars Edborg, Holsbybrumm

Lars and his father have a holding with 26 hectares of pasture and forage crops and 47 hectares of pine and spruce forests. Livestock comprises 60-70 beef cattle. To enable the business to support the whole family Lars has developed a contracting business with a SEK 655,000 forwarder (£65,000 timber extraction machine). The forwarder is also used for handling big bale silage on the home farm and for neighbours.

Lars joined the County Board 'Forestry 87' project two years ago but feels that it has lost some momentum. He is eager for advice and instruction on the implementation of his 10-year forest plan. He would also welcome advice on business management and tax planning to cope with the irregular income produced from the woodland enterprise.

Bo Falk, Halt

Bo lives with his wife and three young children on the family forest farm at Halt in Southern Sweden. It

● *Bo Falk's recent replacement for the farm horse is a versatile tractor, a "Star" winch and a logging trailer* [Sweden]

comprises 100 hectares of commercial woodland, 7 hectares of pasture utilized by horses and sheep and 4 hectares of cereals. Bo inherited the farm jointly with his brother who does not take an active interest in the management and lives elsewhere. Bo's wife is a qualified doctor of medicine who is able to practice part-time.

Bo has a personal preference for work on the farm during the summer and in the forestry during the winter. Until last year he extracted timber with a horse but has now changed to a tractor because of the hard physical work of controlling a horse, low output and his back problem which was exacerbated by all the hand loading required.

He was able to buy a second-hand tractor, a 'Star' winch and an old trailer, all for the same price as a good horse.

Bo considers that his income is inadequate and wishes to take every opportunity to maximize revenue from the woodland in order to support his family and provide a share for his brother. He carefully researches the market before deciding on which trees to cut. The timber is felled and hauled to the roadside which is the point of sale. Bo is now investigating the possibility of buying a mini-sawmill to add value to his products, but complains that government loan schemes are inadequate and not available before the expenditure is incurred.

Mats Anderson, Tingstade, Gotland

Mats, who lives at Tingstade on the delightful Baltic island of Gotland, helps with the management of the family forest farm. He also has a full-time job with the County Board of Forestry and prepared the 10 year forest management plan for the farm. His brother looks after the dairy herd of 50 cows and his father deals with other aspects of management. Two men are employed on arable and forestry work. Dairy herd replacements are reared and there is a flock of 130 Palsfar sheep. Approximately 35 hectares of wheat, barley, oats, and peas are grown.

Farming and forestry are fully integrated. Both employees work on the farm in the summer, and forestry work starts in October as soon as the winter cereals are sown. The men prefer to make a start on woodland work before the winter snows and like the change from agricultural field work. One man does the thinning and final crop felling whilst the other undertakes the haulage and some winter farm jobs. Some timber haulage is done for neighbours. About 5-6 hectares of thinning, and a similar amount of clear felling are carried out each year. Natural regeneration is not very successful because of low rainfall in spring and the poor rocky soil, so most restocking is by planting (2800-3000 spruce or pine per hectare).

Gosta Jannson, Faker, Jamtland

Gosta combines his engineering, farming and forestry interests to good effect. The 15 hectares of farmland is now simply mown for hay which is much less demanding than the former dairy herd. On his 250 hectares of productive forest land Gosta undertakes all the silvicultural work except for the final felling. In addition, he has a further 100 hectares of non commercial woodland.

Annual output comprises:

Thinnings volume 200-600 cubic metres	£5,600-£16,800
Clearcut 80-90 m^3 @ SEK 200/m^3 (nett of felling costs and haulage)	£1,600-£1,800
Hay crop SEK 40,000	£4,000

Much of his present income is derived from thinnings, an operation neglected in the past. Gosta's engineering training has led him to develop a tractor mounted thinnings processor which collects, de-branches and cuts to length previously felled trees. Gosta has a business interest with a local firm now producing 60 of these machines per year for sale to larger private woodland owners and small scale contractors. The next project is a tractor mounted planting machine.

Gosta is an active member of the regional forest owners co-operative association (13,000 members), and markets his timber with them.

4.7 'Everyman's Right'

Everybody in Sweden has the same right to enjoy the countryside. This is called 'Everyman's Right' (allemansratten)[7] and it means that the public can move about in fields and woods, pick flowers (so long as they are not protected), mushrooms and berries in the forest, and go bathing and boating in lakes and seas.

Everyman's Right allows the public:

- To enter somebody else's land, except the private land or gardens adjoining a house.
- To camp for one night providing it is not too close to a house.
- To walk through enclosed land providing no damage is caused and all gates are kept closed.
- To moor a boat temporarily, bathe and go ashore anywhere except on private land surrounding a house.
- To row, sail, canoe or use a motorboat in other people's water.
- To light a fire, so long as there is no danger of it spreading.
- To pick wild berries, flowers and mushrooms.
- To drink or fetch water from springs, rivers and lakes.
- To take a dog providing it is kept under control.

These rights are sometimes modified by government authority regulations.

Comment

Everyman's Right is unique: few countries have anything like it. The rights date from the pre-industrial agrarian society and are woven into the Swedish heritage. Swedish people have a passion for outdoor activities; it provides a valuable asset for recreation in the countryside. Although there are vast areas of lowly populated countryside there are many urban and industrial areas where the rights equally apply, without apparently causing much conflict, thus providing a true example of integrated land use.

4.8 Farm Forestry and the Environment

Farm Forestry, because it accounts for such a large area in Sweden, has major impact on the environment; indeed it is the environment.

Agriculture is becoming increasingly constrained. Many new regulations are in prospect, e.g. strawburning to be prohibited after 1989 and maximum fertilizer levels are to be introduced for different crops. Forestry has a longer history of constraint and is subject to a virtual ban of herbicide usage, so all weeding is done by hand. In contrast, herbicides are still permitted and freely used in agriculture.

The main thrust of environmental conservation lies in special legislation and conservation clauses in agriculture and forestry acts.

Some current issues

a. In some rural areas a big threat is from the withdrawal of agriculture on marginal land because of economic and socio-economic problems. This in turn causes landscape change with implications for wildlife and access to the countryside. Examples include old tree pastures and ancient haymeadows that revert to scrub if not actively managed.

b. Clearcutting of final crops on a large scale always degrades the landscape for a few years, and in many wilderness areas where growth is very slow the effects can last many decades. Local government authorities are able to regulate cutting in critical amenity areas such as the environs of a skiing centre.

c. Reafforestation of the 120,000 hectares of remaining deciduous woodland in Sweden with conifers would have serious implications for wildlife and the landscape. The Broadleaved Deciduous Forestry Act in effect prevents this change unless the land is unsuitable for broadleaves. Forest management plans, which are required under the Forestry Act 1980, require provision to be made for environmental conservation. Environmental advice is available from County Boards of Forestry.

Norway spruce and Scots pine are the main commercial species but birch is gaining in popularity, and it is no longer regarded as a forest weed. The planting of improved strains of birch is increasing, with consequent environmental gain.

Interpretation of the environmental requirements under the Forestry Act 1980 is given by the National Board of Forestry in their advisory literature:

'Do not fertilize within 50 metres of lakes and streams. Avoid fertilizing shallow land.

Adapt the cutting site to the terrain and surrounding forest. Do not clearcut too large areas.

Remove felling residue from banks, brooks and ditches.

Be careful close to ancient monuments.

Remove felling residues from paths and roads. Avoid damaging these paths and repair any damage that may occur.

Clean up loading and resting places. Be careful that no oil leaks occur.

Protect sites with rare plants and spots important to birdlife. Avoid forestry work in the vicinity of these sites during the breeding period.

Haul the timber from vulnerable parts of the terrain only when frost or snow protects it from soil damage.

Avoid draining swamps, dykes, springs and brooks.

Adapt forest roads to the landscape and protect sites with unusual flora and fauna.

Avoid disturbing birds and mammals during spring and early summer when burning or scarifying.

Do not cut large new areas near previously cut sites until the reforested stands are above breast height.

Choose cutting sites with care especially on ridges of mountains and hillsides.'

Comments

Farm forestry is essentially small scale. Because most forest land has never been cleared for agriculture it is not first or second generation but rotational cropping of the native species of pine and spruce on land that has been continuously in forestry since the Ice Age. Consequently its wildlife value is higher than for similar forests in the UK. The sub-compartment size is much smaller (often 2-3 hectares) than large scale forestry. Large scale clearcuts are avoided. The appearance of the countryside

is greatly enhanced by the intimate mixture of crops, woodland and lakes, with interest provided by sympathetically designed farmsteads and other buildings. This is an impressive contrast to the extensive monoculture provided by arable cropping (occasional in southern Sweden) and the large scale forest holdings in central and northern Sweden. Many private owners, including those who live away from their land, have a great regard for their woodland. They are often sympathetic to conservation of the landscape and are interested to hear more about wildlife requirements.

4.9 Energy Forestry

The international oil crisis and the anti-nuclear lobby caused Swedish politicians and scientists to search for alternative sources of energy. Sweden has very few natural resources of fossil fuel and there is little prospect

● *Pest and disease develop in any mono-culture. Here rust fungus* (Melampsora sp.) *is identified on the borad leaves of* Salix dasyclados *but not on the* Salix viminalis [Sweden]

of increasing hydro-electric power. Given a recent history of agricultural surpluses, politicians have committed considerable resources to research and development into energy forestry as a new farm crop. Research has concentrated on growing willows on good quality arable land. Ten years of research and experiments in southern Sweden have shown that careful preparations and management are needed in order to get high production. Research and development is concentrated at the Section for Energy Forestry in the Swedish University of Agricultural Sciences, Uppsala. Various trials are underway to test the performance of hundreds of different willow clones from the great pool of genetic material that is available. Specially 'tanked' plots have been formed so all inputs and outputs including fertilizer run-off can be recorded.

In 1985 extensive field trials were started. One hundred farmers scattered over southern Sweden were commissioned to plant a total of 500 hectares of willows as part of a three year development project. Results will be available in 1988.

So far, the indications are that willows are better than the alders, and a three year cutting cycle is better than one or two year cycles which tend to weaken the stools. For willows a soil pH of 5.5-6.5 is considered optimum. Soils should be moist and satisfy other site requirements of the willows, the cultivation and harvesting machinery.

● *The Swedish University of Agricultural Sciences at Uppsala leads research into energy forestry. On left is 1 year old stand of* Salix dasyclados *on land suitable for good crops of wheat (right)* [Sweden]

● *Willows are cut on a 3-5 year cycle and wood is stored in the open to allow natural drying before it is sold for chipping as fuel* [Sweden]

The system currently being pursued is the planting of 20,000 cuttings per hectare, set out in single rows spaced 1 metre apart or double rows 1.3 metres apart. The stool beds are intensively managed with herbicides to control weed growth in the establishment period, and artificial fertilizer is added to promote the initial growth and compensate for crop removal. Nitrogen leaching is not found to be the same problem as with cereals which may also promote the use of energy forestry as a 'buffer' around cereal crops.

Harvesting is carried out in winter when the leaves have fallen. Machines are now being developed to cut and

bundle the crop. Bundles are stored in the open to allow natural drying – moisture drops from 50 per cent to 20 per cent by the end of the summer. The wood is then sold for chipping and use in heating plants.

In Sweden there are a number of municipal, industrial and domestic heating plants that are fuelled by chipped forest residue (lop and top) so there is already experience in the utilization of a similar type of produce. Indeed competition could develop between the forest crop residue and biomass markets which may lead to depressed prices. Energy forestry yields in southern Sweden are expected to be 12-15 tonnes dry matter per hectare per year, although crops of up to 20 tonnes have been achieved experimentally.

Economics: Investment calculations on the 21 year life of a stool bed carried out in 1985 for a 5-10 hectare plantation with the farmer using his own machinery, showed equivalent profitability to barley production at one level of product price, and considerably higher profitability with a higher product price (Lisbeth Sennerly-Forsse *et al.*, 1986).[8] Other departments at the University of Agricultural Sciences have researched the economics of the system. Matti Perikka concluded[9] that energy forestry can compete with crops (barley and oats) if the production level is higher than 14 ODt (Oven Dry tonnes) per hectare per year and if the price of fuel chips is higher than US $1.7 per MWL. This was the average price of fossil fuels in Sweden in 1987, and the production level is on the limit of what is possible to reach with the techniques and plant material today. The analysis is based on experience from the trial energy forest plantations in the south of Sweden.

A Handbook for Energy Forestry[8] has been published by the Energy Forestry Section of Uppsala giving clear easy-to-read practical advice for innovative farmers and advisers, following their early research. The Energy Forestry Section has also given considerable thought to the environmental implications of the new crop and guidelines on wildlife and landscape aspects are also being produced.

Comment

Some staff in the Energy Forestry Section at Uppsala are somewhat concerned that politicians may wish to press ahead with full scale production before enough research has been carried out. They are conscious that any new mono-culture creates ideal conditions for the development of serious pest and disease problems. Already there are signs that rust can be a problem with broadleaved willows. Disease resistant strains will need to be bred. Machines for harvesting and high level fertilizer need further development.

The main question that underlies all this work is the economic justification. This in turn is linked to cost of alternative energy sources. For Sweden this is natural gas from Norway, imported coal from Poland and oil from the world market. Although the current financial projections are not as favourable as they were before the recent collapse in oil prices, it is likely that other political factors will lead to government incentives for a sizeable programme for energy forestry in the next few years. Some scientists from the Energy Forestry Section would like research turned to less productive and wet areas of farmland. This seems sensible land use providing that production and mechanization problems can be resolved. As this would have less effect on agricultural surplus it may be slower to receive political support.

● *Farm forestry provides an intimate mix of trees, pasture and arable crops* [Finland]

5

Finland – Farm Forestry

5.1 Introduction

Finland is one of the most forested countries in the world, and timber is Finland's most important natural resource. The nation's forests hold a total of 1,660 million cubic metres of wood. It is estimated that 45 per cent of growing stock is pine, 37 per cent spruce, 15 per cent birch and the remainder are other hardwoods. The forest industry accounts for over 35 per cent of Finland's total exports. The 16 million hectares of privately owned forests represent 64 per cent of the country's total area of forest land.[10] There are about 300,000 privately owned forest holdings but, because of joint ownership by families, a much larger number of people in Finland share the ownership.

Agriculture in Finland accounts for 4.5 per cent of the gross domestic product and 23 per cent of the land use. Finnish agriculture is based on the family farm and forest land is an integral part of the farm. The average farm comprises 12 hectares of arable land (pasture and true arable in UK sense) and 35 hectares of forest land (Lauri Kettunen, 1987). There has been a structural change among private forest owners as the result of migration to industrial areas. Only about half the farms are now owned by resident farmers. In general there is more arable land in the south than in the north and the converse is true for forest land. 10 per cent of the working population of Finland is directly employed in agriculture and forestry.

● *Birch, once the forest weed, is now being planted. Markets include veneer, short-fibre pulp and sawlogs* [Finland]

Agriculture in Finland is heavily weighted towards livestock production. Only 15 per cent of farm land is used for producing primary food for human consumption. Milk and beef amount to 52 per cent of total value of production. The quantity of many agricultural products exceeds domestic consumption and, because world commodity prices are much lower than the home market, the cost of 'disposal' of surplus products is very high. Various schemes are in operation to offer contracts to farmers to reduce agricultural production, and others to fallow land. Dairy farms are constrained by a quota system and large scale production units are regulated by a permit system.

Finland's sub-arctic location creates problems for agriculture and forestry. The southernmost tip of Finland is at the same latitude as southern Alaska, yet its climate is less severe because of the warm water brought to the Scandinavian coast by the North Atlantic Drift.[11] The growing season varies between 120-170 days.

5.2 Forestry Policy

The basis of forest policy in Finland has been to ensure sustained, or even increased yield. For private forestry there are two main approaches – legislation stipulating the treatment of forests, and promotional activities.

Permission is required from the Board of Forestry before an area can be clear cut. Forestry law requires owners to replant if natural regeneration is not successful after clear felling operations. However new plantings are not regulated and individuals are free to afforest agricultural land without interference by the State.

Before clear cutting can commence the owner has to deposit money in a special bank account which can only be released when the authorities are satisfied that the restocking has been satisfactory. The Board of Forestry checks the stand after 5 years following which it is free of tax for a further 10 years.

Forest improvement schemes for roads, drainage, fertilizer etc., are often directly promoted by the District Forestry Boards. They carry out programmes on areas of land covering a number of holdings. Boards prepare schemes (voluntary participation) for drainage, fertilizer, roads and other facilities; supervise contracts and collect the contributions from the individual owners concerned. Some of these tasks are delegated to the local forest management associations.

The environment: Aerial spraying is often banned by local communities and most plantation cleaning is done by hand or machine.

Some small scale activities like the afforestation of waste or unproductive land and the pre-commercial thinning of young stands are subsidized by the State. The planning and supervision is done by the local management associations.

Agricultural surplus: If an owner wishes to afforest a new area, the Board will provide the plants free of charge, assist with planning and supervision, leaving the farmer to pay the cost of labour or carry out the work himself.

If the land has been in agricultural production then the agricultural department may grant aid the change of use. Current levels of payment are MKs 5,000-6,000 per hectare of which MKs 4,000-5,000 represents the cost of planting. A further payment of MKs 5,000-6,000 is made after 2 years following satisfactory establishment.

As a disincentive to increasing agricultural production owners have to pay a levy of MKs 30,000 per hectare for clearing forest land for agriculture. (Approximate exchange rate for 1987 £1 = MKs 7.5.)

Structure of holdings: Because of settlement policies and other causes of farm divisions the average size of forestry holdings has dropped from 45 hectares in 1929 to only 34 hectares in 1984 (Viljo Holopainen, 1984). This process has been exacerbated by division of property through inheritance. In 1982 an act was passed to prevent further splitting of farms which are large enough to support one family. Inheritance rights pass to the child who is considered to be most capable of managing the farm.

Land sales are regulated by the State. Individuals have to seek permission to buy land for farming or forestry. This is seen as a way to encourage the enlargement of non-viable holdings by land acquisition, and the prevention of investment in forestry and farming by absentee landlords. The State is also empowered to buy large blocks of land in order to sell back to local farmers.

In recent years forest owners have been content to leave their timber as a growing asset because low interest rates provided cheap alternative sources of capital for investment. Trees were seen to be an inflation proof asset. Circumstances are now changing because timber prices are static, interest rates are high and there is some concern about the deterioration of standing spruce.

Wood production programmes

Several wood production programmes were introduced by the State in the 1960s with the objective of intensifying the development of forestry. They tended to concentrate on measures to enhance the national stock of growing trees through land improvements and silvicultural management.

Forest 2000 Programme[12] was introduced in 1985 with the prime objective of increasing the rate of cutting by 15 million cubic metres by the year 2010. This is almost one third greater than the level during the first few years of the 1980s. The emphasis is placed on increasing the advisory capability of the District Forestry Boards (50 per cent increase in staff proposed) and the local Forestry Management Associations, with renewed efforts to increase the number of holdings covered by forest management plans. Other means of increasing production include the development of forest ownership, forestry legislation and taxation, improving the functioning of the roundwood markets, and the strengthening of demand for timber.

Comments

The Forest 2000 Programme is very ambitious. Further increases in the capacity of the timber trade and extra measures to encourage non-resident woodland owners are probably required. The extension services have a key role and need to expand their activities to reach all types of owners. More integration with the agricultural extension services would be advantageous.

Timber felling levels: One of the main challenges facing the industry is that cutting is currently significantly below the natural annual growth of timber. Figure 10 illustrates a disparity of about 30 per cent between the allowable drain, which is largely a function of actual growth, and realization.

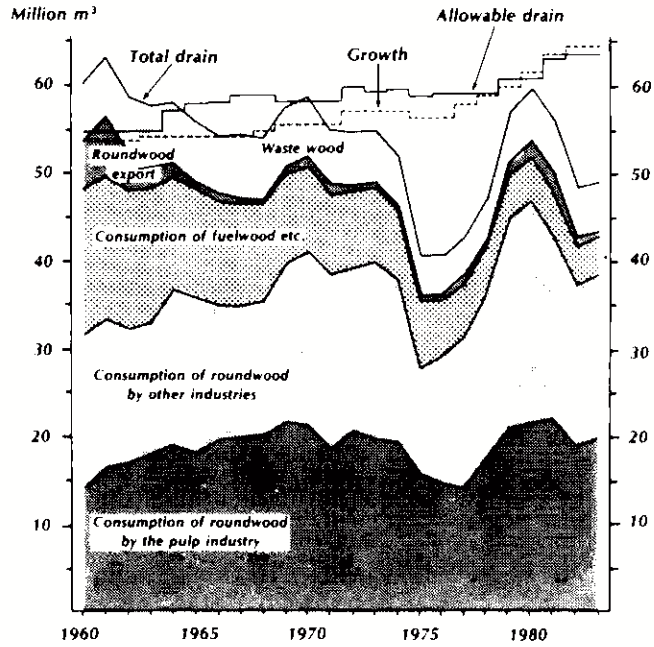


Figure 10: The Forestry balance in Finland. (Annual drain in relation to annual growth and to annual allowable drain.)
Source: Finnish Forest Research Institute 1984.

Research into the motivations of forest owners indicates that farmers rely on woodland as a reserve of capital to be exploited when investment in the agricultural enterprise is required. However, with increasing curbs on agricultural production because of surplus problems, farmers may more readily look to their forestry to maintain their income. A high proportion of available timber is from thinnings because of the distortion in age structure produced by post-war land improvement and planting programmes. This has the implications for profitability because of lower product prices and costs of extraction. On the other hand it means higher rural employment, and the availability of work that is suited to farm labour and machinery.

5.3 Private Forestry Administration

The Ministry of Agriculture and Forestry frames the legislation for forestry in Finland. The promotion of private forestry is largely a function for the Central Forestry Boards and District Forestry Boards as well as the forest owners management associations at local level. Figure 11 describes the current administration components.

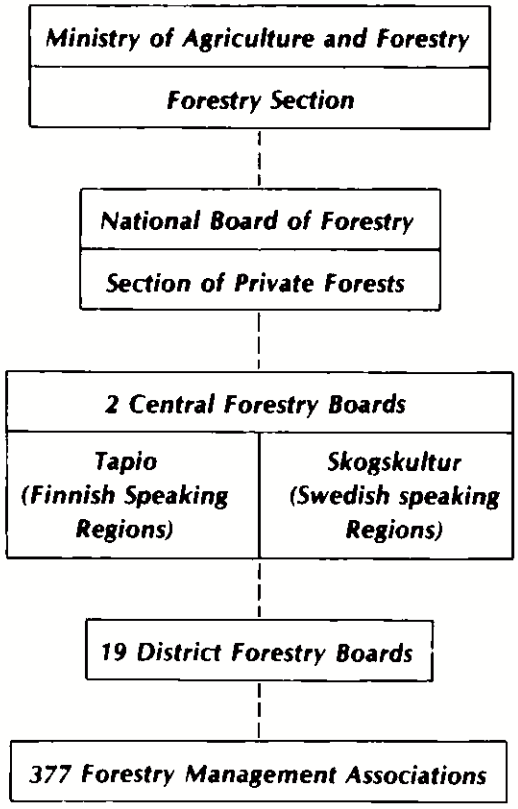


Figure 11: Private forestry in Finland.

The duties of the Central Forestry Boards are twofold: to control the observance of the law concerning private forests and to promote private forestry on the national level. The practical functions are carried out by the District Forestry Boards and the Forest Management Associations, which are self-governing bodies.

The District Boards provide advice and guidance for the Forest Management Associations, and generally ensure that the associations are following the relevant forestry legislation. Their specific duties include:

1. Preparation of forest management plans for private owners.
2. Provision of advice.
3. Training for forest owners, typically ranging from single day to multi-week courses.
4. Guidance and training of forest management association staff.
5. Forest Improvement programmes. Boards often carry out programmes on areas covering a number of holdings.

Forest Management Associations are funded by a levy of 2-6 per cent of the taxable forestry income of every forest owner with an assessed annual yield of over 20 cubic metres. In this way all forest owners contribute to the associations, but they are not obliged to make use of their services. The associations employ full time professional forestry advisers who provide most of the farm level advice on forestry matters in Finland. Their aim is to maximize the forest owners' benefits from their forestry activities. This is done by raising the owner's occupational skills and by providing technical advice. The associations provide management advice and will even supervise silvicultural operations and the marking of stands for felling. Their assistance with valuations and marketing is a large proportion of their work. In some cases they co-ordinate marketing, but they are barred from direct commercial involvement in timber conversion or retailing.

A number of associations provide contractual service for silvicultural operations and have their own gangs of workers. In 1982 some 1,467 officials, including 1,191 professionals were employed by the 377 Forest Management Associations. Advice to woodland owners is usually chargeable and the associations have scale fees for marketing thinnings etc.

The economic and professional interests of forest owners are represented by the Central Union of Agricultural Producers Forestry Council, the parent body of the local Forest Management Associations. The Union co-ordinates policy and conducts negotiations on timber prices with the trade on behalf of forest owners. An important role of the Union is the negotiation with forest industry organizations on issues concerning timber supply and the pricing of raw timber. It also takes an active part in advising Government on legislation concerning the forest industry in order to safeguard the interests of forest owners.

Comment

Farmers value the advisory services offered by the Forestry Boards and local Forest Management Associations, and the Forest Management Associations have the advantage of member participation. The forest management plans offered by the Boards, and the farm level advice and assistance with marketing provided by the local Associations, seem to be particularly successful. The subtle mix of farmer involvement and state guidance of the Forest Management Associations appears to work well. Collectively, via the Central Union of Agricultural Producers, the Associations represent farmers in regional matters and national discussion with Government, and importantly negotiate with the processing industry over timber prices. Perhaps their success can be measured by some of the highest stumpage prices in Europe.

Agriculture and forestry have quite separate administrative structures and extension services in Finland. Even the Central Union of Agricultural Producers divides its administrative structure at a high level. A number of people met during the study tour recognized this as a significant obstacle to the development of forest farm enterprises.

5.4 Extension Services

Farm level advice is provided by the local Forest Management Associations, and to a lesser extent by the District Forestry Boards, who tend to work on a macro scale.

Current challenges to the extension services are to meet the needs of forest owners for financial planning advice, and to reach the urban based owner. The District Forestry Board at Tampere for the first time last year targeted a one week 'training holiday' at 30 urban based forest owners. It was well received and the Board is planning more tours and farm visits to reach this sector. Free loan copies of information video tapes on various aspects of management are being developed.

Forest management plans

With the objective of stimulating extra timber production and improving forest management, the Central Forestry Board provides forest management plans for forest owners through the District Forestry Boards. The plans comprise an itinerary of the content of the woodland, a schedule of its conditions and a description of the management options.

Details vary from the plans offered in Sweden but the principles are similar. The objective is to achieve a sustained and regular yield of timber from each holding. However, in Finland there is no legal requirement for farmers to have a plan as in Sweden.

Plan preparation is carried out on the following basis:

1. Selection of the district.
2. Acquisition of aerial photographs.
3. Acquisition and studying of the general district and holding data.
4. Tentative delineation of stands on the aerial photograph.
5. Field work (inventory and mapping).
6. Inventory data processing (calculations).
7. Compilation of forest management plans.
8. Training of forest owners.

Although the provision of forest plans is a chargeable service, about 60 per cent of Finland's forest holdings are now covered by management plans. For example the Board of Forestry at Savonlinna charge owners MK 20 per hectare which includes a 50 per cent subsidy by the State. Seventy per cent of forest owners in this region now have management plans. The advisory services make special efforts to explain and interpret the plans to farmers. The timber buyers, pay a small premium of MK 2 per cubic metre for timber if the owner has a plan. Local Forestry Association advisers often hold a copy of the plan to aid their silvicultural advisory work and negotiations with buyers on behalf of their members.

Financial planning

The major banks are entering the field with financial management advisory packages, incorporating personal taxation criteria. An example is 'METSO' developed by the Skopbank Group. This is a microcomputer programme used for financial planning and investment guidance of private forest owners. The individual forest management plans prepared by the District Forestry Board are used as primary data for the programme. METSO calculates forest income for the next ten years and draws up investment calculations. It claims to take into consideration annual inflation and calculates for ten years the average nominal and real yield of the investment. The owner can then decide the most economic use of his income.

In the past Forestry Board and Forest Management Association advice has concentrated on silvicultural and marketing advice rather than financial business management. However the Central Forestry Board – Tapio is now developing a new system of integrated forest management planning called 'TARVO'. It allows the farmer to determine the years when he requires money from his woodland and then provides the optimum management to achieve it. The system is compatible with farm management advisory programmes and is designed for integrated forest farming advice. The outputs of TARVO comprise:

1. Cutting sequence of compartments.
2. Revenues and costs of forest operations.
3. Man-day inputs of forest operations.
4. Forest taxation factors including tentative tax calculations.
5. Monetory value of the forest in years 1 and 10 using the maximum allowable cut method.

Comment

The development of silvicultural inventories and management plans followed by advice on implementation options is entirely logical. The Forestry Boards are now grasping the nettle in developing services to give integrated forestry

and agricultural financial advice to forest farmers. To realize the goal of comprehensive advice, integration of the advisory services may be appropriate. It is interesting to note that staff at Tampere from the agricultural and forestry extension services have been brought together for the first time under one roof to further this process.

5.5 Forestry Taxation

Taxation can substantially affect the incentives for an owner to invest or realize money from a forestry enterprise. In Finland, forestry taxation takes two forms:

1. *State and local income tax* is payable on forest land. This is based on regional average production figures subdivided by land quality criteria. Land quality is categorized by indicator species of plants. For example blueberry plants are taken to indicate higher quality land than lingberry.

Certain exemptions are permitted:

a. Afforestation of agricultural land is exempt for 25-35 years depending on the area.

b. Successfully regenerated areas are exempt for 10-25 years, again depending on the location.

c. Newly drained heathland is exempted for 15-25 years.

d. Damaged stands may be exempt for up to 15 years.

2. *Property tax* is based on the 'assessed value of forestry capital'. The nett income as calculated above is capitalized by a factor of 10. The exemptions set out above also apply.

Comment

As forestry is taxed on notional performance, owners have some incentive to manage their woodland to maximize economic advantage. Because urban owners are not currently motivated to carry out felling there is pressure to increase the taxation on mature and over mature stands.

5.6 Socio-Economics and Rural Development

Of the 200,000 farm forestry holdings in Finland in 1982 only about 75,000 farmers obtained more than 75 per cent of their income from agriculture and forestry.

Because of the short growing season, timber rotations are long. Consequently forest holdings have to be large to be viable. Holdings need to have a minimum size of about 120 hectares in the south, and 200 hectares in the north, to provide a reasonable standard of living for a farmer and his family. However the average size of forest holdings is only 34 hectares. Although some owners of smallholdings derive all of their income from other activities, viability remains a problem. Many forest farmers are having a look for new opportunities of diversification to maintain a livelihood.

The market opportunities for adding value through timber conversion are limited. The solution for some is to have part-time jobs. For example, 20 per cent of the woodland owners who are resident on their property in Savonlinna region have part-time jobs off the holding.

5.7 Silvicultural Activity by Forest Owners

The proportion of silvicultural operations carried out by woodland owners (including family and employees) on their land, as opposed to contractors, has fluctuated in recent years:

Period	Proportion of silvicultural operations undertaken by woodland owners
1960s	50%
1970s	25%
1980s	40%
	(Jukka-Pekka Kataja 1987)

The steep reduction in the 1970s is attributed to mechanization developments which favoured contractors. Finland is a world leader in the development of harvester machines, cultivation and extraction equipment. These machines are outside the financial resources of most private owners, and are generally operated by contractors and large forest owning companies which can provide the continuity of work to justify the high costs. The development of small scale machinery has been largely based on the farm tractor. This has provided forest farmers with a direct replacement for the traditional farm horse that was used extensively in farming and forestry up to the 1960s.

● *Horses are now seldom seen on forest farms. Handling horses and the hand loading of timber is very hard work* [Finland]

The multiple use of farm tractors has revolutionized peoples perception of and the practice of farm forestry. Timber felling and extraction is concentrated in the winter when agricultural field work is not feasible. Snow is not considered a problem and frozen conditions assist timber extraction from some of the wetter areas.

Agricultural and forestry operations are often complementary. However, conflicts of demands on time can arise with intensive farming operations or where the owner has a part-time industrial job to supplement his income.

5.8 Forest Farm – Case Study

F.I. Risto Tarvainen, Savonlinna

Risto owns a forest farm of 162 hectares in central Finland. Of the agricultural land 10 hectares are pasture for the herd of 30 suckler cows, and a further hectare of barley is grown as winter fodder. Calves are mostly sold as stores but some are finished for slaughter. The climate is harsh by UK standards; the cows had to be housed for 253 days in 1986-7. At the time of the farm visit, in August, the kitchen garden potatoes were already blackened by an early frost.

A woodland inventory and management prescriptions are set out in a forest management plan that was prepared for Risto in 1982 by the District Forestry Board at Savonlinna. Risto spent a day with the technician who drew up the plan, and considers it an extremely useful framework for planning his operations. The trees are a mixture of Scots pine and Norway spruce with a slight preponderance of sawlog quality timber over pulp. Risto carries out most of the silvicultural operations himself but some timber is sold standing. He also has a thriving contracting business of hauling timber for neighbours with his forwarder. He stopped using the horse in 1971 and praises his tractor for its versatility as a forwarder and for general farm use.

Risto is extremely meticulous, and possibly unique, in the detailed recording of how he spends his time, with diaries spanning 20 years. His summary for 1986 makes fascinating reading.

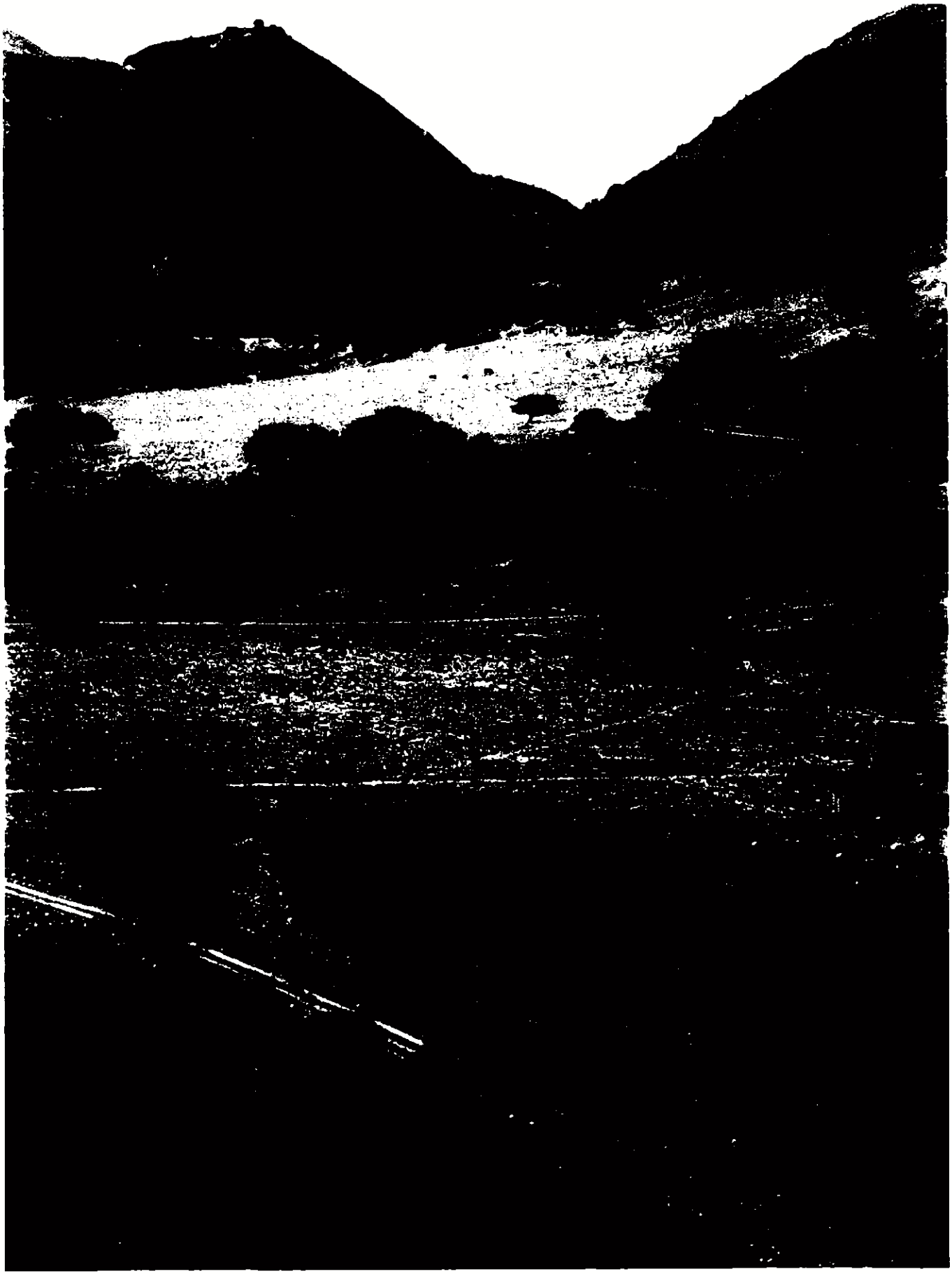
It is interesting to note that the agricultural enterprise occupies 44 per cent of Risto's time yet it represents only 27 per cent of his income. On the other hand the farm forestry enterprise takes 18 per cent of his time and produces 53 per cent of his income.

	Hours	Gross output	Gross margin
AGRICULTURAL ENTERPRISE			
Fieldwork	350		
Irrigation	120		
Cattle	495		
	965	2,200kg Meat	39,091 MKs
FORESTRY ENTERPRISE			
Cleaning and thinning	40		
Sowing pine seeds	70		
Timber extraction mainly thinnings	294	323 m^3 timber	30,000MKs app
	404	323 m^3 haulage	17,535 MKs
Farm timber sold standing		300 m^3 timber	30,000MKs app
CONTRACTING BUSINESS			
Timber haulage	655	3,509 m^3 timber	30,346MKs
Machinery repairs	137		
Negotiations/overheads	36		
	828		
TOTAL TIME IN HOURS	2,197		
APPROX TOTAL GROSS MARGIN BEFORE DEDUCTION OF FIXED COSTS			147,000 MKs

● *Management summary for 1986 by Risto Tarvainen*

FINLAND

● *Farming conditions are hard in northern and central Finland. Risto Tarvainen supplements his income by providing contracting services to local farmers* [Finland]



● *Salinas valley – Scattered oaks with a ground vegetation of Mediterranean annual grasses are typical of the extensive rangeland* [California]

6

California – Oak Woodland

6.1 Introduction

Oak dominated rangeland and woodland accounts for 11.3 per cent of the land area of California. Of the 4 million hectares of mature hardwoods, about 3 million hectares take the form of hardwood rangeland (wide spaced trees with an understorey of grazed pasture) and the remainder is true woodland. The woodlands are declining in area and the rangeland trees suffer from agricultural improvement. About 72 per cent of the hardwood rangeland is privately owned, most by ranchers who have little interest in woodland management. There is considerable concern by ecologists and various institutions about the long term future of the woodland trees.

6.2 Regeneration

In California there has been much concern for many years about the lack of regeneration in a number of species of hardwoods. Records as early as 1908 record the scarcity of seedlings of valley oak *(Quercus lobata)* and blue oak *(Quercus douglasii)*. More recent observations indicate that regeneration is scarcest among valley and blue oak in the drier valleys and foothills. In many cases, regeneration is absent or nearly so. Sudworth (1908)[1] suggested that much of the scarcity of hardwood regeneration resulted from livestock and other agricultural activities, as have many subsequent observers. Griffin (1980)[2] considered that browzing by livestock and wildlife does play a significant role in suppressing regeneration, along with weather patterns, site influences, wildlife, fire etc.

In response to growing concern by environmental interests a study was initiated to assess regeneration throughout California. This study was conducted by Pamela Muik and James Bartolome of UC Berkeley.[3] The objectives were to assess the status of regeneration of 8 main oak species, and to identify management practices. Two types of sample plots were adopted:

a. Random

b. Non-random regeneration plots where regeneration is known to occur

The presence or absence of saplings was used as the indicator of successful regeneration. Further research by Bolsinger[4] (report in press) has developed additional regeneration information by species from his hardwood inventory. Mayer *et al.*[5] reports the results of the two surveys by species.

The surveys revealed that hardwood regeneration is very variable. Woodland species such as Californian black oak, Tan oak and Californian laurel are regenerating well. Some rangeland oaks, i.e. canyon live oak and interior live oaks are also regenerating reasonably well, but others notably coast live oak, Englemann oak and Blue oak have poor regeneration.

● *The size structure of these Blue oaks, indicates that modest grazing levels, or climatic conditions, have favoured natural regeneration at certain periods of time* [California]

6.3 Wildlife Use of Oak Woodlands

Hardwood forests in California are extremely rich in wildlife, supporting 331 vertebrate species compared with 165 species on grassland and 311 on conifers. Oaks support a very high association of flora and fauna. For example, 45 species of birds feed on insects on oak foliage, 3 species eat their sap and 2 eat the berries of mistletoe growing on oaks. Acorns are a near ideal food being abundant, highly palatable and digestable, high in fats and carbohydrates (50 per cent). This abundant, food supply enables many mammals and birds to build up fat stores to survive winter. The activity forms an important inter-relationship with regeneration. Oaks in common with other hardwoods accumulate more nutrients and are richer in calcium, nitrogen, phosphate and potash than conifers, especially in the leaves. Leaf fall builds rich mulch and humus in the soil while retarding erosion.

Several wildlife species in California are wholly dependent on acorns. Examples include deer, Black Bear, Grey Squirrel, Wild Turkey, Wood Duck and Acorn Woodpecker. Of the vertebrate species that depend on hardwood habitats Mayer *et al.* (1987)[5] gives five groups as examples:

Black Bears are found in hardwood and conifer forests. They are heavily dependent upon hardwoods, especially oaks. The bears make heavy use of seeds and nuts and many studies record acorns as their dominant food in late summer and the autumn. The roots and hollows of large oaks are commonly used for 'dens' as they provide conditions for minimal disturbance and thermal protection. Acorn shortages have been attributed as the cause of nutrition-related mortality and poor reproductive success.

The Western Grey Squirrels are completely dependent on hardwoods for their existence, and their distribution closely matches the distribution of oaks in California. Oaks are required for permanent population.[6] Acorns make up half the annual diet of grey squirrels in California.[7] In good or heavy mast years squirrel condition improves, more young are born and survive, fewer juveniles emigrate and more adults survive the winter.

Oaks benefit from this relationship, e.g. buried acorns that are not reclaimed may germinate and assist regeneration.

Woodpeckers primarily bore into dead and rotted wood but sapsuckers are an exception as they often drill into live wood. Woodpeckers feed mainly on insects and other invertebrates found in dead wood but some feed on acorns or sap. Others perch on trees and feed as flycatchers.

One of the most characteristic of Valley Oak and Blue Oak woodlands birds is the Acorn Woodpecker which eats mainly acorns.

● *Native oaks are host to a wide range of wildlife. Here acorn woodpeckers store a winter food supply in a dead limb* [California]

Raptors such as hawks and owls use hardwood trees for perching, roosting and nest sites. Coopers' Hawk almost exclusively nests in live oak trees and many other species are dependent on woodland habitats.

Mule Deer. Hardwoods are vital to deer populations as a food source. They provide a choice of diet throughout the year, shelter from the elements and predators, particularly important for fawning. The deer ranges that can sustain large populations, are those that provide abundant nutritional browze and a variety of alternative foods. In late autumn winter forbs (softened by rain) and fungi are sought. Fallen leaves from hardwoods are an important food source.

6.4 Riparian Forests

The richest, most diverse and most biologically productive hardwood communities in California are the riparian forests, which comprise thin strips of lush forest bordering watercourses and lakes. Several kinds of willow, Fremont cottonwood, Valley oak, Oregon ash, White alder, Box elder, California black walnut and California sycamore are common. These hardwood forests support a greater amount of wildlife than any other habitat type.[8] They provide habitat for 83 per cent of the state's amphibian and 40 per cent of the reptile species. More than 65 species of birds nest in these forests and almost 25 per cent of the mammal species found in California are largely dependent on these riparian communities.

Only small remnant areas of riparian forest now exist and conservationists particularly, value these unique habitats.

When available, deer eat large quantities of acorns which can make up 25-75 per cent of the autumn diet. Indeed of all deer foods produced in hardwoods in California, acorns are the most preferred and play a major role in the building up of fat reserves by deer during the autumn. Mushrooms, an important source of protein (30 per cent by dry weight) are eaten avidly, as are mistletoe and lichens.

Hardwoods, particularly oaks, provide major food sources for resident and migratory deer populations when the quality of rangeland browze deteriorates in the autumn. Indeed the availability of acorns can significantly alter migration patterns. The great annual variation of the weight of the crop between different species of oak points to a need for maintaining diversity of tree species if this productive food source is to be consistently maintained.

6.5 Land Use Change

The main reasons for the clearance of hardwood and conversion to other uses has been rangeland modification for agricultural development, and urban and suburban expansion.

Indeed in 1945 the Agriculture Stablization and Conservation Services (ABCS) offered payments to landowners for clearing their land for intensive agricultural activities. Although hardwoods increased in forests during the period 1945 to 1985 because of conifer cutting, there has been a decline in hardwoods on rangeland. From 1945 to 1973 hardwoods on rangeland decreased by 479,562 hectares, mainly because of agricultural clearance. More recent monitoring between 1966-72 and 1981-4 reveals that residential and commercial development were the leading cause.[4]

Table of woodland conversion between 1966-1972 and 1981-1984 (Bolsinger, in press)

Cause of oak woodland conversion	Per cent of total conversion
Residential and commercial development	46
Road and freeway construction	39
Rangeland clearing	15

Firewood cutting was not listed as a separate cause of woodland conversion on any of the sample plots, although the wood removed was used for firewood in many cases.

An estimated 112,909 hectares of woodland were in areas being developed for residential and commercial use, in 1986. This represents 5 per cent of the total woodland area, mostly in Blue oak, Coast live oak and Valley oak types.

Riparian forests, often occupying fertile lowlands have been subject to large scale conversion to agriculture. Katibah (1984)[9] estimated 41,300 hectares of riparian forest remained in the Central Valley, about 11 per cent of the pre-settlement estimate.

6.6 Hardwoods as a Commercial Resource

In 1985, FRRAP initiated a study to examine the economic forces and activities affecting the removal of hardwoods. The first phase, representing a conceptual model and related evidence is complete.

The main commodity markets for hardwoods are firewood, pulpwood, sawlogs and biomass for energy production. Land-based activities that have an indirect effect on hardwoods include range modification, land division, residential and commercial expansion, and agricultural conversion.

There is demand for firewood in California, as other solid fuels such as coal are either not available or not acceptable on environmental grounds. Marketing outlets, via supermarkets, for prepacked firewood can not be met by local produce, and firewood is imported by train from Oregon. Current demand for native hardwood pulp and sawlogs is said to be fairly stable (Mayer *et al.* 1986). Black oak and Tan oak are the species most utilized. Much of the oak that occurs on the rangeland, being of poor form, is only suitable for firewood.

Range modification and subdivision for residential and commercial purposes is now considered to the main factors with the potential for affecting hardwoods in the state. Agricultural conversion is restricted because of physical impediments such as slope and rainfall of the remaining woodland, coupled with falling agricultural commodity prices.

The modification of rangeland by farmers seeking to improve grass production by thinning or eliminating hardwoods still remains. In many instances the value of the firewood obtained from rangeland 'improvement' is not the incentive but it often pays the cost of the clearance operations.

Standing hardwoods can enhance property values by 15-27 per cent.[10] Relaxed planning legislation enables people to buy small plots of lightly wooded rangeland for building individual houses, and there is now a thriving business in the subdivision of rangelands for this type of development. Whilst purchasers are eager to preserve trees to enhance development, the character of such woodland will change and the implications for wildlife are not known. Oaks are sensitive to root disturbance and premature senescence often results amongst trees near development.

Recreational hunting

Several categories of wildlife on hardwood rangeland have commercial value for hunting. Sympathetic management has a positive influence on the size of the 'crop' and its commercial exploitation. Co-operative extension service advisers report considerable interest by ranchers in the diversification of their businesses and point to some examples whereby 10 per cent of ranchers'

income is derived from leasing well managed hunting. Peter Passof and colleagues record that the value of a commercial hunting enterprise is affected by several factors: the business management and personal qualities of the manager, access and size of property, advertising, reputation and quality of the wildlife habitat, and management practices. Hunting returns range from a net average of US $0.85 per care per year for quail and feral pig to US $1.70 per acre per year for deer[11] [1987 exchange rate – approximately UK £1 = US $1.6].

Livestock production on hardwood rangeland

Post glacial California was vegetated with extensive savannah and woodland but did not support large populations of grazing animals. James Bartholome of UC Berkeley has researched the history of grazing influences on hardwood rangeland. In the second half of the eighteenth century sheep and cattle were introduced to California and formed the basis of the economy for many decades. Grazing pressure is attributed as the reason for the change in rangeland grasses from the native perennial bunch grasses to annual exotic Mediterranean grasses.

Oak woodland is the second most productive dryland range type in California. Livestock grazing thus harvests semi-natural growing rangeland vegetation from lands unsuitable for cultivation.

Much of the privately owned grazing land in California includes hardwood rangeland (defined as having a minimum of 10 per cent canopy cover). Of the 7.4 million acres of hardwood rangeland in the state, 69 per cent is privately owned.[4]

The shrublands and annual grasslands that intersperse with the hardwoods make up most of the remaining private rangelands.

Privately owned hardwood rangelands are generally managed primarily for the production of forage for livestock. Income from hunting and other forms of recreation is now contributing to rangeland income. In 1985 more than 2 million cattle and half a million sheep were attributed to graze range containing a substantial proportion of oak woodland.

The understorey vegetation is dominated by annual grasses and forbs. Seeds germinate in October when there is rapid growth to the autumn. Growth slows in the winter followed by rapid growth in March and seeding in May. From June to October dead grass is available. The worst period for farmers is from October to the beginning of March when little grass is available and supplementary

● *Enhanced grass growth beneath the rangeland Blue oaks may be explained by condensation of fog in a low rainfall area* [California]

feeding is necessary. Grass production is influenced by the overstorey of oaks in three ways:

1. Location, e.g. site conditions and climate
2. Density, e.g. light penetration and completion for water and nutrients
3. Species

Of the last category it has been found that Northern blue oak can supress grass growth whilst Southern blue oak can actually enhance grass growth. The browzing value of oak leaves and of acorns is difficult to quantify. Oak leaves and buds contain tannin which can give rise to poisoning if eaten in excess. Various studies have indicated that if balanced with other forage, oak can make a positive contribution to the diet of sheep and cattle. At UC Hopland Field Station a study with sheep and cattle during July, August and September indicated that more than 5 per cent of forage intake was fallen oak leaves and acorns, contributing 4-12 percent of the diet by weight.[12] Domestic livestock usually consume acorns when available but, because they are low in protein and high in energy, an additional protein source is needed to provide nutritional balance. Studies have shown that if 20 per cent of the diet of sheep is acorns, they can maintain their body weight through the critical dry period when forage is in short supply during the summer and autumn.[11]

The feed value of acorns can be quantified.[11] Blue oak acorns although lacking protein contain 90 per cent of the food value of whole corn. With corn valued at US $144 per ton then the equivalent value of acorns is US $130 per ton. Well stocked Blue oaks can average about 1,000 pounds per acre. Assuming half of the mast is available it is worth US $32.50 per acre to the rancher as a 'delivered supplementary food service'.

To take advantage of the cycle of vegetation most calves on the hardwood range are born in the autumn, grazed through the spring and weaned and sold in June. There is a strong demand at this time because other types of range and grassland reach ther peak of productivity later in the summer. Spring born calves from other rangeland are often purchased in the autumn to make full use of the complimentary forage production and corresponding financial opportunities.

6.7 Influence of Oaks on Understorey Production

It is estimated that about 75 per cent of the hardwood rangelands are grazed, and it is common practice for farmers to thin the oak with a view to increasing grass production.

However the influence of oak on understorey production is subject to controversy. Research in northern California indicated that removal or reduction of Blue oaks increased forage production. In the southern and central foothills and the South Coast area, researchers found that forage production was greater under the oak canopy (Duncan and Ruppert, 1960; Duncan, 1967; Holland, 1973).

Forage under trees may have a longer growing season but the vegetation is often different producing less palatable forage.

Mayer *et al.* consider that oak densities of up to 20 per cent seem to have little impact on the amount of forage produced. When the density reaches 30-40 per cent or more, then there is usually a reduction in forage.[5]

Passof *et al.* consider that forage under scattered deciduous oak trees (less than 40-60 per cent canopy cover) appears to increase when the average precipitation is less than 20 inches of rainfall, but is reduced in the areas of more than 20 inches. In the lower rainfall areas, plants produced beneath such canopies generally produce forage earlier in the spring and later in the autumn. This beneficial effect is more apparent in years with lower rainfall and/or cooler temperatures.[11]

6.8 Attitudes of Rangeland Ranchers Towards Oaks

The attitude of ranchers about the retention of oaks on their rangeland is a reflection of the perceived value of oaks towards forage and browze production, shelter for livestock, hunting and wildlife environment and the general amenity of their holdings. An interesting survey of attitudes was carried out by Louise Fortmann and Lynn Huntsinger of UC Berkeley in 1985.[13] Data was collected from a wide sample of woodland owners in the state to investigate how owners use their land and their oaks, and what factors lay behind their management decisions.

Two-thirds of the owners raised livestock for income. Half of the livestock producers said that increasing forage production was an important reason for them to harvest oaks, and landowners were more likely to remove oaks if they had higher oak densities on their land. Some 86 per cent of the livestock producers harvested some oak, half of which were utilizing the timber for firewood. Of the landowners who cut oak, a quarter reported that increasing waterflow was an important objective. Nearly half considered that improved access was an important reason.

Over half of the hardwood rangeland owners sampled stated that they liked to have oaks on their property. Their reasons were given:

Provision of shade (74%)

Prevention of erosion (69%)

Contribution to natural beauty (81%)

Provision of fuelwood (61%)

Increase in property values (54%)

Provision of wildlife habitat (75%)

6.9 Felling and Land Clearance Regulations

All 15 counties of California have separate regulations controlling the removal of hardwoods. The control measures vary considerably according to the locally recognized problems and political pressures. In rural agricultural areas there tends to be less control and ranchers are often free to carry out thinning or total removal of hardwoods without legal difficulty. All owners harvesting wood for fuel on their own property for home use are exempt from controls. In California hardwood range is considered as non commercial timberland and are exempt from regulations regardless of whether the wood is sold commercially.

6.10 Opportunities for Integrated Management

Opportunities for integrated management have been increasingly recognized in recent years by policy makers and advisory staff in the farm extension service. Landowners are encouraged to explore the possibilities of multiple landuse and exploit the potential of hardwood rangeland for wood products, wildlife habitat, recreation, soil stabilization, water quality and visual aesthetics in addition to livestock production. The Co-operative extension service has published an advisory manual 'Preliminary Guidelines for Managing California's Hardwood Rangelands'[11] which is used to promote multi-use management of oak-grass rangelands throughout California: to feed livestock, to gain fuel, and to protect wildlife and provide recreation. Some of the recommendations contribute to the income of the ranch whilst others embrace wider objectives of environmental conservation. The manual is divided into two sections. The first provides a simplified matrix of oak-rangeland types. A weighting is also given for each individual resource, and the site as a whole, by giving scores for the per centage of canopy cover and degree of slope.

Once the site is described, basic game, range (understorey grassland) and silvicultural management recommendations are offered.

The second part of the manual is made up of individual sections that deal with information necessary for range, forest, wildlife and game management.

Some of the more important management techniques currently advocated are described below:

Ways to regenerate oak

Encouragement of stump sprouting - when cutting is completed the use of growth retardant chemicals is no longer advocated. Cutting some oaks will produce vigorous resprouting (coppicing). Live oaks, such as Coast and Interior are good sprouters. Deciduous oaks, such as Valley, Blue, and Engelmann, are not. Small stumps of younger trees are considered more likely to sprout, and the dormant period of December to April is favoured for cutting. Stumps should be less than 8 inches high and cut at an angle to shed water. Slash is placed around the stumps to protect the sprouts from browzing.

Encouragement of oak seedlings

Above average acorn producing oaks are located and temporary fencing is erected if necessary to prevent browzing. For evergreen oaks light scarification of the ground beneath the canopy is advocated to expose bare soil. Autumn rainfall should ensure germination but vermin control of small mammals that feed on mast may be required.

When seedlings are established there is a choice between individual tree protection or the maintenance of enclosure fencing for a number of years until the young saplings have grown above the browzing level.

Planting oak seedlings

Acorns may be gathered and planted *in situ* or reared in containers for later transplantation. Oaks are available commercially from nurseries in California but local genetic stock can not always be obtained. Again, the seedlings require protection from animal damage.

Comment

Semi-natural, oak dominated woodland on farms in Wales and other parts of Britain also lacks adequate natural regeneration. This is often attributed to grazing pressure by farm livestock. However oaks are long lived and there is little reason to be concerned about gaps of a few decades in the establishment of new seedlings.

Woodland, like any other farm resource needs sound management. New techniques and incentives are required to enable farmers to manage the resource for optimum benefit for the agricultural business and the environment.

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