season and therefore no further treatment is essential, but if longer roundwood is desired then some summer tip pruning (in preference to winter pruning) to encourage straight growth will be needed (a good account of the benefits of summer pruning is given in Barton, 1993).

Some final words of caution. Firstly, success with the above regime will only be possible if prospective growers of *Robinia* pay careful attention to other important aspects such as siting and establishment procedure – see Krijgsman (1993) and Ledgard (1993). And secondly, naturally durable posts (particularly those grown quickly) are unlikely to be as reliable as commercially treated softwoods where a trouble-free life of 30+ years is expected. However, in a world showing increasing resistance to chemically treated products there should be an expanding market niche for well-grown 'natural' *Robinia* heartwood posts in the future.

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Priorities for research on alternative tree species for wood production in New Zealand

M.D. Wilcox*

Introduction

Reviews by the Ministry of Research, Science and Technology of scientific research in New Zealand on plantation forestry (Waite, 1991) and forest products (Cope, 1992) both recommended that more attention should be paid to researching species other than radiata pine. A necessary step identified before instituting major new research initiatives on alternative species was to determine the level of government funding appropriate for research on alternative trees for industrial forestry, the species most likely to repay this investment, and the particular fields of research of highest priority.

Under a contract from the Foundation for Research, Science and Technology, I undertook to investigate what research was being done in New Zealand on alternative tree species for production forestry, and explore what our best economic options might be for growing alternative species on a fully commercial scale. In light of these findings, a research agenda would be proposed to support potential investors, growers, processors, and exporters in making a commercial success of these other species. The idea of the investigation was thus to try to pick winners, and then define what necessary new information and technologies was required to fully develop forests and markets of these alternative species.

My approach was to review the experience in New Zealand with growing, processing, and marketing alternative species, and to identify a "short list" of candidates which seemed to have the best prospects as profitable alternatives to radiata pine. As well as their suitability for forest development, I took account of the extent to which alternative species were likely to be preferred to radiata pine in certain end uses, and of the items of imported timber and other forest products for which locally grown woods might be suitable substitutes. A further important consideration in narrowing down the list of species for attention in research programmes was the future likelihood of them generating major new export sales.

Competition from radiata pine – the major impediment to growing other species

Whilst there is undoubtedly plenty of enthusiasm and support in some quarters for a greater research effort in other trees, there is little commitment to plant them on a significant scale. Past research, and trial-and-error experience throughout the country has already created a valuable body of knowledge on alternative species. The fact nevertheless remains that 90% of the plantation forest resource in New Zealand is radiata pine and that it continues to dominate planting programmes. Only radiata pine figures prominently in the recent spate of new personal investments in forestry, and it is clear that little or nothing else in the eyes of promoters, investors or their advisors is considered a good bet. To make things even tougher for the "alternatives", there is a concerted research programme and promotional campaign aimed at adapting and marketing the wood of radiata pine for virtually the whole range of purposes for which alternative species could be considered. Thus, a major obstacle to the greater use of alternative tree species in New Zealand is the competition for investment finance, land, research effort, management skills, technical resources, and markets, from radiata pine.

Likely profitable alternatives to radiata pine

Species diversification is often seen as "a good thing", but can money be made out of growing alternative species in New Zealand?

The downfall of most alternative softwoods is that slower growth rates mean longer rotations and/or lower yields, and thus higher growing costs, and a longer wait for a financial return. With the possible exception of Corsican pine (*Pinus nigra*) for poles, other pines have no wood quality advantages and few siting opportunities, other than the South Island high country, over radiata pine, and thus little possibility of higher prices to compensate for the higher growing costs.

Of the native softwoods, kauri (*Agathis australis*) and the podocarps have been well researched from most likely angles. For both technical and conservation reasons, prospects are poor for profitably managing natural forests for the sustained yield of wood. Furthermore, prohibitive establishment costs and long rotations make these slow-growing natives poor

* *Senior Forest Consultant, Groome Pöyry Ltd, Auckland.*

commercial prospects in plantations. They could justifiably only be grown for sentimental, cultural, or environmental reasons.

There do, however, seem to be excellent assured domestic and export markets for certain durable introduced softwoods, especially Douglas fir and cypresses, and prices for logs and sawn timber seem likely to be sufficiently high to appreciably offset any extra cost of production, and longer rotations. There is already extensive experience with these species, and a combined resource of 100,000 ha is feasible. Such an investment would largely have to be at the expense of radiata pine, though there are opportunities for Douglas fir in regions such as inland South Canterbury where radiata pine would be at risk from drought and snow damage.

Experience in New Zealand with other durable softwoods such as larch (*Larix decidua* and *Larix japonica*), western red cedar (*Thuja plicata*), redwood (*Sequoia sempervirens*), Japanese cedar (*Cryptomeria japonica*), and Chinese fir (*Cunninghamia lanceolata*) suggests they all have sufficient limitations to discount them from contention in major planting programmes.

Hardwoods have always been a difficult proposition for New Zealand foresters. Many have been tried, but without much sustained confidence, or consolidation into an effective resource. Short-rotation fibre cropping is one possibility, with the attraction of early returns from rotations of 8-15 years. New Zealand is lacking in short-rotation forestry that would be attractive and profitable for investors. Although such short rotations are technically feasible for radiata pine grown expressly for pulp and fibreboard, economics generally dictates rotations of 25 years or more, to yield logs suitable for all required purposes. Some of the eucalypts, most notably *Eucalyptus nitens,* are good prospects for short-rotation forestry, foreseeably mainly for pulpwood. Yields of 250-375 m^3/ha on rotations of 12-15 years are realistic, with the likelihood of improved productivity from research on judicious selection and siting of species, genetic improvement, establishment techniques, and protection from serious pests and diseases.

The only other realistic possibilities for short-rotation fibre forestry in New Zealand are willows, poplars, acacias, and alders. There is no obvious front-runner, and all these trees are problematic in New Zealand for large-scale use in industrial plantations.

There is good potential to develop a hardwood timber industry in New Zealand based on selected eucalypts grown on rotations of 30-40 years. These hardwood timbers will provide alternatives to native hardwoods such as tawa (*Beilschmiedia tawa*), to imported timbers, and to radiata pine, primarily in high-class finishing grades for panelling, joinery, furniture, flooring, and exterior work such as decking. Forest and mill residues would be disposable for fuel, and possibly for pulp or fibreboard.

23-year-old *Eucalyptus saligna* in Waitangi Forest, Northland.

"There is good potential to develop a hardwood timber industry in New Zealand based on selected eucalypts grown on rotations of 30-40 years."

Natural durability, stability, and strength are desirable attributes of the chosen species. *Eucalyptus muelleriana, Eucalyptus pilularis, Eucalyptus obliqua, Eucalyptus botryoides,* and *Eucalyptus saligna* from experience would appear to be the favoured species, with the addition of *Eucalyptus fastigata* as a general purpose hardwood for interior use. In addition to the small domestic market for hardwood timber, there could well be opportunities for New Zealand in producing large plantation-grown eucalypt logs for export to north Asia for veneer and sawn timber as an alternative to traditional hardwood logs from non-renewable natural forests in countries such as Malaysia, Papua New Guinea, and the Solomon Islands. Eucalypt plantations internationally are paying little attention to sawlogs and veneer logs, and this is a niche that New Zealand could specialise in, backed up by an aggressive research programme aimed at minimising growth stresses and other defects.

Cabinet timbers constitute the third category of hardwoods that New Zealand could consider producing for the local and export market. Of the many possibilities, the short-list would seem to be blackwood (*Acacia melanoxylon*) in mixed plantations (with eucalypts or on disturbed native forest sites), and some form of sustained yield management of native beech (*Nothofagus*) in Westland and Southland. Both these possibilities have scope for significant local processing industries and/or export.

There are many other hardwoods that could be planted on a "cottage-industry" scale but which have no realistic hope on evidence to date of making a significant contribution to New Zealand's economy. These include native hardwoods such as mangeao, (*Litsea calicaris*), kohekohe (*Dysoxylum spectabile*), puriri (*Vitex lucens*) and rewarewa (*Knightia excelsa*), and introduced trees such as black walnut (*Juglans nigra*) and paulownia.

Research programme

To deploy scientific resources to the best effect, I proposed that research on alternative species largely be structured into a number of discrete projects, concentrated on just those species, localities, and topics with a good likelihood of supporting

commercial development. Four such projects have been identified.

Douglas Fir Timber Industry

Douglas fir is commercially important in New Zealand, both as a construction timber on the local market and in Australia, and as a valued log export species. The long-term prospects in these markets looks secure.

It was suggested that an annual research programme on Douglas fir be instituted to cover all aspects necessary for the continuation and expansion of this industry. High priority needs to be given to developing strains resistant to Swiss needle cast disease, to obtaining faster early growth, and to the milling qualities of smaller logs. In addition, the option of growing pruned logs could be re-investigated. This project should have national coverage, based on the core existing resources in the central North Island, Nelson, Canterbury, and Otago/Southland. A strong South Island presence will be required to implement an effective programme.

A multi-disciplinary Douglas fir Research Cooperative Programme has recently been formed at the Forest Research Institute, funded jointly by the Public Good Science Fund and the Douglas fir growers, processors, and exporters, and with direct linkages to research programmes in the Pacific Northwest of the USA. This would seem an excellent mechanism to advance the technology of growing and processing Douglas fir. There is a good resource base of 60,000 ha, a developed industry and trade, and scientific knowledge to build on.

Cypress Timber Industry

Cypress timber from farm woodlots and shelter belts is already well established on the market. Macrocarpa (*Cupressus macrocarpa*) is the main species of interest, but lusitanica (*Cupressus lusitanica*) and perhaps lawsoniana (*Chamaecyparis lawsoniana*) should also be considered. Their durability, stability, appearance, and light weight will ensure their continued popularity, and may give them a definite edge over radiata pine in the Asian timber markets. This industry is presently small and scattered, but need not be confined to just a few discrete project localities, though sites must be of high quality to achieve economic growth rates. A target resource area of 20,000 ha of well-managed plantations would be enough to make a worthwhile contribution to the economy.

Present research efforts on tree improvement, propagation, site selection, and silvicultural regimes need to be continued. More attention needs to be given to timber processing, added-value uses, utilisation of residues, and market development. It is expected that the Public Good Science Fund will have to meet most of the costs of this research.

Foliage and flowers of *Acacia melanoxylon* (Blackwood).

***Eucalyptus nitens* Pulpwood Production**

This species has now been proven as highly promising on colder sites, with excellent potential for pulpwood. A favoured locality is Southland, where the tree grows exceptionally well, and where there is already a wood-chipping operation and a commitment to grow the species (Hardwood Forests Ltd, 1992). Prospects are also good in the higher country of the central North Island, where there could be excellent scope for developing a major resource within distance of the pulp mills at Karioi, Napier, Kinleith, and Kawerau. Research is already well advanced, and all aspects of silviculture, forest health, environmental impact, wood properties, and product development should continue to be thoroughly investigated. Highest priority in research should be given to wood property evaluation and improvement, protection, and optimisation of pulping methods. A sensible balance of Public Good Science Fund grants and industry money is required to support a strong, integrated research programme of benefit to growers and pulp mills.

Eucalyptus Hardwood Timber Industry

It is proposed that effort be concentrated on definite localities with good potential as working circles for growing and processing. Suggested project regions are Northland, based on *E. pilularis, E. muelleriana, E. saligna,* and *E. botryoides,* Waikato-King Country-central North Island, based primarily on *E. fastigata,* and Wairarapa/Marlborough based on *E. obliqua* and *E. muelleriana.* This pattern of concentration fits with what is known of the site preferences and performance of these species, and would allow significant resources to be developed for processing and marketing. The species/locality list is not exclusive, and could be stretched to include other species such as *E. globoidea* and *E. regnans*, and other localities such as the Bay of Plenty. A deliberate omission is *E. delegatensis* in Southland, on account of the serious problem of seasoning collapse in the timber.

The problem of optimal species siting and microsite uniformity is already receiving attention in the Management of Eucalypts Research Cooperative. Other research effort needs to be concentrated on provenance selection, tree improvement (including timber properties), forest health, establishment techniques, and silvicultural regimes, together with durability testing, refinements in milling technology,and alternative wood products. Above all, this industry will not survive unless it learns to live with or avoid growth stress in eucalypt logs. As with the

cypresses, a strong injection of Public Good funding will be necessary to maintain an effective research programme, and to provide the necessary data that could persuade investment in timber plantations.

Other Alternative Species Projects

There are a number of other projects that could justifiably lay claim to a slice of the research effort. Among these, the most worthy ones seem to be the development of Corsican and ponderosa pine (*Pinus ponderosa*) forests in the MacKenzie Country, *Acacia melanoxylon* for high-quality timber and veneer in selected localities, management of native beech for timber production in Westland and Southland, and acacia and eucalypt wood chip ventures in Northland.

Research funding

The funding from PGSF for 1993/94 looks to be close to $2.5 m for projects covering all aspects of alternative species for production forestry (Foundation for Research, Science and Technology, 1993a). This seems generous. Of this, around $1.5 m would appear to have been allocated to the priority projects that I have highlighted here. The Foundation for Research, Science and Technology (1993b) has nevertheless demonstrated its willingness to fund an increasing amount of strategic research on alternative species, just in case industry may eventually go ahead with large-scale plantings. It has designated research on non-radiata species an area of key competency, and recommended that effort be significantly expanded.

It is emphasised that alternative species forestry in New Zealand can only expand and flourish at the expense of resources that would otherwise be allocated to radiata pine. This is particularly true with regard to competition for the best sites, and to technical and scientific resources to develop the necessary know-how. Without a commitment to develop a strong second front to New Zealand commercial forestry, using alternative species, there will be little incentive and justification, with most of these species, to step up the research programmes beyond the present modest levels necessary to obtain data and to explore and demonstrate options. Full-blown research programmes on selected species, covering aspects such as molecular biology, physiology, silvicultural stand models, and new product development, must necessarily depend on additional effort and resources by the beneficiary industries, driven by their commitment and enthusiasm to invest in planting.

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Thinking aloud

The sad news of the passing of Steve Spurr recalled to the mind of this reader his championship of Douglas fir at a time when professional foresters (though not, praise be, the amateurs of the Farm Forestry movement) poured the utmost scorn on any suggestion that there might be a role in New Zealand forestry for other than radiata pine. Many, indeed, had no time for anything but the direct sawlog regime and no distinction was made between "economic" and "financial" rates of return. And I recollect with sad delight an occasion when Fenton was reduced to apoplectic silence by Steve's precise articulation of the economic benefits of Douglas fir. He also used the redwoods of Whaka Forest to illustrate the difference between economic and financial values – though, at the time, the redwoods had only recently become a grove, the majesty of which could be freely contemplated. Previously, it was a failed larch mixture, closed to the public and coming perilously close to clear felling and replanting with radiata. Those of us permitted by grace and favour of the Conservator of Forests to enter the surrounding plantations gazed out over an ocean of sombre greenery, relieved only by the golden glory of poison-thinned larch and cankered poplar.

It was not always thus. Both Maori and European immigrants to New Zealand introduced plants and animals and our claim to have once been the greatest ecological democracy that ever existed was established before the Treaty of Waitangi. The early European immigrants were prodigious planters and environmental improvers. The New Zealand Company's "Handbook for Colonists", published in 1848, urged the introduction of everything from mulberries to mistletoe. ("To a British Colonist, the experiment of planting the symbol of the Ancient Druids in the Britain of the South Seas, should at least seem worth trying.") Ludlam, in the first volume of the Transactions of the New Zealand Institute in 1856, published a list of trees he had planted in Lower Hutt since 1840. He had successfully established 84 conifers (including a juniper from Bermuda), seven palms, 17 species of oak (Linnaeus des-cribed only 14), more than 50 camellias, and a huge variety of rhododendrons. The horticulturist Mason in 1896 recorded the heights of over 300 species planted in the 1840s at Avalon – adding another 230 to the planted list in 1903 (though not all of these were trees). The earliest photograph I have seen of what later became the FRI nursery (in the classic "Tree Culture In New Zealand" by H.J. Matthews published in 1905 – I think) shows vast seedling beds of **Catalpa!** What, I wonder, became of them?

Bob Burstall's magnificent "Great Trees of New Zealand" notes the measurement and recording of tree growth in the South Island as early as 1866 of 77 varieties of conifer and "numerous examples of trees being saved by vigilance, such as the oak at Runciman for which a motorway was diverted, the Moreton Bay fig which was saved by altering a factory extension, etc." It is indeed strange that by 1985 it was possible to write in all seriousness that "it is doubtful whether future generations of foresters will be able to recognise a fraction of the exotic tree species planted in New Zealand or Australia in the last century, (Richardson, 1985).

This viewpoint promised to be overturned by the theme of the 1993 NZIF Conference – "Managing New Zealand Forests for Future Markets". Since we are confidently expecting an economic future based firmly on tourism, the challenge of the subject was exciting. Clearly, we were about to address manifold problems of indigenous forest management (conventionally, it is the indigenous forests to which the tourists flock) and we have as a nation affirmed a conviction that their role in **resort** management is to be more important than that in **resource** management.

A Challenge

It is a challenge because as foresters we know virtually nothing about it. No doubt we shall learn from history. To assist us we have the seminal study of the first-ever designated World Heritage site – Yellowstone Park – (Chase, 1984) which details the almost incredible cata-