WORKSHOP PROCEEDINGS

Sustainable Forest Industry Development in Tropical North Queensland

Edited by
S. R. Harrison and J. L. Herbohn

Rainforest CRC
Cooperative Research Centre for Tropical Rainforest Ecology and Management

SUSTAINABLE FOREST INDUSTRY DEVELOPMENT IN TROPICAL NORTH QUEENSLAND

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Edited by

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PREFACE

Substantial research has been conducted into the forest industry in North Queensland, stimulated by the creation of the Cooperative Research Centre for Tropical Rainforest Ecology and Management (Rainforest CRC) as well as the Community Rainforest Reforestation Program (CRRP), both in 1992. While the CRRP was intended in part to replace the timber resource lost to the market by the formation of the Wet Tropics of Queensland World Heritage Area (WTWHA) in 1988, it has become apparent that private profitability of forestry is relatively low, and that new plantation establishment has proceeded at a slow pace. At the same time, plantation forestry is recognised to provide considerable regional socio-economic and environmental benefits, hence there is a strong case for promoting new plantations, at both the industrial and small-scale level.

A proposal for a forest industry development workshop in North Queensland was made at two Rainforest CRC workshops held in Brisbane in 2003 (on the Community Rainforest Reforestation Program, and on Timber Marketing in North Queensland), and at the September Program Support Group meeting for Rainforest CRC Program 5.3 – Social and Economic Aspects of Reforestation. A planning meeting was held at the annual conference of the Rainforest CRC in Cairns in 2003.

A workshop theme was defined in general terms, as the development of effective policies at federal, state and local government levels to create a sound planning framework that supports sustainable forest industry development in North Queensland, taking into account economic, social and environmental considerations. It was envisaged that members from various forestry stakeholder groups would attend the workshop, and a forum would be created for expressions of views on directions and strategies for forest industry development.

The North Queensland Forest Industry Development Workshop was held in the Murraya Conference Room, Cairns Student Lodge, over Wednesday 28 and Thursday 29 April 2004, as an activity of the Rainforest CRC. State agencies represented included the Department of State Development Forest Policy Group, DPI Policy Analysis and Industry Development, DPI Forestry, and the Department of Natural Resources and Mines. Federal representation was made by the Forest Industries Group of the Australian Government Department of Agriculture, Fisheries and Forestry and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Other delegates represented the Rainforest CRC, Private Forestry North Queensland, Central Queensland Forest Association, James Cook University, Griffith University, The University of Queensland, and private tree growers. A stimulating exchange of ideas took place. A barbecue on the evening of 28 April provided a relaxed atmosphere for informal discussions between attendees.

These proceedings are an output of the workshop. Most speakers provided written papers or PowerPoint series. Also, most of the presentations were tape-recorded. The papers have been considerably revised and peer reviewed since the workshop.

1. EXPLORING THE POTENTIAL FOR FOREST INDUSTRY DEVELOPMENT IN NORTH QUEENSLAND

S.R. Harrison

The rationale for holding a workshop on North Queensland Forest Industry Development is the view that there is a clear need for plantation expansion for economic, social and environmental reasons. This paper presents arguments to support such a rationale, and reviews the particular circumstances in which forest industry development in North Queensland would take place. Comments are made on the planning and focus of the workshop, and the expected workshop outcomes.

FOREST HISTORY IN NORTH QUEENSLAND

North Queensland has a long history of commercial forestry, based on logging of native forests. The first efforts to establish plantations took place with the planting of red cedar between 1903 and 1906, with softwood plantations (Caribbean and Hoop Pine) established from the 1950s (Gould 2000). A Crown softwood plantation area of about 14,600 ha has been established in North Queensland (Kent, these proceedings). The logging of native forests was the subject of much environmental debate, culminating in the gazettal of the Wet Tropics rainforests in 1988 as Australia's eighth World Heritage Area (Tisdell and Wilson 2002).

World Heritage listing caused a sharp contraction in timber supply, with closure of many timber mills (Wiles, these proceedings). Subsequently, various efforts have been made to restore the timber industry, this being an objective for example of the Community Rainforest Reforestation Program (CRRP) (Shea 1992). Other planting took place under the Wet Tropics Tree Planting Scheme and the Plantation Joint Venture Scheme. However, the CRRP resulted in the planting of only about 1,780 ha over about 600 farms, and in total the plantation area of eucalypts and rainforest species (excluding Crown Hoop Pine plantations) in the Wet Tropics is only about 3,200 ha (Vize *et al*. 2005). Harrison *et al*. (2004) noted that landholders are applying silviculture to – and intend to harvest – a substantial proportion of their CRRP plantings. However, overall the plantation resource in North Queensland is relatively small, and plantation expansion is needed to ensure a viable timber industry.

REASONS FOR PROVIDING INDUSTRY ASSISTANCE OR FACILITATION MEASURES

A number of arguments for promoting the redevelopment of the timber industry in North Queensland have been advanced by Harrison *et al.* (2003), as summarised below.

To Achieve Forestry Industry Take-Off

It may be that the timber industry in North Queensland can achieve a take-off with a relatively small amount of well-targeted government support. There is an existing industry operating which provides a foundation on which to build. Many North Queenslanders are highly sentimental about native rainforest timber species and the forest industry in general, and have furniture items made from species such as Queensland Maple, Northern Silky Oak and Queensland Kauri Pine. A number of landholders have great enthusiasm for forestry, and

community groups have volunteered efforts to promote planting, e.g. Trees for the Atherton and Evelyn Tablelands (TREAT). Recently, there has been a number of plantings of African Mahogany, particularly in the dry tropics. A problem arises in that unless there is a threshold level of timber turnoff, there will not be a demand from cabinet-makers, both locally and in southern markets, and market outlets will be limited to a few local small-scale furniture producers and hobbyists such as woodturners. It is unlikely that these local niche markets alone will require sufficient resource to create a sustainable forestry industry in the region. Other domestic and export markets for timber are likely to demand higher wood volumes.

Positive Environmental Externalities and Market Failure

In an area of high rainfall (in some locations averaging over six metres per year) and with much degraded farmland, watershed protection is an important function of forestry. There is concern that sediment and agrochemical transport from farmland is causing harm to the Great Barrier Reef Marine Park. In economic terminology, there is less than a socially-optimal amount of plantation forestry in the region, a case of market failure arising because the private benefits of plantation establishment are less than the overall benefits to society. There would appear to be a case for subsidising environmental services to encourage landholders to establish forestry plantations or to create new markets, recognising these services as tradable and developing appropriate resource rights and licenses so that stronger market incentives for plantation forestry can arise.

Forestry Supports the Tourism Industry

Trees on the landscape can add to the scenic amenity of a region. The ideal landscape would appear to be a mixture of forested and grazing land. Broadleaved and attractively flowering native rainforest species add to the appearance of the landscape for locals who have high regard for these tree species and also for visitors to the region. The patchwork of sugar fields is also attractive when viewed from highways running up the range to tableland areas, though less so from a horizontal view. Landscape benefits of forestry are probably important in some localities, although it must be recognised that there are large areas of protected forest in North Queensland, such as the Wet Tropics World Heritage Area of over 900,000 ha of rainforests, mostly on Crown land.

A Source of Economic Activity to Replace Failing Agricultural Industries

The last decade has seen falling prices and severe financial difficulties for the tobacco, tea-tree oil, dairying and sugar industries in North Queensland (although there has been a recent revival of sugar prices and the use of former dairy farms for fattening beef cattle). Tobacco growing has now been phased out, and tea-tree oil production has come to a halt due to market oversupply by a prospectus company and a failure to expand markets. Deregulation of the dairy industry led to a sharp fall in the milk price and exit of some dairy farmers from the industry on the Atherton Tableland. The contraction in primary industries has affected the viability of infrastructure such as banks, schools and professional offices in some Tableland towns. An expanded forestry industry – based on high-value species and local value adding, with expansion or at least long term sustainability of traditional current timber processing operations – would contribute to employment and income generation and community viability. Plantation expansion if sensitively managed could add considerably to the attractiveness of the Tablelands for residents and tourists (both domestic and international).

Import Replacement

Australia has a net deficit in timber trade, and large expenditure on timber imports, which a revitalised industry in North Queensland could help to redress. Forest industry development based on high-value tropical species may one day displace some of the unsustainable imports from the rainforests of developing countries, as well as generate exports. The native softwood Hoop Pine (*Aracuaria cunninghamii*) is a high-value species when sold into markets that recognise the special features of this timber, and is gaining recognition in international markets (Cox 2000). Development of an integrated hardwood pulp and sawlog regime is also possible, though the financial viability requires further analysis.

The Need to Support the Isolated North of Australia

For strategic reasons, ensuring economic activity and population growth in northern Australia warrants the attention of Australian Federal and State governments. While growth has been rapid in south-east Queensland, with high migration from interstate and New Zealand, the north faces the 'tyranny of distance' and high transport costs, severe cyclones and greater reliance on the vicissitudes of tourism and agriculture.

Overall, it can be concluded that there are sound reasons to support forest industry development (or more correctly, redevelopment) in north Queensland. Currently, expansion of plantations, particularly of hardwoods, is being promoted in south-east Queensland. The industry in the north continues to operate with a plantation area and annual log turnoff marginal in terms of achieving economies of scale. However, the most cost-effective approach to development of a socio-economically and environmentally sustainable forest industry in North Queensland is unclear, and the workshop is designed to generate insights into industry development options.

PARTICULAR FEATURES OF THE NORTH QUEENSLAND SITUATION IN RELATION TO FORESTRY EXPANSION

A number of distinct regional characteristics in relation to forest plantation development in North Queensland may be noted:

Diversity of Suitable Tree Species

Over 100 tree species with high timber quality have been demonstrated to grow well in plantations or woodlots, as well as a variety of native and exotic species. Growth rates for many species are impressive when compared with species grown in temperate climates.

Local History of, and Interest in, Forestry Activities

There is a history of logging of the Wet Tropics rainforests and wet sclerophyll (eucalypt) areas, and in cabinet making, although some deskilling has taken place since World Heritage listing in 1988. Also, there is strong community interest in growing native tree species, though this has not translated into a large area of planting. Indeed, there is a perception of high sovereign risk amongst landholders, in part associated with the World Heritage listing, and reinforced by recent speculation about new restrictions on logging on private land.

A Substantial Land Area Potentially Available and Well Suited for Forestry

Various studies have identified adequate land available for forestry expansion, with estimates of area within trucking distance of Cairns of up to more than 100,000 ha. This includes an area on the Atherton Tableland with suitable soils and climate, not presently in high-value

uses, of the order of 40,000 ha. Land available for forestry varies from very high rainfall sites (with more than 4,000 mm per year) on the coast to cooler elevated areas of both high (1,200-2,000 mm) and moderate (1,000-1,200 mm) rainfall.

Need for an Alternative Land Use and Farm Diversification

With the varying fortunes of other agricultural activities, forestry can play a role as a form of farm diversification through the establishment of a valuable asset or legacy.

Regional Economic Dependence on Tourism

Plantation forestry has the potential to complement protected rainforest areas in making the region more attractive for ecotourism.

Environmental Sensitivity

The Wet Tropics region is recognised to have high environmental values, Cairns being surrounded by two World Heritage areas (the Wet Tropics rainforests and the Great Barrier Reef). Any form of plantation forestry must be compatible with community attitudes to the landscape. Environmental sensitivity favours development of plantations of native tree species, especially as mixtures, while discouraging use of exotics and clearfell logging.

Locational Disadvantage and Need for Value-Adding

The population in North Queensland and hence local markets are small, with most of the State's four million people living in the south-east, about 1,500 km away. A consequence is the need to sell high-value products in distant domestic or export markets.

Difficult Timber Marketing for Small-Scale Producers

Marketing has proved a major obstacle for farm-grown timber. Contractual arrangements between government plantations and 'Ravenshoe Timbers' restrict access of small growers to the softwood market. The small quantities, variety of species and infrequent sales of small growers are also obstacles to them developing established marketing relationships with timber processors.

Occurrence of Extreme Weather Events

Recent cyclones in North Queensland, particularly Category 5 Tropical Cyclone 'Larry' in March 2006, caused major plantation damage, and highlighted the need for care in plantation siting and in selection of species with the ability to withstand high windspeeds.

In summary, North Queensland is a special region, in terms of forest history, available resources and high environmental qualities, and any forest industry must be sympathetic to these qualities. While there is considerable enthusiasm for tree planting, farm forestry has not been financially attractive. There would appear to be a great need for an expanded timber industry, and considerable opportunities for this to develop, but also major constraints. Many alternative timber industry options and scenarios can be identified, and indeed there are some clear visions for the future of the industry. Any strategies to expand the timber industry require a sound knowledge base.

WORKSHOP BACKGROUND AND OBJECTIVES

It is apparent that there are some major information gaps in relation to expansion of plantation forestry in North Queensland. Forestry involves many stakeholder groups, and many individuals hold key information, but much of this information is not readily available to policy makers, hence the need for a 'forest industry development' workshop.

During two workshops in Brisbane in mid-2003 – on the Community Rainforest Reforestation Program and on Timber Marketing in North Queensland – discussions took place about holding a forestry policy workshop in North Queensland. The policy workshop concept was again considered at the Program Support Group meeting in September 2003, as an activity of Rainforest CRC Project 5.3 – Social and Economic Aspects of Reforestation.

It was suggested that State agencies, which might be involved in a forest policy workshop, could include the Department of State Development Forest Policy Group, the Environmental Protection Agency, the Department of Natural Resources and Mines, the Department of Primary Industries' Policy Analysis and Industry Development Unit (DPI-PAID), and DPI Forestry. Local groups like Private Forestry North Queensland and the North Queensland Timber Cooperative were identified as essential participants. The desirability of representation from local government, the regional natural resource management (NRM) boards, the Atherton Tableland Sustainable Regions Advisory Committee and the Federal government (Agriculture Forestry and Fisheries Australia, AFFA) was also noted.

A workshop theme was identified in general terms, as the development of effective policies at Federal, State and Local government levels to create a sound planning framework that supports sustainable forest industry development, taking into account economic, social and environmental considerations.

Some general questions were posed to assist in formulating the workshop focus:

- What are the major and specific policy impediments to expansion of the North Queensland forest industry?
- What visions of forestry 'futures' for North Queensland are held by industry participants and other stakeholders, and can any shared visions of forest industry development be identified?
- Under present policies, will sufficient timber resources be available to sustain a forest industry over the next 25-50 years?
- What is the relationship between the forestry sectors of commercial softwood production and processing, and multiple-use small-scale forestry based on native hardwoods?
- What are the strengths, weaknesses, opportunities and threats with regard to forestry in North Queensland, and with regard to specific forestry 'models' or 'futures'?
- What measures could be implemented and what resources are needed to promote reforestation in North Queensland, and what benefits would these generate for the region?
- How should the discussions and recommendations of the workshop be formalised and presented to policy makers?

Some possible workshop themes (and areas where presentations or discussions could be encouraged) were also identified:

- The current state of forestry in North Queensland;
- Visions for a future forestry industry;
- Forestry constraints / impediments, issues, and keys to progress;
- Land availability for plantation forestry in North Queensland;
- Timber resource projections under current policies;
- A SWOT analysis of the North Queensland forestry scene;
- Social considerations in relation to forestry expansion;
- Environmental considerations in relation to forestry expansion;
- Options, possibilities, benefits and costs relating to incorporating environmental goals into timber plantations;
- Economic issues in forestry industry expansion;
- Financial modelling of alternative forestry systems;
- Institutional factors in forestry industry expansion;
- Best-bet species, and site-species-socioeconomics matching;
- Threshold volumes for viable processing and value adding;
- Timber supply chain and marketing issues;
- Attracting finance for reforestation;
- Prospects for payments for ecosystem services;
- Forest industry development strategies; and
- Lobbying strategies to advance forestry in North Queensland.

It was suggested that the venue be either on the Atherton Tablelands or in Cairns, with the Cairns Student Lodge eventually being chosen as a more convenient location. It was agreed that proceedings should be produced as a permanent record of the presentations and insights gained.

Subsequently, a workshop of forestry experts was held in Cairns over 28-29 April 2004, to examine ways to promote forest industry development. The expert group assembled collectively had a huge amount of practical and research experience in forest industry issues in or relevant to North Queensland, and included 'stakeholders' from the timber growing and marketing side of the industry, and from government agencies, forestry support organisations, research institutions and community groups. Representatives attended from the Federal Government (Agriculture, Forestry and Fisheries Australia), Queensland government (Departments of Primary Industries, State Development and Innovation, and Natural Resources and Mines), industry (Private Forestry North Queensland, landholders), and academia (James Cook, Queensland and Griffith Universities).

The workshop sessions were designed to allow exchange of views, provoke wider thinking and generate new ideas, and find where consensus exists as to desirable ways forward for the North Queensland timber industry.

PLANNED WORKSHOP OUTPUTS

Some desirable outcomes to which the group would aspire included: forest industry development (FID) options endorsed by the group; a business case to support one or more options; and a strategy for implementation of one or more industry development options. It was envisaged that such options could run across land types and tenures (government, industrial and farm forestry), species types (softwoods and hardwoods), and stages in the value chain (tree growing, processing and marketing), and would need to take into account sustainability of production from the economic, social and environmental perspectives. It was recognised that these goals may be difficult to achieve. An intermediate outcome might include: recognition of some forestry options as preferable to others; some options rejected as not acceptable in the region; and some elements of a business case as well as target agencies or individuals to which to present findings and recommendations. The idea of forming a small group to further progress the workshop recommendations was discussed.

In the event, these aspirations have come to pass through the support of the Sustainable Regions Programme of the Federal Department of Transport and Regional Services (DOTARS), through which funding was obtained by the Atherton Tablelands Sustainable Regions Advisory Committee (ATSRAC) to develop a business case and implementation plan for Hoop Pine expansion on the Atherton Tablelands.

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2. INVESTMENT IN AUSTRALIA'S FOREST AND WOOD PRODUCTS INDUSTRY

A. Flanagan

Australian industries are facing an increasingly international environment in which there are no uniform levels of compliance and sustainable management at the global scale. The future of Australia's forest and wood products industry will be influenced by its response to the opportunities and challenges arising from this new environment, while balancing the interests of those who derive their livelihood from our forests and those who place increasing importance on the conservation value of these very same forests.

INTRODUCTION

Fora such as this gathering of forestry experts are important for the industry's development, and this workshop will no doubt provide fruitful discussion and progress on important issues. Indeed, the number of attendees and the interests represented underscore the strong interest in developing the full potential offered by North Queensland's forest and wood products industry. It is the right time to review the investment potential of the forest and wood products industries in this region and the benefits the sector creates.

This workshop has been held at a time when the Forest and Wood Products Council and the Forestry and Forests Committee are looking to develop a Vision of the Industry. In addition, domestic and international investors are focusing on the potential the Australian industry provides. This is a theme the Forest Industries Branch of the Australian Government Department of Agriculture, Fisheries and Forestry (AFFA) promotes. In October 2002, the Department hosted the National Forest Investment Workshop in Canberra, attended by more than eighty people, including many captains of industry.

The national workshop identified actions that industry and all levels of government need to address in order to provide a more attractive investment environment. The list is not overly long, but it is all embracing. It covers resource security, consistent political support, including providing transport and unambiguous approval guidelines and policy, and documenting existing infrastructure and identifying gaps. It also includes identifying potential investment opportunities and suitable locations, combined with the need to address environmental and community concerns. Those who took part in the workshop agreed that many of these issues could only be addressed at the regional level.

To date, five Regional Forest Investment Workshops have been held: Portland, Victoria (April 2003), Katanning, Western Australia (October 2003), Morwell, Victoria (August 2004), Grafton, NSW (September 2004), and Mackay, Queensland (March 2005). A final 'wrap-up' workshop is being held on 28-29 April 2005 in Hobart, Tasmania. This final workshop will build on the common issues, themes, strategies and actions identified within each of the Regional Workshops to develop a National Investment and Regional Development policy paper (the policy paper). The policy paper will look to develop a partnership approach between industry and governments to attract new investments and support existing industries to realise the full national potential within each major forest-growing region.

At this North Queensland Forestry Industry Development workshop, an important topic for discussion will be options for increasing investment in North Queensland's forest and wood products industry, and what government and industry can do to achieve this. When

discussing these issues, it is important to remember that, while Governments provide the broad framework conducive to investment, companies are the investors. It is only through cooperation between forest companies – growers and processors – that investment will take place.

THE AUSTRALIAN FOREST AND WOOD PRODUCTS INDUSTRY

The forest and wood products industry is one of Australia's largest manufacturing sectors, directly employing more than 130,000[1] people across regional and rural Australia. Our eleven million hectares of multiple-use native forests and 1.7 million hectares of plantation forests produce nearly twenty-seven million cubic metres of fibre, valued at just over AU$1.4 billion. More than 1,100 mills and processing facilities turn this fibre into more than AU$18 billion of products[2].

These products include 3.1 million kilotonnes of paper and paper products, four million cubic metres of sawnwood and two million cubic metres of panels. Australia is, however, a small player internationally. Australia imports nearly AU$4 billion of wood-based products each year, and 65% of this is paper products. Clearly, attracting new investment in Australia's forestry-based industries, including ultimately a new pulp and paper mill, is the path to significant long-term benefit and opportunity. To remain competitive, the Australian industry must be a smart player.

The Australian Government recognises the important contribution investment makes to Australia's economic growth. It has instituted policies and programs to foster a positive attitude to investment, support industry confidence and stability, and encourage a greater willingness by industry to seek out new and more profitable markets. The government has created a commercially competitive environment and stimulates substantial private capital investment in the timber industry through several measures. These include implementing national competition principles, reduced business taxation rates, and associated wide-ranging taxation reforms, as well as direct funding of research and development agencies.

The Australian Government's support for research and development underpins the globally competitive performance of our forest and wood product industries. The Australian and State Governments, in partnership with industry, fund research programmes that facilitate sustainable forest management, improve wood and fibre performance, increase wood and paper processing efficiency and environmental performance, and increase value adding for wood and paper products.

Australian governments have developed a national approach to forest management, encompassing the National Forest Policy Statement, Regional Forestry Agreements, Plantations for Australia: The 2020 Vision Statement, and the Forest and Wood Action Agenda. Australia is a world leader in sustainable forest management. We have decades of experience in competitive management of our hardwood and softwood resource.

Managers of Australian production forests and plantations can also demonstrate – through the Australian Forestry Standard (AFS) – that they sustainably manage their forests to maintain a balance of environmental, social and economic outcomes. The AFS is Australia's national forest management certification standard, which Standards Australia and the Pan European Forest Certification Council recognise[3].

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[1] *Industry Data Collection Survey* Report, Forest and Forest Products Employment Skills Company, www.fafpesc.com.au.
[2] Australian Forest and Wood Products Statistics, November 2004, ABARE.
[3] www.forestrystandard.org.au

AUSTRALIA'S COMPETITIVE ADVANTAGES

Our strong and ever-growing plantation resource base is the foundation for our increasing participation in the expanding Asia-Pacific market. As the Australian Government's State of the Forests report showed last year, Australia's expanding plantation resource stands at more than 1.7 million hectares, about 1% of Australia's total forested area. The area of plantations has increased by 50% since 1990, encouraged by the 2020 Vision Statement. Since 1997, more than 0.5 million hectares of new plantations has been established under the 2020 Vision Strategy[4]. These actions demonstrate that Australia now has 'the fundamentals right'. Figure 1 illustrates that government subsidies did little to stimulate private investments in plantations. However, once the business environment was improved, private investment rocketed.

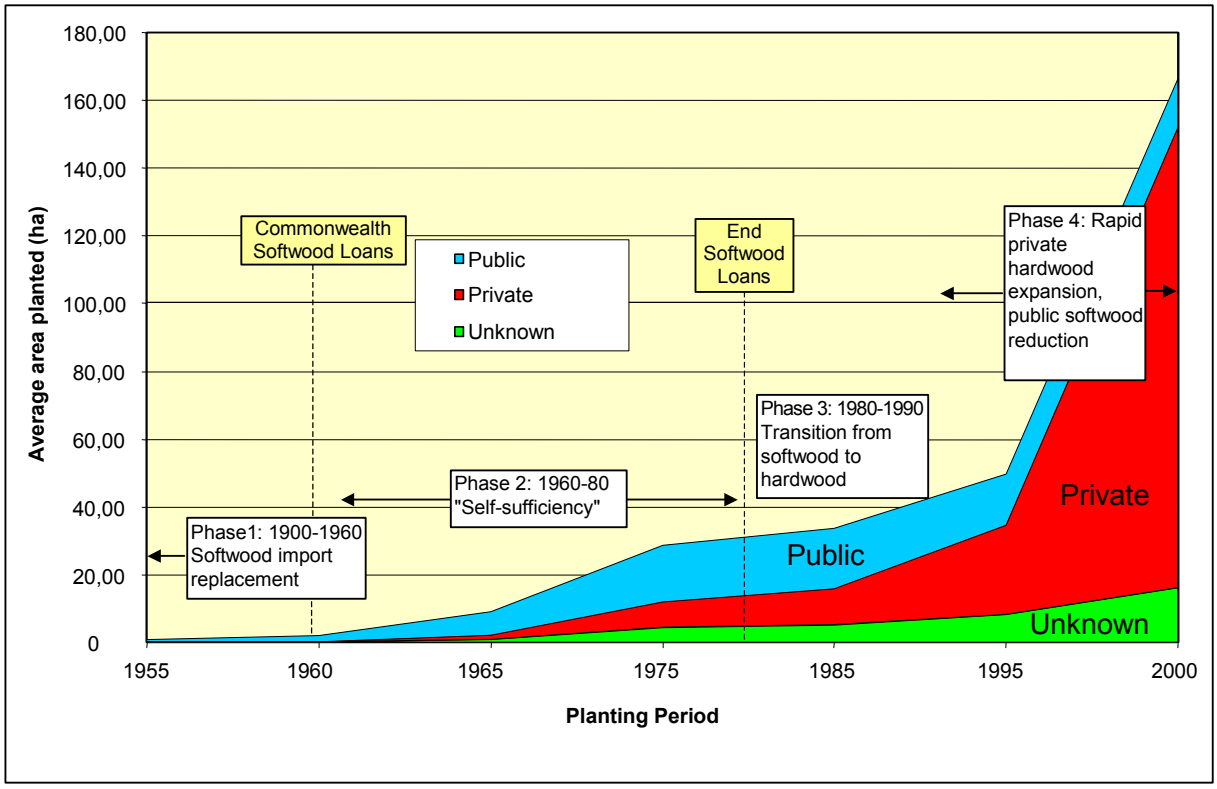

Figure 1: Plantation phases in Australia.

Australia's timber industry is recognised as internationally cost competitive and as possessing particular strengths in plantation management, transport infrastructure and power generation. The 2003 World Competitiveness Index – based on economic performance, government efficiency, business efficiency and infrastructure – rated Australia as the second most competitive country, compared with thirty other countries with populations of more than twenty million[5]. Australia's strong domestic market is a solid platform for investment strategies to increase production, decrease imports and value-add along the supply chain. The domestic market also provides a springboard for processors to develop new export markets in the Asia-Pacific region.

[4] www.brs.gov.au/plantations

[5] The 2003 World Economic Competitiveness Index which is based on economic performance, government efficiency, business efficiency and infrastructure: http://humandevelopment.bu.edu/dev_indicators/show_info.cfm?index_id=100&data_type=1 Australia is also rated 14th out of 130 countries surveyed in the 2004-05 Business Competitiveness Index: www.weforum.org/pdf/Gcr/Business_Competitiveness_Index_Porter

Consequently, Australia is a low-cost producer of wood fibre, and can compete successfully with the world's best because of:

- Uniform resource management policies;
- Highly mechanised harvesting and processing sectors;
- High-grade national, state and regional infrastructure;
- Highly trained and well-educated workforce;
- Closeness of resources to mills and port facilities; and
- Specialised, industry-focused research and development organisations.

If we get the fundamentals right, companies will invest – as Figure 1 demonstrates.

The Australian forest and wood products sector is entering a period of growth and expansion that is a result of the increasingly available resources and new investment in the industry. Since 1994, more than AU$10 billion has been invested in the forestry sector, including AU$3.4 billion invested in new plantations[6].

Over the next ten years, it is projected that this trend will continue with investment in a new pulp mill (possibly in Tasmania), increased paper production in Victoria, an innovative, engineered strand lumber mill in Western Australia and many more innovative projects across the nation. Plantation expansion is expected to continue, with North Queensland and the Northern Territory likely to become significant plantation timber centres, while the southern states will reap the benefits of the trees planted since the *Plantations for Australia: The 2020 Vision* was launched in 1997.

Regional Opportunities

A 2001 report by an independent consultancy firm, *Investment Opportunities in the Australian Forest Products Industry* [7], indicated the newly established plantation resource within each of Australia's growth regions could supply enough fibre – at least 750,000 tonnes per year – to support a world-scale kraft pulp and paper mill. A new mill would provide increased value-adding opportunities for low-grade forest products, inject more than AU$2 billion into regional Australia during construction, increase regional employment opportunities and provide forest growers with up to AU$40 million a year in royalties.

Australian forestry can be viewed within the broader Asia-Pacific region, a context which is important as this industry becomes more internationally focused. Forecasts of European and North American consumption and production of wood products show these markets will remain relatively stable. However, the Asia-Pacific region's improved economic development is expected to substantially increase the demand for forest products, and by 2010 net regional imports may exceed 200 million tonnes. The forecasts suggest most of the imports will be higher valued products, particularly pulp and paper.

Europe, North America and northern Asia account for 80% of the world trade in forest products[8]. Table 1 indicates the top three export / import countries, by value, of forest and wood products.

[6] DAFF, 2004 compiled with assistance from URS Forestry and Jakko Poyry Consulting.
[7] Jakko Poyry, 2001, available at www.daff.gov.au/content/publications.cfm?ObjectID=BE45A763-2CCB-4CFB-B5D47431DCAE4680
[8] www.fas.usda.gov

Table 1: Top three countries based on value of export and import of forest and wood products, 2003[9].

Exports	Value US$ billion
Canada	12.7
EU	7.8
USA	5.0

Imports	Value US$ billion
USA	16.6
EU	15
Japan	9.9

The broader Asia-Pacific region is a market, which is important as this industry becomes increasingly internationally focused. Overall, the markets in the Asia-Pacific provide us with many trade opportunities, which a number of bilateral and multilateral negotiations will provide, as the region's demand for paper products is expected to double by 2010 and the region is expected to remain a net importer of softwoods.

This forecast now seems to be on target as regional economies recover and China emerges as an international participant in World Trade Organisation (WTO) and other fora.

Within the Asia-Pacific region, Japan is the largest purchaser of wood products. Japan's wood manufacturers consumed 30.5 million cubic metres of logs in 2003, down 1.2% from the previous year: 15.1 million cubic metres were supplied from domestic forests and 15.4 million cubic metres from imported logs. Eighty-three percent of all logs were softwood. Imported softwood logs were principally from North America (6.1 million cubic metres), Russia (5.4 million cubic metres) and New Zealand (1.6 million cubic metres). Australia provided 109,000 cubic metres. However, Australia continued to be the principle supplier of woodchips, providing over 33.5% of the 13.6 million cubic metres imported: South Africa provided 21.7% and Chile 11.8%[11].

The region's fifth largest market, Korea, imports more than 93% of its wood needs. The Korean Forest Service estimates that in 2004, consumption of wood products would reach 28.3 million cubic metres (round-wood basis), composed of 26.5 cubic metres of imported wood products and 1.79 cubic metres of local wood products[12].

China is rapidly becoming a significant importer, especially as greater regulation and control restrict access to its own timber resources. In a decade, China moved from a ranking of seventh up to second among all nations in total value of forest product imports and is now the top importing country worldwide of industrial round wood[13]. In 2004 the import value of timber (excluding paper pulp) was about US$4 billion (sawn timber imports increased 10.5%), plywood US$1 billion and furniture was US$2.8 billion[14].

There is also uncertainty as to whether some Asia-Pacific countries can maintain their supply of high-yield, low-cost wood from native forests. In many of these countries, the availability of natural timbers is steadily being reduced, greatly limiting the amount of wood available to local processors. China, for example, faces a shortage of sixty million cubic metres of timber supply arising from its ban on logging in sensitive areas of high conservation[15].

At the same time, there may be a decline in timber supplies from North America as environmental concerns there put a brake on production. To give an example, sawlog production is expected to decline by ten million cubic metres by 2010. This may result in US imports of paper and paperboard products increasing by three million tonnes – to a total of

[9] Information incorporated from reports at www.fas.usda.gov
[10] Information incorporated from reports at www.fas.usda.gov
[11] www.fas.usda.gov/gainfiles/200407/146106963.doc
[12] US GAIN Report: KS4034. www.fas.usda.gov/gainfiles/200407/146106866.pdf
[13] FAOSTAT Agricultural Data,FAO, 2004: http://faostat.fao.org/ on March 12, 2004
[14] BEIJING, Jan 14 Asia Pulse media reports at http://au.news.yahoo.com/050114/3/sl4l.html
[15] Chief Executive Officer of MTC, www.mtc.com.my

twenty million tonnes – over the same period. This is an opportunity for Australian manufacturers made easier through the Free Trade Agreement (FTA) with the United States of America. Already, reduced harvesting volumes are impacting on exports with the value of US exports decreasing from US$5,832 million in 1998 to US$5,005 million in 2003[16]. However, it should be noted that exports to China have increased in value from US$41.3 million to US$253.5 million, while exports to Japan decreased from US$1,622 million to US$818.5 million over the same period.

Focus on Emerging Regional Markets

Opportunities exist in international and domestic markets for increased processing capacity within the forest and wood products sector. Australia is well positioned to take advantage of the expanding wood and fibre markets within the Asia-Pacific region.

2005 will be a crucial year for the Doha Round and Australia's bilateral efforts. On 1 January 2005 Free Trade Agreements with the United States of America and Thailand entered into force. A number of other agreements are in prospect, e.g. between Australia, ASEAN[17] and New Zealand, Australia and Malaysia, and Australia and China.

Bilateral agreements are an important tool used by the Australian Government to foster trade and develop market opportunities in mature markets (such as the USA), traditional markets (such as Malaysia), growing markets (such as China) and emerging markets.

The agreement in Jakarta in September 2004 to investigate the establishment of a FTA between ASEAN, Australia and New Zealand is an important milestone in the regional relationships[18]. The parties committed to a comprehensive agreement covering goods and services, with a no *a priori* exclusion of sectors and the elimination of all forms of trade barriers. If realised, this FTA would enhance and strengthen existing and significant regional trade and investment linkages. It is estimated that between 1993 and 2003, Australia's bilateral trade with ASEAN increased annually by 9.7%; the 2003/2004 bilateral trade was valued at around AU$33 billion, accounting for more than 11% of Australia's merchandise exports and around 15% of services exports[19].

Focus on China

China imports 6 million tonnes of paper products a year – 42% high-grade printing and writing paper, and 22% coated paper. By 2010, it will need another 3.7 million tonnes of pulp – equivalent to 18.5 million tonnes of wood – to meet its growing demand. And in the next twenty years, more than 600 million people of the total population will have moved into the middle to high-income bracket, i.e. more people than the combined populations of Europe, North America and Japan.

China's accession to the World Trade Organisation (WTO) in December 2001 was a watershed event – not only for Australia – but for the world economy. China's WTO membership guarantees Australia access to this valuable market under predictable, transparent and enforceable rules. The commitment to tariff reductions and imposition of

[16] www.fas.usda.gov/ffpd/US_Exports_Trade_Data/archived_exports_trade_data/A_VCountry.xls

[17] The Association of Southeast Asian Nations or ASEAN was established on 8 August 1967. Members are Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei Darussalam, Vietnam, Laos, Myanmar and Cambodia.

[18] ASEAN countries have a combined population of about 500 million people, a total area of 4.5 million km^2, a combined gross domestic product of US$737 billion, and a total trade of US$720 billion.

[19] MinterEllison Trade Law Focus paper, online at www.ecm7.com/cm/images/53/Newsletters/TradeLawFocusDec04.pdf

limits on future tariff rate rises will make China a relatively open economy by world standards. Hence, strengthening and deepening trade and economic relations with China is a major priority for the Australian Government.

In October 2003, Australia signed the Trade and Economic Framework with China, setting the direction for developing the strong and rapidly expanding trade and economic relationship with Australia. A key element of the framework is a commitment to undertake a joint feasibility study into a possible Australia-China Free Trade Agreement (FTA). This follows the FTA negotiated recently with the United States of America, which will mean an immediate zero tariff level on all forest product exports to the USA. The FTA provides exciting opportunities for the industry. The completion date for a joint feasibility study into a possible FTA between Australia and China is 31 October 2005, and AFFA will be working to ensure favourable outcomes. At the same time, Australia must not lose sight of existing markets, including America, Japan, and other emerging opportunities, such as those in India.

In summary, great opportunities exist in international and domestic markets for increased processing capacity within the forest and wood products sector. Australia is well positioned to take advantage of the expanding wood and fibre markets within the Asia-Pacific region. In addition to the bilateral and regional market access opportunities that Australia is pursuing – with the USA and China for example – the Australian Government has not overlooked the forest product trade barriers that will be addressed in the WTO Doha Round of multilateral trade negotiations. Specifically, forest products are being addressed under the umbrella of non-agricultural market access negotiations, which are sometimes called 'Industrials'. Multilateral trade rounds are recognised as long and difficult affairs, but they still offer the greatest rewards. Successful outcome in this area could see lower tariffs facing Australia's forest product exports and address a reduction in the non-trade barriers currently holding back Australian trade in forest products. The Australian Department of Agriculture, Fisheries and Forestry is working with the Australian Department of Foreign Affairs and Trade (DFAT) to ensure these issues are addressed.

On a different note, the Australian Government is increasingly recognising the multiple benefits plantation forests can provide, including mitigating dryland salinity and combating land degradation. Through the Natural Heritage Trust, the Government has financed a major three-year project called Commercial Environmental Forestry, to develop a co-investment framework for plantations to deliver commercial and environmental outcomes. The Commercial Environmental Forestry project will target areas where forestry can deliver reasonable growth rates and substantial salinity benefits in the short term. This is one of the elements through which progress can be made towards achievement of the plantation expansion targets outlined in the 2020 Vision Statement needed to support the growth of forest industries. At the same time, the project will generate substantial private investment in the forest and forest products industry, and deliver important environmental and social benefits through salinity mitigation.

One final point – the Australian Government has recognised the benefits from, and contribution to, the forest and wood products industries, which indigenous communities can make. There are opportunities for Indigenous communities to participate more in this industry. Currently, 13% of Australia's forest area is under Indigenous ownership. This is why AFFA is developing a National Indigenous Forestry Strategy, which will investigate current Indigenous involvement in the industries and identify actions to assist both Indigenous groups and industry to develop valuable forestry projects. This strategy is another step along the path towards a more sustainable and profitable industry by increasing the capacity and opportunities for all participants.

CONCLUSION

The above analysis suggests that there are four particular themes that need to be addressed if the timber industry is to continue to expand.

- Australia must attract more investments to use our increasing fibre resource;
- Value-adding is critical to provide the products consumers want and to address Australia's trade deficit in forest and wood products;
- Markets must be consolidated and developed; and
- The benefits created by forest and forest products industries must be maximised.

Through initiatives such as this workshop, the various forestry stakeholders as partners can meet these challenges.

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3. AN INTEGRATED APPROACH TO EXAMINING OBSTACLES TO AND OPTIONS FOR FOREST INDUSTRY DEVELOPMENT

S.R. Harrison

The reestablishment and expansion of a forest industry in a country or region after an era of severe resource loss – such as arises from deforestation or designation of protected areas – presents a considerable challenge for government and industry stakeholders. Various approaches may be adopted to identify the obstacles to and opportunities for increased tree planting and timber processing. This paper proposes an integrated approach to developing forest industry redevelopment strategies, involving SWOT analysis, systematic identification of impediments, value chain analysis, exploration of forestry 'visions' or 'futures', identification of keys to forestry development and identification of forestry facilitation measures. Some comments are made on how this approach might be applied in North Queensland.

INTRODUCTION

In countries where there has been a high rate of deforestation in recent decades, redevelopment of forestry industries based on plantations is typically a policy objective. In developing countries, major difficulties arise because of lack of finance to support large-scale reforestation, and often weak property rights for industrial and small-scale forestry. However, in developed countries, it might be expected that redevelopment of timber industries would be feasible, in terms of resources and technology available and administrative capacity, yet progress is sometimes disappointingly slow.

If the plantation area remains small in a region well suited for forestry expansion, can we identify why this is so, and formulate measures to promote more rapid progress? Observation of persistent disappointing progress suggests that either this is not the case, that there is lack of commitment by government and industry, or there is a combination of both. In many regions of Australia, for example, a substantial land area exists that is suitable for forestry and for which forestry is an economically and environmentally appropriate land use. Given that Australia has large net annual timber imports there would seem to be a strong case for expansion of the plantation estate.

Over recent decades, many government support programs have been introduced to promote forestry (e.g. see Boutland *et al*. 1992). However, these programs have invariable been of short duration (Herbohn *et al*. 2000), suggesting a trial-and-error approach, perhaps with episodic politically driven motivations. While there has been a rapid increase in the area of short-rotation eucalypts for pulpwood along the southern fringe of Australia, elsewhere increases in plantation sawlog production do not appear to have matched withdrawal of the native forest resource.

A clear need exists for an effective method to examine the obstacles to and prospects for regional forest industry development. Such a methodology would assist in designing forestry development strategies, and in the formulation of durable forestry support programs. It could also be used to inform National Forestry Programs (NFPs) and regional forestry program, such as have been progressively adopted in Europe since 1998 (Tikkanen *et al*. 2002).

These programs are designed to provide a strategic framework to facilitate cross-sectoral approaches and policy coordination through participation and partnership arrangements.

This paper outlines a proposed integrated methodological framework for examining the progress in, and obstacles to, forest industry development, and partially applies this to tropical North Queensland as a case-study region.

THE RATIONALE FOR PROMOTING FOREST INDUSTRY DEVELOPMENT

A starting point when considering strategies for forest industry development is to examine reasons why forestry should be promoted, and the type of industry that this implies. Convincing reasons – relating to both timber production and environment – often exist for government policy to support an increased forest plantation area, some of which are presented in Table 1. Some of these benefits are not captured by forest or plantation owners, for whom forestry may be a marginal or unprofitable investment without public financial support or improvements in the investment environment. Dominant-use forestry would be favoured where wood production is the main goal, while greater priority on a multiple-use forestry regime is suggested where environmental and tourism benefits are high.

Table 1: Reasons to support forestry expansion.

Timber self-sufficiency	Particularly where there is a regional or national deficit of timber, yet suitable land available for plantation establishment, there can be an imperative for import replacement.
Replacement of declining agricultural industries	Where other rural industries are in decline, forestry provides an alternative land use and income generation activity for landholders.
Linkages with other industries, including tourism (complementarities)	Timber production provides input for timber processing industries, material for construction, landscape amenity and wildlife habitat for tourism, benefits for water supply, and has other inter-industry linkages.
Positive environmental externalities	Forestry can provide positive environmental externalities (watershed protection, carbon sequestration, wildlife conservation, flood mitigation, reduction of siltation of rivers or marine areas).
Support for rural populations	Some types of forestry directly or indirectly provide regional employment, supporting maintenance of rural infrastructure and services and preventing population drift to cities. Maintaining regional viability may be a policy goal for social and strategic reasons.

ANALYSIS METHODS FOR EXPLORING FOREST INDUSTRY DEVELOPMENT OPTIONS

There would appear to be no single approach to identifying policies, which can lead to accelerated progress in forest industry development, and literature suggests that a range of approaches can be applied to generate insights into effective policies.

SWOT Analysis

The SWOT Analysis approach of identifying the Strengths (to be utilised), Weaknesses (to be overcome or minimised), Opportunities (to be exploited) and Threats (to be avoided) has found wide use as an analysis framework in relation to particular industry and policy

initiatives (e.g. see Dayananda *et al*. 2002). The analysis is typically carried out subjectively, in group-discussions involving people with particular knowledge and experience in the subject area. The SWOT analysis framework is well suited for application to forest industry development in a specific region. Here, forestry 'experts' can identify the critical features of the forestry environment, as a backdrop to identifying how improvements can be made. The experts may reflect individually, say, by filling out a pro forma list of items, after which the responses are summarised – as adopted by Suh and Emtage (2005) – or may deliberate by interacting in a panel setting (e.g. in a workshop). An alternative could be to use split groups at a workshop, in which case the findings of the groups could be compared for consistency, as a partial validation of the approach.

Systematic Identification of Forestry Impediments

It is often possible to identify a long list of impediments to forestry in a region. For example, Venn *et al*. (2001) identified 21 impediments to forestry expansion in the Philippines (with a focus on the growing of Australian eucalypts and acacias), grouping these under headings of profitability concerns, resource input scarcity, market constraints, property rights constraints and attitudinal impediments. These groups provide a convenient basis for a checklist of impediments to tree planting by government, industrial foresters and farmers. Such a checklist could take the form of:

- Profitability concerns: timber prices, rotation length, scale of planting, taxation system, risk levels (of windstorm, wildfire, pests and diseases, timber price fall, regulatory change);
- Resource input scarcity: land availability and site-species matching considerations, availability and quality of inputs (capital, machinery, labour and seedlings);
- Market constraints: local market size and demand strength by species and product type, distance to markets, reliance on middlemen;
- Property rights constraints: security of land and tree tenure, harvest security, transport approval difficulties; and
- Attitudinal impediments: landholder interest in growing trees, lack of a plantation forestry culture, species preferences, attitudes to equity-sharing funding arrangements.

Analysing Obstructions Along the Supply or Value Chain

Further insights into obstacles to forestry development can be gained by examining the flow of wood along the supply chain and price mark-ups in the value chain. Weak property rights frequently exist in relation to gaining approvals for tree planting and harvesting. These can create negative signals for potential tree growers, and their identification may present an opportunity to promote planting through policy reform.

The timber supply chain consists of a sequence of markets, at each of which both market and technical inefficiencies can arise, and dampen prices to other participants in the chain. The stumpage price to tree growers is, in a sense, a residual after other agents in the 'timber production pipeline' have taken their shares of the final market price. Where joint products arise (e.g. thinnings, non-timber forest products, ecosystem services for which growers receive some compensation), the supply chain may become quite complex, and timing issues of products and services, and hence cash and labour flows, may become important.

A further complication in analysing the timber supply chain is that demand may be weak where forestry activity is low in relation to processing thresholds – the infant industry problem. A basic premise in industry is that there is no point in producing a product for which

no market exists. Forestry is something of a special case, because presence of product can lead to development of a market, and the long time lags in production mean that there is little point in establishing processing infrastructure until it is clear that a timber resource will be available to process. In practice, a low level of processing often is available, and hence a weak product demand, and substantial tooling up will be required if production is expanded. Tree growers, timber processors, or both, may be required to take on substantial financial risk if they are to invest in forestry.

Identifying Keys to Forestry Progress

Byron (2001), in reviewing forestry in developing countries, came to the view that four enabling factors consistently arise, which are all necessary for forestry to advance, referring to these as 'keys'. His analogy is to a door with a number of locks, each of which must be released before the door can be opened.

Byron's keys are:

- Secure property rights to land and tree crops;
- A viable production technology;
- Capacity for crop protection; and
- Adequate markets.

Intuitively, a set of keys would also exist in developed countries, although these might differ in nature, e.g. the production technology may be more developed and crop protection (from timber theft or appropriation) less difficult.

Identifying Forest Industry Scenarios, 'Visions' or 'Futures'

It is often the case that forest industry stakeholders – including people in government agencies, timber processors, landholders and conservationists – will have strong views on what type forestry industry is most appropriate for a region. The views are typically partisan, often not clearly enunciated, and frequently conflicting, but these enthusiasts or champions of forestry can provide valuable input into industry development options.

Various approaches may be adopted to identify forestry 'futures'. Perhaps the simplest is to identify individuals with considerable experience of forestry in a region, and conduct semi-structured interviews. At a more formal level, a multi-objective decision-support system or MODSS approach may be adopted. This involves consultation with various stakeholders, whereby forestry options are identified, and community goals or objectives defined (in terms of economic, social and environmental outcomes) and importance weights obtained for these goals or objectives. The level of performance of each forestry option is then estimated. A complexity in applying MODSS to plantation forestry is that various time periods must be identified (plantation establishment, the maintenance period, and the harvest period). This technique has been applied in southern and northern Queensland by Jeffreys (2003). Forestry options were considered at three time scales, namely the establishment period, transitional period (plantation age five to thirty years), and the steady-state period.

Identifying Forestry Support and Facilitations Measures Which May be Appropriate for the Particular Region

Various measures may be implemented to support forestry, including:

- Creation of a favourable institutional structures;
- Creation of a supportive regulatory environment (e.g. removal of sovereign risk, assurance of secure harvest rights, separation of land and tree ownership through *profit à prende* arrangements);
- Creation of a level playing field for foresters (e.g. between government or industrial versus private growers);
- Provision of financial assistance;
- Provision of technical information or extension services to growers; and
- Facilitation of markets for ecosystem services.

In practice, some mix of these measures is usually adopted, sometimes within a national or regional forest policy framework.

Various organisational structures may be instituted to provide support for development of non-industrial forestry, some of which are:

- Government-funded forestry subsidy arrangements;
- Provision of forestry extension services;
- Equity investment by government in non-industrial forestry;
- Provision of timber marketing services by government;
- Government and community co-management of forestry;
- Support for establishment of clubs, unions, clusters and new age cooperatives;
- Arrangements for accessing external capital to support forestry development;
- Arrangements for trade in immature plantations; and
- Organisational arrangements for marketing ecological services.

Relationship Between Approaches and Integration in an Analysis Technique

The above approaches clearly are not independent, and have substantial overlap, some of the linkages being illustrated in Figure 1. Identification of forestry impediments is closely related to listing of regional weaknesses. An analysis of supply chain failure sheds further light on regional weaknesses or obstacles in the current industry environment, particularly in relation to market and regulatory failure. Formulation of visions, which may draw on comparative regional strengths, provides insights into possible forestry development opportunities. Identification of keys and facilitation measures can reveal weaknesses and provide insights into how opportunities may be pursued. Facilitation measures may also be designed to prevent threats.

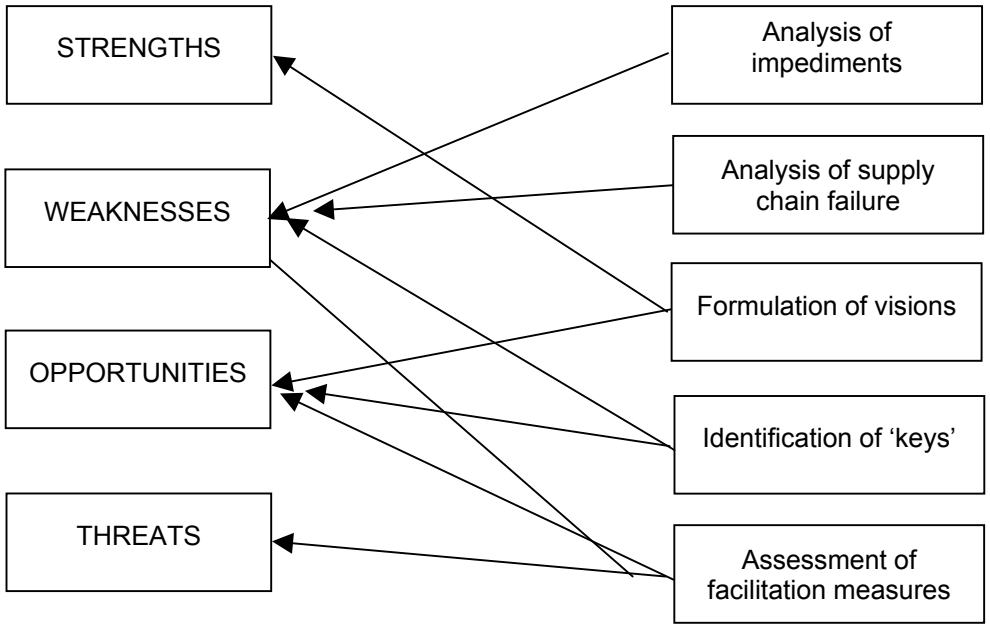

Figure 1: Relationship between SWOT analysis and other approaches to assessment of forestry options.

Combining these analysis approaches into an integrated analysis technique has the potential to provide valuable insights into forest industry development options. Figure 1 provides the basis for an integration framework. No single analysis approach would appear to provide an overarching framework. Also, there would appear to be no logical time sequence, suggesting that simultaneous application of each approach be adopted. The output of the analysis includes both forestry development options (equivalent to opportunities in the SWOT analysis) and a greater understanding of the environment in which these opportunities may be pursued.

Implementation of the integrated technique would presumably require harnessing the inputs from a group of forestry 'experts', or people with expertise in silviculture, timber processing, finance, and social and environmental issues. This might be best achieved in a workshop situation. The outputs of such an analysis would provide decision-support input for policy making.

APPLICATION TO FOREST INDUSTRY DEVELOPMENT IN TROPICAL NORTH QUEENSLAND

Features of the Current Forest Industry Situation in North Queensland

North Queensland (defined here as approximating the Statistical Divisions of North and Far North Queensland) has a history of logging of Wet Tropics rainforests and wet sclerophyll (eucalypt) areas since early settlement (Lamb *et al*. 2001). The allowable cut of rainforests on Crown land was progressively reduced during the 1980s and ceased with gazettal of the Wet Tropics of Queensland World Heritage Area (WTWHA) in 1988. While some logging of native forest on private land has continued, there has been a radical contraction of the timber industry.

Native forests and plantations are found on a variety of sites, including high rainfall (> 4,000 mm per year) humid coastal areas, cooler moist elevated tableland areas (1,200-2,000 mm), and the more favourable dry tropics areas (1,000-1,200 mm). Much of the land has suitable soils for forestry, being derived from basalt, granite and metamorphic rock types.

The Queensland Department of Primary Industries (the State forest agency) has approximately 14,000 hectares of Caribbean Pine (*Pinus caribaea*) in North Queensland, mostly in coastal areas near Cardwell, and approximately 1,000 hectares of Hoop Pine (*Araucaria cunninghamii*) on the Atherton Tableland. An area of approximately 2,500 hectares of plantations (rainforest species, eucalpyts and exotic conifers) exists on private land, some of which has lacked silvicultural management.

A single softwood mill (Ravenshoe Timbers Pty Ltd) operates on the Atherton Tableland, using modern milling technology (laser guided bandsaws, finger jointing, several kilns). This mill processes about 25,000 cubic metres of Hoop Pine and Caribbean Pine per year, to produce a range of value-added timber products for sale into the domestic and international markets. A handful of small family-owned hardwood sawmills still operate in North Queensland, collectively processing approximately 500-2,000 cubic metres of rainforest species per year, sourced primarily from private land. One of these hardwood mills has invested in kiln drying and chemical treatment facilities. No slicing or peeling veneer infrastructure exists in the region (Killin *et al*. 2002), nor is there any woodchip or pulp industry.

The region has recognised high environmental values, with two World Heritage areas (the rainforests of the WTWHA and the Great Barrier Reef Marine Park). Tourism is the largest single industry in the region, based on the attractive landscape and marine areas, and supported by a pleasant winter climate, relatively safety for visitors, and proximity to Asia (through Cairns International Airport). In the last decade, farm-gate prices for sugar and milk have fallen sharply, the tobacco industry has ceased to exist, and a tea-tree oil industry had a short life before collapse. Foreshadowed approvals for banana imports from the Philippines were expected to adversely affect the coastal banana industry, although these imports did not eventuate. While sugar prices have increased, and there has been some recovery in dairying on the Atherton Tablelands, to some extent a vacuum still exists for profitable and environmentally sustainable enterprises on rural land.

Periodic government subsidy and extension programs between about 1970 and 1990 resulted mainly in small plots of conifer plantings on farms. Farm forestry was promoted in the 1990s, with the Community Rainforest Reforestation Program leading to establishment of about 2,000 hectares of mainly native timber species on about 550 farms over fourteen local government areas (Creighton and Sexton 1996). The Plantation Joint Venture Scheme between the state forest agency and landholders resulted in the planning of 160 hectares of four species over sixteen farms using legally binding *profit à prendre* sharefarming agreements. The North Queensland Joint Afforestation Board and Trees for the Atherton and Evelyn Tableland supported small areas of riparian revegetation plantings.

SWOT Analysis for North Queensland Forestry

The author's experiences, discussions with forestry experts and literature reveals a number of factors affecting forestry expansion in North Queensland, which may be expressed in the form of a SWOT analysis as in Table 2.

Table 2: SWOT analysis of North Queensland forest industry environment.

Strengths	Abundant available land where forestry is an appropriate land use.
	A wide variety of high-value fast growing native tree species available.
	Strong enthusiasm among landholders for growing trees.
	Forestry is an acceptable land use in the region, which has high environmental sensitivity.
	A substantial amount of information is available from forestry research in the region about species-site, silvicultural requirements and social and environmental factors.
Weaknesses	Long distance from major population centres (timber markets).
	Low stumpage prices and lack of interest in forestry by commercial farmers.
	Lack of support for forestry expansion by the state forest agency.
	Lack of a forestry culture amongst landholders.
	Little integration between the softwood and hardwood sectors of the industry.
	Perceived high sovereign risk.
	Low stumpage prices charged by state forest agency as price leader.
	Unsaleable farm conifer stands send negative messages.
	Lack of market recognition of many of the species grown.
Opportunities	Acquisition of non-viable dairy farm land for commercial softwood plantings.
	Value-adding furniture manufacture using plantation-grown rainforest cabinet timbers.
	Marketing forest products (furniture, fittings, flooring and poles) in southeast Asia.
Threats	Harvest security and new environmental regulations.
	Tree damage from tropical cyclones.
	Low-priced timber imports from New Zealand and developing countries.
	Large number of species and lack of threshold volume for each.
	Displacement of high-value solid wood furniture by composite wood products.

A major *strength* is the abundant land available that is appropriate for use in forestry. Area estimates include 36,780 hectares (Kent and Tanzer 1983a,b), 40,000 hectares (Fullerton 1985), 41,000 hectares (located within 150 km of Cairns with rainfall, slope and soil conditions suitable for plantation forestry, and potentially available taking into account current economic conditions for competing land uses, estimated through a geographical information system) (Keenan *et al*. 1998), 86,000 hectares (extending the Keenan *et al*. estimates to 200 km from Cairns) (Annandale 2002), and 134,000 hectares (also 200 km radius of Cairns) (Anderson and Halpin 1998)[1]. Another strength is that twenty rainforest species with timber of high commercial value (some of which are very high quality furniture timber including Queensland Maple and Northern Silky Oak) have been demonstrated to grow in plantations in the region, plus a variety of native and exotic pines, eucalypts and acacias, and several exotic tropical species (including African Mahogany and West Indian Cedar). The

[1] High activity in land sales and sharp increases in land prices on the Atherton Tablelands in the last three years have changed the financial picture somewhat, in that at a land price of about AU$5,000 per hectare the purchase of land for investment in forestry would not appear warranted.

environmental and natural heritage qualities of the region favour forestry development, but not the growing of exotic species or clearfell logging.

Perhaps the most critical *weakness* is the small North Queensland market, with most of the state's four million people living in the south-east, about 1,500 km away (hence a need to sell high-value products in distant domestic or export markets). Also, there is considerable uncertainty amongst landholders about harvest rights (e.g. Harrison *et al*. 2001). This stems in large part from the unilateral decision of the Australian Government to nominate the Wet Tropics rainforests for World Heritage listing against strong opposition by the State government, local governments and North Queensland community (e.g. see Winter 1991). Combined with the small area of hardwoods planted, the wide variety of species prevents economies of scale in processing. Also, market research reveals that the species being grown by farmers are not a close match with those expected by cabinet making firms to be in greatest demand in the future (Herbohn *et al*. 2004).

Major *opportunities* for forest industry development exist in relation to both softwoods and hardwoods. Further softwood resource would allow the existing technically efficient processing activity to be expanded, with increased economies of size. The wide variety of native cabinetwood species are well suited for local value adding to produce high value furniture products for domestic and overseas markets. Low-priced softwood imports and displacement of solid wood furniture by composite wood products present major threats to an expanded industry.

Application of Other Analysis Frameworks in North Queensland

Impediments to forestry development in North Queensland have been examined by Stork *et al*. (1998), Herbohn *et al*. (2000), Harrison *et al*. (2001), Creighton and Vize (2001) and Emtage *et al*. (2001). Profitability concerns rank highly. For commercial farmers, unwillingness to divert land from current profitable use is important. A surprisingly high level of concern about sovereign risk was revealed in landholder surveys, apparently associated with the listing of the WTWHA.

There is evidence of obstructions in the *supply chain* and value chain. Timber in some existing farm woodlots has proved unsaleable, due to inappropriate species choice (exotic softwood lack of silvicultural treatments (no pruning). The presence of only one large timber purchaser, specialising in softwoods acquired almost exclusively from government-owned plantations, presents marketing difficulties for small producers of softwoods. Stumpage price for plantation hardwoods are typically about AU$40 per cubic metre roundlog, with woodpacks sold for more than AU$1,000 per roundlog equivalent (AU$2,500 per cubic metre sawntimber). The low stumpage price does not appear to be due to rent capture by mills so much as high milling costs due to low throughput and use of old technology.

In relation to forestry development scenarios and visions for a future industry, Harrison and Herbohn (2002) identified a number of industry design components, including:

- Proportion of the landscape devoted to trees;
- Proportion of native or rainforest tree species;
- Extent of utilisation of remnant native forests;
- Extent of focus on multiple-uses;
- Major types of producers and business organisation arrangements;
- Product types; and
- Time scale of industry development.

Through the application of MODSS, Jeffreys (2002) identified a number of forestry systems with potential in North Queensland, and ranked these according to economic, social and environmental criteria. From the MODSS analysis, the five most preferred options in order of preference as identified by Jeffreys are:

1. Private medium-sized plantations – monoculture plantings with Government assistance;
2. Commercial plantations – monoculture plantings with joint ventures;
3. Commercial plantations – monoculture plantings with leased land;
4. Private medium-sized plantations – mixed plantings with Government assistance; and
5. Sustainable harvesting of private native forest regrowth.

Conflicting views exist among stakeholders as to the ideal nature of a future timber industry in North Queensland. Extreme positions include a focus on industrial forestry, growing exotic and native hardwoods, and a strongly environmental focus, growing mixtures of native rainforest and eucalypt species, for multiple purposes, in small stands on private land. Four options for the Atherton Tableland have been elaborated by Killen *et al*. (2003):

1. Small self-funded landholder-driven planting, of a variety of mainly native rainforest and eucalypt species, grown in small plantations (typically not more than about twenty hectares), for furniture production, poles and sawlogs. Logging would be selective or staged by species, with harvests typically over twenty to fifty years.
2. Government softwood plantation expansion, or at least 1,000 hectares – primarily Caribbean Pine (*Pinus caribaea*) with a thirty year rotation but also of Hoop Pine with a 40-45 year rotation – with clearfell logging. Products would include finger jointed boards, furniture and laminates.
3. Private company (high-value) plantation development, or of exotic species including *Tectona grandis* (Teak), *Khaya senegalensis* (African Mahogany) and *Cedrela odorata* (West Indian cedar) using tax-effective private and individual funding, sourced via prospectus or information memoranda, usually on company-owned land, and often without official Australian Securities and Investment Commission (ASIC) Product Ruling approval.
4. Private sector hardwood plantings, supported by the Greenhouse Gas Abatement Program (GGAP) of by the Australian Greenhouse Office (AGO), including eucalypts established by timber companies and perhaps also farm forestry using rainforest and eucalypt species.

Killin (2001) identified seven primary *keys* to unlock industry development in North Queensland, namely:

a) A shared vision;
b) Active industry participants;
c) Local community partnerships;
d) Further research funding; regional industry sustainability;
e) Private sector finance;
f) Sufficient resource scale; and
g) Payments for ecosystem services.

A variety of *facilitation measures* have been identified by Harrison *et al*. (2003), critical amongst which are ensuring harvest security, strengthening of the existing timber industry cluster and grower cooperative, and access to external finance for the industry.

North Queensland Forest Policy Insights

North Queensland appears locked into a relatively small forestry industry, with a weak timber market discouraging further planting and with low timber turnoff discouraging investment in timber processing. An innovative approach by government and the industry is necessary to break this cycle. Government subsidy programs and joint ventures have proven successful. Policies are needed which harness the enthusiasm of landholders to grow native tree species, and create a more favourable forestry investment environment, e.g. through removing impediments such as those relating to harvest rights and taxation treatment, facilitating marketing and providing extension services.

DISCUSSION

There is a strong rationale for promotion of forestry in regions where this can integrate closely with other land uses to promote regional economic and social viability. The combination of six analysis approaches to identifying obstacles to and options for forest industry development, supplemented by inter-regional comparison, provides a useful integrated technique for exploring forest industry development scenarios. Application of this methodology to tropical North Queensland provides insights into how the current stalled industry may be advanced. The forest industry in the Black Forest area of Germany is potentially a viable model to be followed in North Queensland. While considerably more analysis of the North Queensland situation is required, greater facilitation effort by government including development of a regional forestry plan appears desirable.

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4. DPI FORESTRY'S ROLE IN FOREST INDUSTRY DEVELOPMENT, AS THE STATE'S LEADING COMMERCIAL FOREST GROWER

G. Kent

This paper describes the DPI Forestry plantation estate in Queensland, and the R&D strategy on exotic pines, hoop pine and native hardwood species.[1] Details are also provided on the plantation areas by species in North Queensland. Customers of DPI Forestry in North Queensland include Ravenshoe Timbers, Pentarch Forest Products and Townsville Pallet and Crate. One of the major obstacles to attracting industry to North Queensland to utilise the Ingham/Cardwell forest plantation resource has been the size of the resource. In the long term both DPI Forestry as resource managers and the currently proposed industry would derive significant benefits from expanding the exotic pine plantation estate in coastal North Queensland, ideally within Cardwell and Hinchinbrook Shires. An assessment of forest plantation programs elsewhere in Australia supports the notion that 15,000 to 20,000 ha is the minimum for a viable plantation estate based on a commodity species such as Caribbean Pine. Options being considered for resource expansion include purchase of land by DPI Forestry, entering into land rental arrangements with existing landholders, and joint venture arrangements with investors, industry or landholders.

INTRODUCTION

DPI Forestry, Queensland's principal forest grower, was established as a commercial business group within the Department of Primary Industries on 1 July 1995. Its business goal is to achieve a commercial rate of return from forest production within a sustainable development framework. Since 1995 DPI Forestry has returned more than $105 million to Queensland Treasury as dividends and other payments.

DPI Forestry supplies 86% of domestically produced log timber used each year by Queensland's regionally based timber industry. The industry includes sawmilling, resawn and dressed timber processing, timber preservative treatment, joinery and furniture production, paper and paper board production, reconstituted board manufacturing and chip export. DPI Forestry helps strengthen the industry's international competitiveness by continuously improving its forest growing efficiency and the quality of its products.

The State-owned production forests managed by DPI Forestry cover both plantations and designated native forest areas. DPI Forestry's plantation estate is already one of Australia's largest, covering 191,000 ha, with further modest expansion being planned to consolidate the key growing areas in the south and the north of the state. This expansion will probably involve both land leasing and acquisition and will enable the development of internationally competitive wood products manufacturing industries. It will also create further opportunities in the forest growing sector as the processing industries grow and expand. In 2002-2003 DPI Forestry harvested almost 1.9 million cubic metres of softwood log timber from these plantations. Major plantation species are:

- Slash Pine (*Pinus elliottii*), 19% of the estate;

[1] This paper was prepared prior to the reorganisation from DPI Forestry to Forestry Plantations Queensland, and the severe damage to forestry in North Queensland resulting from Cyclone *Larry*.

- Caribbean Pine (*Pinus caribaea*), 28% of the estate;
- Native pine species, mainly araucaria (*Araucaria cunninghamii*), 23% of the estate;
- Slash Pine and Caribbean Pine hybrids, possessing superior attributes of both species, 22% of the estate;
- Other exotic pines, 2% of the estate; and
- Hardwoods, mainly *Eucalyptus* and *Corymbia* species, 3% of the estate.

Approximately 3% of the estate is unplanted at any particular time.

Hardwood and cypress log timber marketed by DPI Forestry from Queensland's State-owned native forests in 2002-2003 amounted to about 370,000 cubic metres per year.

DPI Forestry intensively manages their softwood plantations to maximise timber volumes, timber quality, environmental benefits, and other community benefits. The DPI Forestry softwood plantations are managed in accordance with a certified ISO14000 Environmental Management System (EMS). This covers the management of environmental aspects and impacts associated with plantation establishment, maintenance, harvesting and infrastructure and associated works. The fundamentals of DPI Forestry's EMS is the objective of sustainable forest management and continuous improvement in forest management practices.

Through the implementation of these programs, DPI Forestry is in an advanced position to seek certification for its forest management practices against a range of internationally recognised forest certification systems. These include the Forest Stewardship Council's FSC certification system and the Australian Forestry Standard.

DPI Forestry makes significant investments in research and development to improve business performance in terms of commercial outcomes, business growth, risk management and sustainability. The primary focus of the research and development strategy is on exotic pines, hoop pine and increasingly native hardwood species for DPI Forestry's plantation program. Research and development priorities seek to:

- Reduce costs, especially for early age establishment and maintenance;
- Improve productivity via genetic improvement, better matching of taxa, families and clones to sites and stand management;
- Improve resource quality including wood properties, stand uniformity, tree form and straightness and characterisation of these properties at the log, tree and forest estate levels to permit product segregation and value adding;
- Manage pest and disease risks; and
- Minimise environmental impacts of plantations and demonstrate sustainable management practices that meet community expectations.

North Queensland Plantation Resources

DPI Forestry currently manages approximately 14,600 ha of plantations in North Queensland. The majority of these plantings are in the Ingham/Cardwell area. Smaller resource areas have been established on the Atherton Tablelands and at Cathu near Proserpine. Table 1 provides a breakdown of plantation areas by species and location.

Caribbean Pine (*Pinus caribaea var. hondurensis)* accounts for over 95% of the exotic pine planted in North Queensland.

Table 1: DPI Forestry's North Queensland plantation estate (ha).

Location	Exotic pine	Hoop pine	Other species	TOTAL
Ingham/Cardwell	10,229	5	39	10,273
Atherton Tablelands	2,367	1,057	200	3,624
Cathu	469	248	0	717
TOTAL	13,065	1,310	239	14,614

Wood Properties

Hoop Pine is suited to the production of a range of high quality ply and sawn wood products. Applied research to assist processors make better use of the product is being supported by DPI Forestry. This includes research into wood quality and drying techniques as well as research to enhance predictive techniques for plywood suitability.

Caribbean Pine, which is DPI Forestry's principal plantation species in North Queensland, has been the subject of a number of studies of its wood properties to enhance its market potential. These indicate that the species is of a superior quality with regard to straightness, taper and branch size and angle. It is suitable for the production of structural and appearance grade sawn products or veneer, plywood and laminated veneer lumber products.

In 2001, research carried out by the Queensland Forest Research Institute, (now the Agency for Food and Fibre Science), indicated that the Caribbean Pine in the Ingham/Cardwell area has an average whole stem basic density, of the log component of 528 mg/m³, which is suitable for sawn wood production. This will provide high yields of either high machine stress graded timber or high strength and stiffness veneer or plywood.

Existing Forest Industries

DPI Forestry's North Queensland plantations support a number of existing industries. Ravenshoe Timbers purchase both Hoop and Caribbean Pine log timber from the Atherton Tablelands resource. Their sawmill at Ravenshoe is the major private sector employer in Herberton Shire, where they produce sawn wood and finger jointed products. In addition, they have a panel plant in Cairns.

Pentarch Forest Products currently have a short-term sale for approximately 200,000 cubic metres of Caribbean Pine logs from Cardwell State Forest. These logs, which are being exported from Townsville to East Asian markets, are being processed into plywood, sawn wood and pulp. Feedback from the processors regarding log and product quality has been very positive.

Townsville Pallet and Crate are also using Caribbean Pine from Cardwell State Forest to produce a range of pallets and packaging products. Their products are principally used to facilitate exports of meat and metals from Townsville.

Plans for Industry Expansion

DPI Forestry initiated a twelve-month process in October 2003 to attract investors wishing to purchase Caribbean Pine logs from its North Queensland forest plantation estate, preferably with the intention of processing the timber in the region. On offer are 200,000 cubic metres per annum of logs, of which approximately 180,000 cubic metres is classed as sawlog. It is proposed that this sale would run for at least ten years. The bulk of the plantations being offered are in the 15 to 25 year age classes. Log supplies will be principally drawn from the

Ingham/Cardwell plantations with smaller quantities to come from the Atherton Tablelands and Cathu.

A consulting company URS Forestry (Australia) has been engaged by DPI Forestry to assist with the search to obtain suitable Australian or international investors for the process and in the assessment of proposals. To ensure that positive whole of Government outcomes are achieved by this significant forest resource sale, the Departments of the Premier and Cabinet, State Development and Innovation, Treasury and Main Roads have been involved in an advisory capacity to assist with the provision of infrastructure and workforce skills. Relevant Local Authorities are also being kept informed of the process.

Rigorous assessment criteria have been developed by DPI Forestry, URS Forestry and other Government stakeholders to assess the detailed proposals that are due for submission by the end of April 2004. From these proposals, selected proponent(s) will be identified for negotiations with a view to entering into a Heads of Agreement with DPI Forestry. This will provide a commitment by DPI Forestry to supply log timber resources and will provide a commitment by the proponent(s) to enter into a log supply agreement subject to the completion of a detailed feasibility study and construction of any infrastructure required.

Forest Plantation Resource Expansion Plans

One of the major obstacles to attracting industry to North Queensland to utilise the Ingham/Cardwell forest plantation resource has been the size of the resource. Typically, internationally competitive forest industries based on plantation resources require a log input of at least 200,000 cubic metres per annum. To achieve this quantity for the current sale process, resources from the Atherton Tablelands and Cathu are being included. However, in the long term, both DPI Forestry (as resource managers) and the currently proposed industry would derive significant benefits from expanding the exotic pine plantation estate in coastal North Queensland, ideally within Cardwell and Hinchinbrook Shires.

An assessment of forest plantation programs elsewhere in Australia supports the notion that 15,000 to 20,000 ha is the minimum for a viable plantation estate based on a commodity species such as Caribbean Pine. In keeping with this assessment, DPI Forestry has plans to expand its Caribbean Pine estate in North Queensland by 5,000 ha, by the year 2010. At a productivity target of 20 m^3/ hectare/annum, the expanded estate could provide in excess of 350 000 cubic metres per year of log product, 80% of which should be sawlog quality or better. This would provide significant opportunities to expand current and proposed forest industries in North Queensland.

To achieve this resource expansion target a range of options are being considered. These include:

- Purchase of land by DPI Forestry;
- Entering into land rental arrangements with existing landholders; and
- Joint venture arrangements with investors, industry and/or landholders.

All of these options have been used successfully in other parts of Queensland and Australia. The proposed expansion is supported by targets identified in the National Forest Policy Statement 1992, Plantations for Australia – 2020 Vision and DPI Forestry's Corporate Plan. It is also consistent with the Queensland Government's commitment to the development of an ecologically sustainable and commercially viable forest industry that is based on plantation resource. The focus of plantation expansion will be on cleared land in keeping with the Government's requirement to phase out the clearing of remnant vegetation in Queensland.

CONCLUSION

DPI Forestry's plans for expanding both the industry and plantation estate in North Queensland will provide significant benefits for the forestry sector and the regional economy. These benefits are consistent with those identified in the 2020 Vision and the Queensland Government's priority initiatives for the State. They include:

- Greater production from plantations to reduce Australia's trade deficit in wood and paper products (nearly $2.2 billion in 1999-2000) with the potential to turn it into a surplus;
- Reduced reliance on native forests for commercial timber production;
- Enhanced regional development opportunities, as the associated processing plants are established/expanded to utilise the additionally available plantation log timber;
- Increased rural employment, including jobs in plantation forestry and harvesting, domestic processing of wood products, transport and, from the flow-on effects of growth, in exports and local wood processing; and
- Environmental benefits, including reduced impact on the Barrier Reef, wind and water erosion, and waterlogging on agricultural land.

The plans will also provide landholders with an additional incentive to consider plantation forestry as an economically and environmentally sound alternate land use in North Queensland.

5. EXPANDING THE ARAUCARIACEAE ESTATE ON THE SOUTHERN ATHERTON TABLELANDS

D.R. Killin

The paper is designed to focus the attention of the timber industry, government, universities and private sector investors on the regional economic development opportunities presented by expanding the existing native conifers plantation estate. A cooperative approach is required by stakeholders to develop an economic model and finance the expansion of this valuable timber species. There are convincing reasons why development of the forestry industry on the southern Atherton Tablelands will best be achieved by expanding the commercial estate of native conifers. This implies a focus primarily on araucaria or hoop pine[1] but also including two other species of the native conifers (*Araucariaceae*) family, namely kauri pine and klinki pine. Growing eucalypt or other rainforest species is likely to involve a far greater level of investment risk for both the public and private sectors. At an expected growth rate (MAI, i.e. mean annual increment) of 15 m³/ha/yr, the yield of mature (40 year old) araucaria plantations established on ex-pasture land would be about 600 m³/ha, and can be obtained with a high final stocking of 450 stems per hectare. An additional 5,000 ha of araucaria established in the next 5-10 years with this productivity would yield approximately 3 M m³ of round-wood (logs) by about 2050–2055. At a conservative average stumpage price of $60/m³, this resource would be worth $180 million in today's dollars even before value-adding in sawmills. The recommendation from this study is that a full economic assessment (of financial and non-financial impacts) be carried out to determine the full value of expanding this resource based on the three species from the *Araucariaceae* family, and that a business case be developed to attract investment.

INTRODUCTION

There have been a number of proposals put forward over the past decade as to the expansion and future development of the forestry industry in north Queensland. This paper examines in detail the current situation with regard to the plantation forestry industry on the southern Atherton Tablelands and the opportunities for its further development, through a review of information on almost a century of experimental trials, combined with the field experiences of leading industry practitioners.

The purpose of this paper is to focus the attention of the timber industry, government, universities and private sector investors on the regional economic development opportunities presented by expanding the existing native conifers estate on the southern Atherton Tablelands, focussing primarily on araucaria (*Araucaria cunninghamii* Aiton ex D. Don in Lambert 1837), but also including two other species of the native conifers (*Araucariaceae*) family (Henkel and W. Hochst 1865), namely kauri pine (*Agathis robusta* C. Moore ex F. Muell 1883) and klinki pine (*A. hunsteinii* K. Schumann 1889). A cooperative approach is required by stakeholders to develop an economic model and finance the expansion of this valuable timber species.

[1] The common name 'hoop pine' is normally used for this species, although the trade name 'araucaria' has been promoted from about 2002. The name 'hoop pine' derives from the fact that the fallen trees leave long-lasting cylinders of bark (or hoops) on the forest floor as the soft timber quickly rots and disappears (Holzworth 1999). The species name 'araucaria' is adopted in this paper.

Araucaria is a native Queensland conifer species with wide distribution from Papua New Guinea to northern New South Wales, and occurs naturally in more than 10 highly disjunct localities in north Queensland. Araucaria timber is white to pale brown, fine-textured and carries a little figure. The reputation of araucaria as a world-class timber and an indispensable building resource in the settlement and development of Queensland, as well as the impressive height of this tree, earned it the title or 'Monarch of the Woods'. It is one of the few plantation-grown native conifers in Australia. The species potential uses include all indoor work as well as for mouldings, panelling, lining, ceilings and joinery.

Currently, 979 ha of araucaria plantations has been established on the Atherton Tablelands, either wholly or partly owned by the State Government and managed by their commercial forestry group, Forestry Plantations Queensland (previously part of DPI Forestry). With the assistance of the Federal Government's Sustainable Regions Program, Ravenshoe Timbers is increasing its processing capacity from 25,000 m³/yr to at least 35,000 m³/yr. The employment of at least 70 people in a depressed rural economy is currently dependent on Ravenshoe Timbers.

A major concern of the local forestry and timber industry is the need to replant new areas of araucaria to achieve a consistent resource supply and increase output to maintain profitability. Expanding the araucaria resource will result in greater capacity to absorb the price variations associated with export markets and world trends. Funds for financing the carbon component of araucaria plantations may be available from regional power companies and energy utilities such as Stanwell Corporation Limited, but it is yet to be fully explored.

Over 50 years intensive silvicultural research has been conducted on araucaria in the following areas: seed collection and storage, nursery production, site selection, site preparation, planting, pre-plant and post-plant weed control, pruning, thinning, nutrition harvesting, cover crops, and slash retention. This work has led to the development of a comprehensive araucaria silviculture manual. The development of timber seasoning techniques and specifications, high-temperature drying schedules, and improved gluing methods for the important plywood industry are other major recent advances. Forestry Plantations Queensland's expertise in the management of araucaria is available for landholders and the private sector on a contract or fee-for-service basis.

The area of the southern Atherton Tablelands that is most suitable for araucaria plantation development is located on the red krasnosem soils of basaltic origin surrounding Millaa Millaa, Malanda, as well as small areas near Ravenshoe. A number of studies have identified 20,000 to 40,000 ha of land suitable for timber plantation development in this area. This is the freehold land and any plantation project planned for the region will obviously need the support of landowners. Existing plantations of araucaria grow well on the southern Atherton Tablelands, where a number of eucalypts and rainforest species trials have also been established over the past 30 years. It is considered by local experienced industry experts that the area is too wet for most eucalypts and too cold (due to the elevation of 800 m to 1000 m) for commercial production of rainforest hardwood species. Plantations of araucaria can be designed to complement the natural terrain of the landscape and have some potential to contribute to biodiversity via the development of understorey species.

Despite the positive attributes of araucaria relative to other native species on the southern Atherton Tablelands, there are a number of political, market structure, policy and price issues that need attention prior to any substantial araucaria plantation expansion. Unlike Forestry Plantations Queensland, private growers have to pay annual local government rates on their timber plantation land. More could be done by the State Government to assist (part-fund) the marketing of existing privately-grown araucaria. It could also be argued that the bilateral monopoly (one grower and one buyer) arrangement that currently exists in the softwood log market in north Queensland distorts the regional market, and the inherent viability of a

competitive timber supply chain is compromised by political interference in decision-making and resource allocation.

This paper is divided into then sections. The next section describes the ecology, distribution, timber quality and uses of araucaria. The history of almost 100 years of araucaria plantations and other species trials on the Atherton Tablelands is then reviewed. Then, the next section outlines the research and development that has been applied to araucaria. A description of the land available on the southern Atherton Tablelands for a future plantation expansion follows, leading on to an outline of how araucaria timber products are marketed. Some options for sourcing finance for araucaria expansion are then discussed, followed by suggestions for improving key policy and price signals. A description of the type of economic modelling needed for such a project is provided. The conservation and biodiversity values of araucaria are discussed, followed by concluding comments and recommendations.

ECOLOGY AND DISTRIBUTION OF ARAUCARIA (HOOP PINE)

Araucaria is a native Queensland species with wide distribution from Papua New Guinea (PNG) to northern New South Wales (Gould 2000). It occurs naturally in more than 10 highly disjunct localities in north Queensland from near Townsville (19°25´S) to Captain Billy Ck (11°39´S) (Nikles and Newton 1983), including small populations on the Gillies Highway, Tully Falls and the Hann Tableland (Stocker 2003). Radiocarbon dating of pollen records from Lynch's Crater indicates that forests with araucaria tree species were more prominent on the Atherton Tablelands 40,000-75,000 years ago, when the average annual rainfall was about 1400 mm/yr, much less than the present levels of 2200 mm/yr, leading some authors to suggest that the introduction of fire management by Aborigines, along with climate change, may have combined to reduce the species' natural distribution and assisted the development of dry sclerophyll forest (Singh *et al.* 1981).

E. H. F. (Harold) Swain (1928 p. 66), who was Head of the Queensland Forestry Branch over 1918–32, described the tree as follows:

> *[Araucaria has an] unbuttressed, shapely cylindrical bole and a certain nobility of habit. Tall, erect and of sparse proportions [it] develops, at towards two-thirds of its total height, a crown of almost spear-head outline, composed of open storied whorls of horizontal to ascending stick-like limbs, fringed and tufted with dark dull-green foliage consisting of a quarter to one half inch incurved and imbricated needles covered in dense spires. The bole is horizontally banded by a tough elastic integument of coppery hue and lustre, which in peeling curls up at the ends and invests the surface with a drab brown feathering of hard leathery texture. The blaze is a maroon-edged white. The inner bark is a tough snow-white blast longitudinally fibred.*

Boland *et al.* (1984) described araucaria, along with bunya pine (*A. bidwillii* Hooker 1843), as Queensland pine, as an impressive tree growing to a height of nearly 60 m with a diameter of 60–190 cm. The open crown is dark green and in the native forest the tree is usually free of branches until the top third of its height. Many trees have long internodes, which makes the species useful for forestry plantation purposes due to reduced pruning costs and an increased proportion of 'clearwood' timber.

Araucaria is monoecious (male and female strobili on the same tree) after passing through an intermediate phase when only female flowers are produced; female strobili are first produced at about age 10 years and male strobili are produced at about 25 years (Huth *et al.* 2001). It occurs frequently as a dominant over-storey tree, well above the rainforest understorey, and has the ability to form pure stands (Stocker 2003).

TIMBER QUALITY AND USES

Araucaria timber is white to pale brown, fine-textured, carrying little figure. The reputation of araucaria as a world-class timber and an indispensable building resource in the settlement and development of Queensland earned it the term 'Monarch of the Woods' (Holzworth 1999) and, along with smaller plantings of kauri pine and bunya pine, is one of the few plantation-grown native conifers in Australia. According to Swain (1928), 'But chief among the products of the Queensland sawmills are the Hoop Pine and Bunya Pine, the chief softwoods of the State, universally used for all indoor woodwork, for joinery and cabinet work, and for butter boxes and cases. They are superfine white pine woods, closely approximating to *Agathis robusta* in quality'.

The wood properties of araucaria have long been favourably compared with those of Oregon pine, Douglas fir and, more recently, exotic *Pinus* species. Araucaria timber, while only in the middle of the density range of the above timbers, has a more uniform density (Holzworth 1999). Key desirable timber properties such as strength and hardness are more uniform in araucaria, and machining, gluing, nailing and finishing are less of a problem than for the other species listed above, especially in timber from pruned stems. Swain (1928) identified the potential uses as 'for all indoor work and for mouldings, panelling, lining, ceilings and joinery'. Swain also noted the absence of aroma and taste in the wood, which in the past led to its use in the production of butter boxes and today makes it suitable for use in human consumption items such as ice cream sticks and the large market for chopsticks in Asia. It is also the only plywood accredited in Queensland for use in boat building (Harrison 2003). Araucaria is now marketed under the trade name Arakaria, a derivative of its botanical genus name, by Hyne and Sons sawmill.

The traditional and current uses of araucaria (adapted from Holzworth 1999) are:

Panelling
Exterior cladding
Structural joinery
Colonial architecture (French doors)
Glue-laminated structural members
Ladders
Chamfer boards
Balustrades and decorative finishes
Fascias and barge boards
Laminated beams
Reconstituted wood products
Chopsticks and ice cream sticks
Mouldings
Fencing material
Boat planking and decking
Plywood
Doors and window framing
Edge-glued panels
Tongue and groove boards
House framing
Engineered roof trusses
Woodchips
Woodwool packaging product
Packaging material: cases, crates

THE HISTORY OF ARAUCARIA ON THE SOUTHERN ATHERTON TABLELANDS

In 1931, the Provisional Forestry Board was concerned about the exhaustion of native stands of Queensland pine, and generated curves comparing rate of cut with predicted demand, known as the 'Araucarian Eclipse'. The Board presented figures to a Royal Commission (Payne *et al.* 1931) that claimed that average plantation of araucaria on the Atherton Tablelands would yield 869 m³/ha of marketable timber in 50 years, resulting in an average annual increment of 105,474 m³ of timber produced (Fullerton 1985). In 1929, Swain, valued the looming deficit in the domestic (Queensland) softwood market at £44 million (Queensland Forest Service 1929), and if the government of the day had resource and implemented the

grand vision as he proposed at that time, it is likely that north Queensland would now have an araucaria resource to rival that of south-east Queensland.

In hindsight, Swain's original production predictions, based on no systematically recorded growth data, have proved to be optimistic but not unrealistic; the yield of Forestry Plantations Queensland araucaria plantations in north Queensland recently has ranged from 650-1000 m³/ha for 55-80 year old plantations that are beyond what is now considered to be commercial rotation age (Hanrahan 2003). At a reasonably conservative expected growth rate (mean annual increment or MAI) of 15 m³/ha/yr, the productivity of mature (40 year old) araucaria plantations established on ex-pasture lands would be 600 m³/ha, and can be obtained with a high final stocking of 450 stems per hectare (Last 2003). An additional 5,000 ha of araucaria established in the next 5-10 years with this productivity would yield 3 M m³ of roundwood (logs) by 2050-2055. At an average stumpage price of $50/m³, this resource would be worth $100 M in today's prices, before value-adding in a sawmill, assuming 66% (two-thirds) of each standing tree is sawlog with the remainder pulplog.

Review of Twentieth Century Forestry File Records

There have been a number of attempts to trial a range of timber species for possible plantation development on the southern Atherton Tablelands, with the following information obtained directly from reading the annual reports of the Forestry Department from 1903-1970.

In 1912, the Director of Forests, Jolly, established a nursery at Wongabel (Queensland Forest Service 1912) and conducted a series of trials of numerous native and exotic species, with araucaria and the locally occurring kauri pine, being the best performers in terms of survival and early growth rate (Queensland Forest Service 1912). The Forestry Branch of the Department of Public Lands saw a need in 1916 to build upon this initial work, and established plantations to secure long-term timber supply, with trial plantings of various species at Wongabel State Forest (Fullerton 1985), including red cedar and araucaria. A few individual trees from this original 1916 araucaria planting remain today.

During a very dry period in 1918, experiments with both red cedar (*Toona ciliata*) and Queensland maple (*Flindersia brayleyana*) pointed to the necessity of using a nurse crop in open plantations (Queensland Forest Service 1918); the red cedar was continually attacked by tip borer *(Hypsiphyla robusta)* and the open planted Queensland maple, despite impressive early growth rates, succumbed to both frost and drought on the Atherton Tablelands. Although Queensland maple plantations were successfully established later, growth was found to be slow compared with eucalypts (Cameron and Jermyn 1991). Araucaria, being naturally drought resistant, achieved better initial establishment success during this time than red cedar, Queensland maple, kauri pine and other species planted.

In 1928-29, 65 species were trialled at Gadgarra State Forest, the most promising proving to be araucaria*,* kauri pine, various eucalypt species, red mahogany (*Eucalyptus resinifera),* tallowwood *(E. microcorys),* spotted gum *(E. maculata),* forest red gum *(E. tereticornis*), and a number of rainforest species (Queensland Forest Service 1928, 1929). The promising rainforest species included southern silky oak (*Grevillea robusta),* Queensland maple*,* maple silkwood *(F. pimenteliana),* northern silky oak *(Cardwellia sublimis),* Mexican cedar *(Cedrela mexicana)* and West Indian cedar *(Cedrela odorata*).

In the early 1930s, with the low-cost labour market created by the depression years, came a second attempt at planting up to 80 rainforest species at both Gadgarra and Wongabel. Queensland maple, southern silky oak, araucaria and a few eucalypt species were reported as being promising plantation candidates (Queensland Forest Service 1930, 1931, 1932). Species trials at this time at Mt Baldy State Forest revealed that the following species, in

order of merit, warranted planting programs beyond the experimental stage: kauri pine, araucaria, Queensland maple, cedar of Goa *(Cupressus lusitanica)*, grey ironbark *(E. drepanophylla)*, Caribbean pine *(Pinus caribaea)* and tallowwood.

Another widespread drought affected Queensland in 1947 and once again araucaria proved its drought resilience. High drought tolerance could be an important advantage of araucaria should the rainfall in north Queensland decline as a result of global warming. In that large changes in the distribution of wet tropical forest types are likely to occur even with minor climate change (Hilbert *et al.* 2003), planting a species such as araucaria, that can grow in wet or dry climates, may reduce the risk of project failure over the next 50 years.

In 1949, araucaria was deemed by the Forestry Department as important to the Australian economy. The species was given first priority for further development, with 'every endeavour being made to increase the planting of this species' (Queensland Forest Service 1949). The initial drivers for forest industry development were employment creation and the need to replace natural stands of softwood timber species (araucaria and kauri pine) which were being harvested at a rapid rate (Gould 2003). At the same time, yield plots were established to cover existing plantations of araucaria, kauri pine and Queensland maple, and growth and yield tables were developed for araucaria (Queensland Forest Service 1951).

Research in the 1950s indicated the most appropriate species for planting on rainforest or open forest types on the volcanic soils of the southern Atherton Tablelands were kauri pine, Queensland maple and araucaria (Queensland Forest Service 1953). This was before the breakthroughs in site preparation (deep ploughing) and modern silviculture (timely weed control with herbicides, pruning and thinning) and tree breeding systems (use of hybrids and clonal material) now used to establish araucaria plantations. The Atherton Tablelands araucaria plantation program, suspended at the onset of the Second World War, was recommenced in 1955 at Danbulla. Farmlands which the government had resumed in conjunction with the construction of Tinaroo Dam were targeted for this activity (Gould 2000).

From the 1960s onwards, it was decided by the then Forestry Department to focus on, in order of preference, araucaria, varieties of the exotic Caribbean pine (predominantly *Pinus caribaea* var. *hondurensis* or PCH), kauri pine and Queensland maple. These species were deemed to have commercial plantation potential in north Queensland. However, Queensland maple was soon dropped from the focus list, because it became formless and suppressed surrounding trees when open-planted in mixtures with araucaria (Gould 2003). It was believed that Queensland maple and other rainforest or broadleaved hardwood species required a nurse crop. Hence they were often under-planted in existing natural stands or plantations of araucaria. Although Queensland maple grew well when under-planted after the first thinning of araucaria, this research practice was deemed to be not commercially viable (Gould 2003). Increasingly, research focussed on improving the productivity of pure araucaria and PCH plantations.

The Community Rainforest Reforestation Program (CRRP) spent about $15 million from 1992 to 2000 and established about 2,000 ha of farm forestry plantings of up to 170 rainforest and hardwood species. The program had multiple objectives, rather than only timber production. Table 1 lists the top 25 most planted species – by area and number of plots – in the CRRP. Araucaria was second in the top 10 most frequently planted species in the CRRP, after red mahogany (*E. pellita*). This was a reflection of the ready availability of araucaria seedlings, its preference as a production species by Forestry Plantations Queensland for the CRRP program (Sexton 2003), and its suitability for the area. Five other eucalyptus species and three rainforest species – namely Queensland maple, kauri pine and silver quandong *(Elaeocarpus angustifolius*) – made up the other nine of the top 10 species. Only one of the top 10 species was fleshy-fruited (silver quandong).

In summary, a review of the literature on the history of forestry on the Atherton Tablelands reveals that araucaria consistently proved to be the primary Queensland native plantation species worthy of investment and development by the State Government during the 20th century.

Table 1: The 25 tree species most commonly planted in the CRRP.

Rank	Scientific name	No of plots planted	Numbers of seedling planted	Number of seed batches produced
1	*Eucalyptus pellita*	310	134,499	10
2	*Araucaria cunninghamii*	208	105,195	5
3	*Eucalyptus cloeziana*	225	98,775	14
4	*Flindersia brayleyana*	453	90,665	15
5	*Agathis robusta*	317	62,866	12
6	*Elaeocarpus angustifolius*	390	60,379	30
7	*Eucalyptus grandis*	132	52,962	11
8	*Eucalyptus tereticornis*	177	38,178	12
9	*Eucalyptus microcorys*	98	27,791	3
10	*Eucalyptus citriodora*	125	27,233	9
11	*Castanospermun australe*	279	26,154	12
12	*Blepharocarya involucrigera*	259	24,404	12
13	*Cedrela odorata*	208	22,473	17
14	*Acacia mangium*	140	21,484	10
15	*Paraserianthes toona*	20	19,861	2
16	*Flindersia schottiana*	198	17,962	13
17	*Eucalyptus drepanophylla*	67	16,105	12
18	*Flindersia pimenteliana*	177	14,506	10
19	*Eucalyptus pilularis*	50	14,500	3
20	*Flindersia bourjotiana*	176	14,055	9
21	*Grevillea robusta*	117	14,028	12
22	*Eucalyptus robusta*	58	12,546	10
23	*Eucalyptus resinifera*	95	12,546	15
24	*Terminalia sericocarpa*	49	11,696	8
25	*Eucalyptus acmenoides*	65	11,205	12

ARAUCARIA RESEARCH AND DEVELOPMENT

There has been over 50 years of intensive research and development into improving the naturally occurring araucaria, initially funded by taxpayers and carried out by the then Department of Forestry. Forestry Plantations Queensland (a government-owned corporation) owns most of the intellectual property associated with the species, and generates an annual dividend for the Queensland State Government treasury as a return on this earlier investment that contributes to consolidated revenue.

Araucaria Tree Breeding Improvements

Nikles (1996) described how the commercial araucaria plantations established in south-east Queensland in the 1920s and 1930s became the base for the genetic improvement of the species with seed from phenotypically superior, natural-stand trees of local provenances being used to establish these plantations. Initially, seed sources for araucaria plantations were selected from larger trees of high quality phenotype within the natural stands (Haley 1957). It is estimated from seed collection records that many hundreds (if not thousands) of trees across about 20 southeastern Queensland provenances contributed seed (Nikles 2003b). The first rotation plantation base is therefore considered to have been highly diverse genetically, to have included superior provenances and to have been a representation of the best trees of the natural stands (Nikles 1996, Dieters *et al.* 2003).

Between 1929 and the 1970s, a series of araucaria provenance trials was established, including a number of north Queensland upland site plantings in the 1970s. In the mid-1940s, controlled crossing of selected plantation trees began and the results became evident by the early 1970s. In 1957, seed production areas were proposed, and first-stage clonal seed orchards were established in the late 1960s and early 1970s (Nikles 2003a). Stock raised from seed of these clonal seed orchards has been sufficient for all plantings from 1985. Potential timber yield increases of up to 50% attributed to appropriate selection of phenotype and genotype qualities in araucaria, have led to the capacity for an increase in the productivity and quality of the species (Holzworth 1999).

Several provenances of Papua New Guinea araucaria have been introduced to both north and south Queensland in the past 20 years (Nikles 2003b). Recent efforts to breed a hybrid between the most advanced genetic material of south Queensland and of some north Queensland and PNG provenances of the species are showing potential (Dieters *et al.* 2000). The genetics are sufficiently advanced with araucaria presently to commence firstly ‘family’ forestry (i.e. where the best families within various provenances are selected and bred), followed by clonal forestry (where the best individuals are reproduced vegetatively), with attendant large gains in timber yield, improved cost-effectiveness and therefore increased plantation profitability (Nikles 2003a). Additional genetic gains would be achievable in new north Queensland plantations with only modest research and development inputs because expertise and genetic resources, such as a clonal seed orchard (of locally-selected, superior trees of PNG origin), a mature breeding population of PNG and north Queensland select trees and small stands of second-generation PNG and first generation (F1) hybrid families, are already well established in the region (Nikles 2003a).

Araucaria Crop Protection Issues

Araucaria is highly sensitive to fire, which (apart from prescribed burning activities) is excluded from all plantations, and a network of well-maintained firebreaks and roads is constructed between compartments (Huth *et al.* 2001). Retained buffers of rainforest vegetation act as extra protection. These buffers can harbour a range of native and introduced wildlife, which attack some trees after establishment, although the attacks can be

controlled (Huth *et al*. 2001). Insects occasionally attack individual araucaria trees, but none have caused serious economic loss (Huth *et al.* 2001).

The two major diseases affecting araucaria in north Queensland, especially second rotation plantations established adjacent to existing rainforests, are brown stain heartwood (BSHW), and two forms of root rot – brown root rot and Poria root rot – which are caused by the fungi *Phellinus noxius* and *Rigidoporus vinctus*, respectively. Research into these pest and disease issues is carried out by DPI Agency for Food and Fibre Sciences. Pegg and Ramsden (2003a) provided a thorough literature review of both forms of araucaria root rot, which affect a number of other timber species (softwoods and hardwoods) throughout the world, although effective control strategies exist to limit losses, and during the first rotation losses due to root rot are estimated to be less than one per cent 1% of the stand (Huth *et al.* 2001).

Root rot seems to affect small areas of young trees in patches within plantations, more so in second rotations, although the spread of fatal attack is slow because the fungi rely primarily on root-to-root contact. Infection foci in plantations arise from remnant stumps of felled native forest trees (Pegg and Ramsden 2003b). There is sometimes another wave of deaths following thinning or harvesting operations when fresh stumps are exposed (Bolland *et al.* 1989). Risk management strategies for root rot include use of tolerant or resistant provenances of araucaria, biocontrol – injection of fresh stumps with other fungi to accelerate the decay of stumps and roots that can be sources of brown root rot infection (Bolland *et al.* 1989) – and chemical control, silvicultural control, or a combination both (Pegg and Ramsden 2003a). The severity of the root rot problem in plantings on land previously under pasture is not predictable (Nikles 2003b), but it is expected that new plantations established on cleared ex-pasture sites away from areas of native forest will not be severely affected by root rot (Hanrahan 2003), because the main vector, tulip oak species (*Argyrodendron* spp.) is unlikely to be present (Bragg 2003).

Alternative Species with Resistance to BSHW

There are two other native coniferous species with similar wood properties in the *Araucariaceae* family that could replace araucaria on particular sites where it is deemed that root rot or brown heart is a problem, namely klinki pine and kauri pine. There has been substantially less technological development and experience with these species locally. Kauri pine is more tolerant of brown root rot than araucaria (Bragg 2003), and could be planted in specific problem locations. This species has been planted previously at Wongabel State Forest, in small plots located on primary school grounds and in small private plantations including CRRP timber plots. Unpruned kauri pine has been shown to produce at least 100% more high-quality, defect-free timber than pruned araucaria, albeit on a rotation of 50 to 60 years (Grenning 1957, Nikles 2003), so it could be a satisfactory substitute for araucaria from a production point of view. Klinki pine has virtually no brown heart (Nikles and Robson 2003), and also produces timber of a high quality, so this could be a useful second-rotation species for some araucaria sites (Bragg 1979).

Silvicultural Standards for Araucaria Plantations

Araucaria has been grown in plantations in Queensland for more than 70 years, with major changes in management occurring over the last 10 to 20 years (Lewty and Last 1998, Huth *et al.* 2001). Intensive silvicultural research has been conducted into seed collection and storage, nursery production, site selection, site preparation, pre-plant and post-plant weed control, planting, pruning, thinning, nutrition, harvesting, cover crops and slash retention. This research has led to the development of a comprehensive araucaria silviculture manual. This manual is the intellectual property of Forestry Plantations Queensland, and is used for operational management of commercial plantations, covering nursery practices, estate and

plantation design, site preparation, planting, weed control, dozer tending, stand nutrition, pest control, pre-commercial thinning, pruning, and pruned stand certification. An annual tree health survey is conducted in all Forestry Plantations Queensland araucaria plantations. All management practices are subjected to a quality-controlled environment management system that was certified against the international environment standard AS/NZS ISO 4001 in December 1999 (Huth *et al.* 2001). Forestry Plantations Queensland's expertise in management of araucaria is available for landholders and the private sector on a contract basis.

Considerable research on the timing and method of pruning was carried out for araucaria during the 1950s and 1960s, and the practice up to 1972 was to carry out up to six pruning stages or 'lifts', with the best final 300 stems per hectare pruned to a height of 6.8 m (Huth *et al*. 2001). After a number of changes during the 1970s, a two-stage pruning was implemented in 1980 with all stems being ground pruned to 2.4 m using light weight chain saws, with the 400 straightest and most vigorous stems per hectare being pruned to 5.4 m using ladders or pole saws (Huth *et al*. 2001).

Research findings have been applied to nursery practices including the use of chemical additives and new herbicides in nursery beds, and the use of cuttings for field planting trials (Holzworth 1999). Development of alternative approaches to nursery seedling production (cuttings are not feasible commercially), using containers instead of tube stock, has reduced the length of time spent in the nursery from 24 months to 14 months, reducing costs (Huth *et al*. 2001).

Timber Technology Research and Development

The development of timber seasoning techniques and specifications, high-temperature drying schedules, and improved gluing methods for the important plywood industry are all major advances made in araucaria timber research and technology recently. Wood science R&D has also been conducted on utilisation and grading, wood chemistry and physics, shrinkage, basic density and stability of commercial thinnings, development of volume tables, and sawing patterns to maximise the timber value (Holzworth 1999). Catchpoole and Harding (2003) reviewed the available information on the wood properties of araucaria and developed a ranking of priority parent trees used in breeding programs and seed production orchards for wood properties.

FUTURE FORESTRY DEVELOPMENT ON THE ATHERTON TABLELANDS

The area of the southern Atherton Tablelands most suitable for araucaria plantation development is located on the red krasnosem soils of basaltic origin surrounding Millaa Millaa and Malanda, and areas near Ravenshoe. These areas are in the Eacham and Herberton shires, where dairying, beef cattle grazing, and native forest harvesting are the traditional primary industry activities. Profitability of dairying fell with deregulation of the Australian dairy industry. Logging of native rainforests on Crown land ceased with World Heritage listing of the Wet Tropics rainforests in 1988, although limited small-scale logging operations have continued on private land. Tourism (particularly eco-tourism) is making an increasing its contribution to the area's economy. Development of silvo-pastoral enterprises offer the potential for increases flexibility for landholders. The beef cattle industry is well established and, although prices fluctuate according to changing global commodity prices, it is possible that a combination of beef cattle, araucaria plantations and eco-tourism will provide opportunities for sustainable regional economic development.

A number of studies have identified 20,000 to 40,000 ha of freehold land suitable for timber plantation development in north Queensland, including the Atherton Tablelands (Kent and Tanzer 1983b, Fullerton 1985, Shea 1992, Keenan *et al.* 1998, Annandale *et al.* 2003). Any plantation project planned for the region will obviously need the support of landowners. Existing plantations of araucaria grow well on the southern Atherton Tablelands, where a number of eucalypts and rainforest species trials have also been established over the past 30 years. It is now considered by local and experienced forestry experts that the area is too wet for most eucalypts and too cold (due to high elevation of 800 to 1,000 m) for commercial production of rainforest hardwood species (Gould 2003, Stocker 2003, Simms 2003).

Other practical requirements to consider in relation to an expansion of araucaria the are that: the growth conditions should provide commercially satisfactory MAIs; the selection of planting sites should not, as far as possible, conflict with (viable) agricultural and pastoral interests; the plantation areas should be situated close enough to existing sawmill infrastructure to avoid expensive haulage; and slopes generally should not exceed 25 degrees due to unfavourable economics of establishment, maintenance and harvesting on such sites (Webb and Tracey 1967).

Currently, 979 ha of araucaria plantations has been established on the Atherton Tablelands, either wholly or partly owned[2] by the State Government and managed by Forestry Plantations Queensland. These plantations are located at State Forest (SF) 185 Danbulla (635 ha), SF 191 Wongabel (144 ha), SF 310 Gadgarra (132 ha) and SF 1229 Kuranda (23 ha), and are harvested and replanted on a rotational basis. An additional 45 ha of araucaria was planted in the late 1990s on five farms under the Forestry Plantations Queensland joint venture sharefarming scheme, a private forestry pilot project that provided useful management lessons and insights to inform policy development in terms of engaging local farmers.

Ravenshoe Timbers Pty. Ltd. – the only softwood mill on the Atherton Tablelands – is the largest employer in the shire of Herberton (Simms 2003), and uses modern milling technology to produce a range of value-added timber products for sale into the domestic and international markets. As a result of recent private and public sector investment, through the Federal Government's Sustainable Regions Programme, Ravenshoe Timbers is increasing its processing capacity from 25,000 m³/yr to at least 35,000 m³/yr. The timber processed consists of araucaria and Caribbean pine. The former species makes up an increasing proportion, because overmature araucaria plantations, which can produce over 800 m³/ha, have now been harvested, and some areas currently under araucaria at Danbulla State Forest will be replanted with PCH due to poor soil type (Hanrahan 2003).

A major concern of the local forestry and timber industry is the need to replant new areas of araucaria to achieve a consistent resource supply and increase the processor output to maintain profitability (Simms 2003). The employment of at least 70 people in a depressed rural economy is currently dependent on Ravenshoe Timbers, and expanding the araucaria resource will result in an improved capacity to absorb the price variations associated with export markets and world trends (Shaw 2003).

[2] Part-ownership applies in the case of plantation joint ventures between landholders and Forestry Plantations Queensland.

MARKETING ARRANGEMENTS FOR NORTH QUEENSLAND ARAUCARIA PRODUCTS

At least five distinct plantation products are produced in the Queensland softwood timber market, these being, in descending order of value: (i) plywood; (ii) joinery and mouldings; (iii) construction timbers and framing; (iv) round timbers and poles; and (v) fibre and woodchips. For araucaria, Forestry Plantations Queensland and the processing industry are differentiating the product from that of exotic pine, particularly for sales into high-value Japanese markets (Crevatin 2002). Recent trade delegations of the Araucaria Australia Group (AAG, not now operating) travelled to north Asia to promote timber exports and create awareness of the desirable qualities of araucaria timber.

In general, the high-grade sawn araucaria product is aimed at the upper end of the market. Long lengths of clear-wood are manufactured into joinery and furniture, and clear mouldings that are generally stained, with short lengths finger-jointed and manufactured into furniture, which is normally painted (Lewty and Last 1998). Desirable raw material properties for such applications include stability, uniform and satisfactory density, defect free or clear wood and an absence of distortion problems (Catchpoole and Harding 2003). Lower grade wood is marketed as large structural material (200, 250 or 300 mm wide and 38-50 mm thick) and can be preservative-treated and used for fencing (Huth *et al*. 2001). Araucaria can also be mixed with exotic pine and supply the lower end of the market, i.e. as construction and framing timbers, round timbers and poles, and fibre, woodchips and packaging material. Recently, however, PCH has eroded some of the traditional araucaria markets. Ravenshoe Timbers has recently had success in selling finger-jointed araucaria specifically into the joinery and mouldings markets. In summary, araucaria markets exist, but the processing and manufacturing sectors must remain focussed on continuous improvement and forest product innovation due to market competition from other softwoods (Gordon 2003).

SOURCES OF INVESTMENT FINANCE FOR PLANTATION EXPANSION

In the past 100 years, the Queensland State Government has been the primary source of investment funds for timber plantation development in north Queensland (Killin *et al*. 2002), with a few notable exceptions. The introduction of the *Commonwealth Softwood Agreement Act 1965*, which was in place for 14 years, provided loan funds to Queensland (and other states) for the establishment of softwood (araucaria and PCH) plantations. The CRRP was another example of the Federal Government providing funds to establish plantations. The support of the state government remains critical to the success of any araucaria expansion program. However, Forestry Plantations Queensland has no current plans to expand any plantation resources in north Queensland; its priority is to expand PCH on the wet tropical coast near Ingham and Cardwell, due to the need to achieve greater economies of size and add resource to the existing 12,000 ha PCH estate (Kent 2003). Killin *et al*. (2002) outlined the reasons why north Queensland, despite being a highly promising area for timber plantation development, has not yet experienced the same level of plantation expansion as in many other regions of Australia.

There are a number of existing Federal Government funding programs that could be targeted to fund plantation development, including Atherton Tablelands Sustainable Regions ($18 million), the $1.7 million allocated under the Australian Greenhouse Office's Greenhouse Gas Abatement Program (GGAP), the Bush for Greenhouse program, the Great Barrier Reef plan, indigenous and youth employment programs and apprenticeship programs.

Killin *et al.* (2002) identified and discussed eight critical keys to industry development in north Queensland: a shared vision, further research funding, active industry participants, local

community partnerships, regional industry sustainability, private finance, sufficient resource scale; and payments for ecosystem services. Having a viable market for end products is most likely to be the master key to unlock industry development in the region, and the only native rainforest species with a current market on the southern Atherton Tablelands is araucaria.

Killin and Brazenor (2003) investigated the potential for innovative methods to attract private sector investment into timber plantations in north Queensland and noted that araucaria may not be attractive to managed investment scheme marketers, due to investors' requiring a median 12% internal rate of return within 15 years of their original investment (Sharp 2002). It may be that the financial returns on 40-45 year rotations of araucaria plantations alone will not be sufficient to attract impatient private sector capital investment. This rotation age is when the land expectation value (LEV) is maximised, which is approximately when the MAI is maximised (Gordon 2003). In terms of the private sector investment market, araucaria may be attractive to risk-averse long-term investors such as institutional superannuation fund managers with large portfolios seeking product diversification, vertically integrated forestry corporations, and domestic companies in the energy sector seeking offsets for greenhouse gas emissions.

Stanwell Corporation Limited, a government-owned corporation with a wind farm asset near Ravenshoe, indicated its interest in establishing a regional forestry carbon sink when it commissioned DPI Policy Analysis and Industry Development, in association with Private Forestry North Queensland (www.pfnq.com.au), in 2002, to produce a consultancy report on investment opportunities on their company-owned land located at the Tully River and Wooroora Station near Ravenshoe. This demonstrates that alternative funds for financing the carbon component of araucaria plantations may be available from existing regional power companies.

Combined with its conical form and stem height and straightness, the ability of araucaria to sustain an increase in volume production over a given area exceeds that of many other species, and may make araucaria attractive as a predictable long-term carbon sink investment. Carbon finance could possibly be obtained from another developed country (perhaps Japan) under the Joint Implementation flexible mechanism of the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change, should Australia decide to ratify the international treaty. Another option may be to attract finance through the the BioCarbon Fund or Prototype Carbon Fund (PCF), both operated by the World Bank.

IMPROVING KEY CURRENT POLICY AND PRICE SIGNALS

Despite the current attractiveness of araucaria relative to other native species on the southern Atherton Tablelands, there are a number of policy and price issues that need attention prior to any substantial araucaria plantation expansion. Because the timeframe for maximum profitability for araucaria may be too long (40-45 years) for private sector investment, it could be argued that there is a market failure and that State Government intervention is initially justified to enhance the viability of the existing government-owned estate and continue to supply the existing sawmill infrastructure at Ravenshoe. It could also be argued that the bilateral monopoly (one grower and one buyer) arrangement that currently exists with respect to softwood on the Atherton Tablelands, leads to inappropriate log prices, and the inherent viability of the timber supply chain is compromised by political interference in decision-making and resource allocation.

Apart from environmental plantings, which potentially could attract public funds from the Natural Heritage Trust (NHT), delivered through regional bodies, the current preferred policy of both the State and Federal Governments is to facilitate increased private sector investment for commercial forestry plantations (Shaw 2003, Byrne 2003). However, despite

recent efforts to attract private sector investment in the plantation sector in north Queensland, this has not eventuated for a number of reasons (Killin and Brazenor 2003). The recent emergence of a forest policy group within Department of State Development may provide leadership in the private forestry policy area to tackle this issue.

Perhaps the State Government needs to consider selling off some plantation assets (in either south-east or north Queensland) so as to attract private sector investment. Long lead times associated with planting long-rotation sawlog species are a major obstacle to new entrants; if a private sector buyer could use the existing government resource to offset establishment costs, investment might proceed.

There is scope for the State Government to assist (partly fund) the marketing of privately owned araucaria (and PCH) plantations in north Queensland. Difficult marketing is perceived by some farmers to be the main impediment to establishing araucaria plantations (Gould 2003). In the absence of competition in the processing sector, Ravenshoe Timbers has a monopoly, they also have 'take-or-pay' contracts with Forestry Plantations Queensland, which means that their contractors must harvest a prescribed amount of timber within a given timeframe, or pay for it anyway. Although this mechanism ensures government plantations are harvested, it also acts as an impediment to private araucaria growers. Private growers perceive that current government stumpage prices paid by Ravenshoe Timbers, estimated to be \$45-55/m³, and hence benchmarking the private resource, are unacceptable (Wiles 2003). A doubling of returns to growers to about \$90-100/m³ for the highest quality pruned sawlogs is required. This price is high enough to attract interest from private araucaria growers in north Queensland (Cossins 2003), and could provide the commercial signal landholders need to enter the industry.

Another policy issue that requires attention concerns the fact that private growers, unlike Forestry Plantations Queensland, have to pay local government rates on their timber plantations, often at the same level as other agricultural pursuits including beef cattle grazing. A privatised Forestry Plantations Queensland would have to compete with private growers on a level playing field. Achieving a competitive value chain is the key to attracting private sector investment from either corporate entities or landholders.

If the non-market benefits of an araucaria expansion program were internalised and growers received investment funds from government, this might add sufficient value to overall profitability to stimulate forestry investment and consequent economic development on the Atherton Tablelands. Local employment opportunities would be raised through plantation establishment, maintenance and harvest. Also, environmental benefits would accrue, such as carbon sequestration, reduced off-farm transport of agricultural chemicals and biodiversity enhancement. The plantation expansion could involve direct land purchase, or leases with annual payments linked to general price movements. The trend with sharefarming forestry options in Queensland is increasingly moving away from complex joint venture equity sharing arrangements due to high administrative and management costs (Robb 2002).

DEVELOPING AN ECONOMIC MODEL FOR INVESTMENT PROMOTION

For the purposes of attracting investment funds, any araucaria expansion will require quantification of the total project economic value, including the environmental and social outcomes of araucaria plantations. A comprehensive economic assessment of the benefits of araucaria plantations is required, incorporating the existing financial data and models of Forestry Plantations Queensland, the research data on silviculture and genetics, and recent wood quality work from the Agency for Food and Fibre Sciences – Forestry Research (AFFS-FR). An investment vehicle comprising elements from both the public and private sectors

needs to be developed to finance implementation of any proposed araucaria expansion, and this will need prior support from local landholders with a long-term view of farm capital improvement.

There are three elements to be considered in the development of a practical model for the development of araucaria plantations on the Atherton Tablelands. The first is modelling the actual and potential private financial benefits and costs to individual investors and landowners. The second is modelling of the economic costs and benefits, including a financial model of the financial cash flows attributed to the project, including the broader social benefits of regional employment and multiplier effects. The third is an economic model accounting for all market and non-market benefits and costs (at local, national and global levels) of an araucaria plantation development as a whole (Hunt 2003). Important among non-market benefits in the latter model are ecosystem services, such as watershed protection; including stream flow maintenance, and carbon sequestration.

In the case of carbon sequestration, there are two potential methods of inclusion of benefits. The first is the estimation of notional carbon credits or the value of carbon credits if there were a market. Trading values of carbon can be estimated from market analysts such as Point Carbon (www.pointcarbon.com), early carbon prices emerging from voluntary emissions trading markets developing in the United Kingdom (http://www.defra.gov.uk/environment/climatechange/trading/index.htm) and the Chicago Climate Exchange (www.chicagoclimatex.com), forward options in the compulsory European Union emissions trading market being devised presently (due to commence 1 January 2005), as well as numerous carbon-related models produced in the last decade by governments and businesses. The second method is to credit the development with the value of the reduction in global damage caused by rising carbon dioxide emissions as a consequence of the absorption of carbon from the atmosphere by araucaria plantations (Hunt 2003). This credit, particularly if funded through the Australian Greenhouse Office's Greenhouse Gas Abatement Program, could be used to offset national greenhouse gas emissions.

CONSERVATION AND BIODIVERSITY VALUES OF ARAUCARIA PLANTATIONS

Pine plantations are often considered 'biological deserts', but this is not true of araucaria plantations established in Queensland (Huth *et al*. 2001). Older first rotation stands (50+ yrs) of araucaria established on the Atherton Tablelands can develop a diverse rainforest understorey over time (Tucker *et al*. 2003), and those established close to areas of remnant rainforest have been shown to increase biodiversity relative to a baseline of cleared agricultural land (Keenan *et al*. 1997, Stork *et al*. 1998), although this is unlikely to occur for plantations isolated from rainforest, or for wide-spaced plantations with grassy inter-rows (Gordon 2003). It has been suggested that araucaria plantations could even be used to rehabilitate degraded rainforest lands (Keenan *et al*. 1997), because they can be established at lower cost than other restoration methods. However, if second rotation plantations develop a lantana-dominated understorey, due to reduced thinning and lower stocking rates, researchers suggest that they may not support as many rainforest specialists as the current crop of old plantations (Kanowski *et al*. 2001).

Araucaria has been grown in several mixed-species designs over time but these have not achieved the yield of monocultures and have encountered problems at harvesting due to the necessity for several harvesting cycles and problems associated with controlling damage to the residual stand (Gould 2003). Monocultures of araucaria are preferred for a number of reasons; they maximise commercial wood production on limited available areas of productive land, which is the highest priority objective of the local timber industry, as well as increasing the profitability from any potential sales of carbon credits to global investors. Plantations of

native conifers can be designed to complement the natural terrain of the southern Atherton Tablelands landscape and have the potential to enhance biodiversity by providing an environment for shade-tolerant understorey species to germinate from surrounding areas of remnant native vegetation. Araucaria plantations can be established successfully in undulating landscapes with remnant vegetation, similar to the land likely to be suitable for araucaria expansion on the southern Atherton Tablelands.

COMPARISON OF ARAUCARIA AND OTHERER NATIVE AND EXOTIC SPECIES

A preliminary qualitative assessment by the author of the availability of data and information for plantation-grown timber genera groups for the north Queensland region is presented in Table 2. A full quantitative assessment and final species comparison, including site requirements, establishment and silvicultural management costs, rotation lengths, growth rates, yields, carbon sequestration rates, income from products, internal rates of return and net present values for various scenarios could be completed once the relevant data were obtained from Forestry Plantations Queensland and AFFS-FR.

Although the weight of evidence reviewed by the author favours planting araucaria on the southern Atherton Tablelands, other native plantation species have potential for multiple-objective farm forestry. None of these alternative species have received the sustained focus and funding that araucaria has received over the past century, simply because of the ability of araucatia to yield 600–800 m³/ha of high quality wood. In Cameron and Jermyn's (1991) review of the plantation performance of high-value rainforest species, a number of species were recommended for further concentrated research; araucaria was excluded from their list because they deemed that adequate information already exists (i.e. araucaria was deemed financially viable).

Table 2: Author's preliminary assessment of data availability for plantation-grown timber genera groups in north Queensland.

Genera groups[a]	Silvicultural information	Tree breeding[b]	Productivity data[c]	Processing information	Marketing information
Araucaria[a]	Excellent	Excellent	Excellent	Excellent	Excellent
Pinus	Excellent	Excellent	Excellent	Excellent	Excellent
Agathis[a]	Excellent	Marginal	Marginal	Excellent	Marginal
Eucalyptus[a]	Excellent	Marginal	Marginal	Marginal	Marginal
Flindersia[a]	Marginal	Limited	Marginal	Limited	Limited
Toona[a]	Marginal	Limited	Limited	Limited	Limited
Tectona	Marginal	Excellent	Scarce	Limited	Limited
Khaya	Limited	Limited	Scarce	Scarce	Scarce
Cedrela	Limited	Scarce	Scarce	Scarce	Scarce
Elaeocarpus[a]	Limited	Scarce	Scarce	Scarce	Scarce

[a] These genera contain Australian native species.
[b] This column represents the extent of work undertaken into the genetics and tree breeding of the various genera groups and the availability of improved genetic material.
[c] The productivity data column refers to the availability of the data, not the data itself.

A commercial araucaria resource could certainly co-exist with multiple-objective farm forestry plantings. In his report on a new timber industry based on valuable cabinetwoods and hardwoods, Shea (1992) envisaged that a new scheme could consist of two components: (i) long-term rotations (50 to 100 years) of mixed rainforest species, and (ii) short rotation (30 to 50 years) of widely spaced high-pruned plantings of the native conifers (araucaria and kauri pine) and a number of eucalypts. Although the Shea report does have some major assumptions, it was used as the foundation document by local government for the CRRP. Agroforestry (silvo-pastoral) systems using araucaria or other conifers could play a complementary role with dairy or beef production. Such systems have already been extensively studied (Brooks and Snell 2001), and research has shown that grazing with dairy cattle can commence almost immediately after tree planting, due to the prickly nature of araucaria needles (Sun *et al.* 1997).

Maintaining Global *Araucariaceae* Genetic Diversity

The Southern Hemisphere conifer family *Araucariaceae* consists of three genera and 40 species, and now has a highly restricted distribution, unlike in the past. The genus *Araucaria* is represented by fossil material in both hemispheres as early as the Jurassic era, while *Agathis* is only known from the Southern Hemisphere beginning in the Cretaceous period. Locations in Australia, New Zealand and many parts of Malaysia have been logged, and many of the species are threatened or endangered. Aboriginal or traditional owners often ate the nuts of some species, including bunya pine (http://www.botanik.uni-bonn.de/conifers/ar/index.htm). By planting a range of various *Araucariaceae* species and provenances from around the world, it could be possible to contribute to the conservation of global *Araucariaceae* genetic diversity and seed sources, for example a small portion of the plantations (1 to 2%) could be reserved and not harvested. Non-commercial funding support for this aspect of the project would be required if this were to occur. The rare and endangered Wollemi pine is a member of the *Araucariaceae* family.

CONCLUDING COMMENTS

Araucaria plantations have been established and managed on the Atherton Tablelands for over 50 years, and provide timber, employment and environmental benefits on a continuing basis. Expanding this resource will help secure the forestry industry on the southern Atherton Tablelands. The native conifers of the southern Atherton Tablelands – especially araucaria (hoop pine) but also kauri pine and klinki pine – present an excellent opportunity for the State and Federal Governments to facilitate an expansion of the forestry industries in north Queensland. Almost a century of experimentation has generated substantial information about silviculture, tree breeding, timber properties, productivity and proven growth rates, industry processing, the availability of improved genetic material, and established marketing arrangements for araucaria, which is far superior to that of any other native species option.

It is suggested than other species options for plantation development on the southern Atherton Tablelands – including eucalypts and native or exotic rainforest species – have a substantially smaller information base, and are likely to involve far greater investment risk for both the public and private sectors than does araucaria. It may be possible for some of these other species to be used as strategic revegetation along waterways in association with the commercial araucaria production. Although some policy work is still required by government to create competition in the supply chain, araucaria is the clear native species choice for the southern Atherton Tablelands to facilitate forestry industry development. It is recommended that an economic model be developed to assess how an araucaria expansion might benefit the whole community, and a business case be established on this modelling work to attract investment.

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6. A CASE-BASED STUDY OF PRIVATE LANDHOLDERS WHO HAVE PLANTED TREES

R.I. Maczkowiack

Twenty-two case studies of small-scale forestry were conducted in southern and far north Queensland using personal interviews and a semi-structured questionnaire. The research focused on landowners who had already planted trees on their land, and identified the attitudes and motivations that led to their actions. The study revealed that the people planting trees fit the demographic criteria of being well-educated, approaching or in their retirement years, having high (off-farm) income and being lifestyle or 'hobby' farmers. Their motivations relate to the value they place on the ownership of easy-to-manage real estate, leaving a lasting legacy for their heirs, and an ideological love of trees. These non-monetary rewards are much more operative in their decision to 'invest' in trees than the prospect of financial gain, especially to themselves personally. The expected financial viability of their ventures was calculated using a generic computer package, the Australian Farm Forestry Financial Model (AFFFM). It was found in most cases that for competitive returns, there would need to be a conjunction of several favourable key criteria including rapid growth rates, high timber prices, non-inclusion of the owner's labour as a cost and a low discount rate applied to future cash flows. However, uncertainty of financial rewards has not been an impediment to the types of landowners who have proceeded with small-scale forestry.

BACKGROUND

Planning is needed to ensure adequate future timber supplies in Queensland. There has been a clear move away from harvesting publicly-owned old-growth forests in the state. This was exemplified by the World Heritage Listing of large portions of forest in north Queensland in 1988. There have also been moves to reduce logging in native forest reserves that are not under World Heritage Listing, particularly through the South-east Queensland Regional Forest Agreement. There has been no corresponding increase in the area of publicly-owned land being planted for timber so the net effect is that over the coming decades there is likely to be less timber supplied from government-owned land. On the other hand, timber demand in Queensland can be expected to rise, with greater demand for housing timber due to increasing population, and perhaps increased demand for superior cabinet timbers for furniture as standards of living increase. Depending on the supply situation in other countries, there may also be opportunities to export increased amounts of timber in all forms (from low-priced pulp through to high-grade finished products), although Australia lacks cost competitiveness for the latter product type.

A factor that may further exacerbate the supply side of the market equation is the operation of 'green' ideologies (and green political parties) that have increasingly captured the hearts and minds of urban-dwellers, and whose attitudes differ at times from those who live and work in the 'bush'. In the future, 'greens' may well seek increasing areas of permanent forest and a further decrease in the harvesting of native forest species on public land. Their influence can also be expected to extend increasingly to the management practices permitted on freehold land (for example in recent tree clearing legislation contained in the Queensland *Vegetation Management Act*), and serve to increase the sovereign risk of planting trees on private land. Regardless of how much one may applaud or deplore their perceptions and influence, what is real for all farmers, foresters, fishers and miners is that the votes of urban dwellers greatly outnumber those of rural and regional areas. Future policy

direction for all primary industries can therefore be expected to be increasingly influenced by the opinions of those who are not directly influenced by the effects of those policies.

Since little new planting occurs on government-owned land, the remaining source of land for this purpose is that which is privately owned. The necessity to increasingly use private land as the basis for future timber supplies has been recognised by governments, which have encouraged and trialled various joint venture schemes. In Queensland these have been between the Department of Primary Industries (DPI) and interested private landholders. The DPI plantation joint venture scheme (instigated in the late 1990s) achieved some degree of success, but planting under this scheme in north Queensland was terminated after only two years. Other states also have plantation joint ventures between landholders and government or private companies. An alternative to this arrangement is for the non-farm joint venture partner to *lease* the land, with the landowner being a totally 'silent' party. The Queensland government has sought landowners and investors for such a scheme in areas between the NSW border and Miriamvale (DPI 2004). Under that scheme the government would rent the land for approximately 25 years under a *profit à prendre* basis (a legal separation of ownership of the land and of the plantations) for the purpose of producing hardwood sawlogs (DPI 2004).

A second approach is to promote fully private small-scale forestry – to deliberately seek to capture the benefits of having plantings at the scale chosen by individual landholders. Benefits of these plantings are likely to be environmental and social in addition to being financially oriented.

Through the use of those various approaches, private land may become available to fill the gap in Queensland between timber demand and supply. However, it does not follow, as implied by economic theory of industry entry, that a reallocation of land resources to forestry will actually take place. It is easy from one's armchair to visualise rural Australia being a patchwork of properties, some with cattle, some being cropped and others with plantation timber on them, all producing the nation's collective needs. One may even visualise rural towns that thrive on being part of these industries. But it is a reality check to consider what the landholders and community members themselves think of the vision. Are the grain-growers, cattlemen and other landowners really likely to change their livelihoods, landscape and communities transformed to fit the vision of the armchair strategist? Are they likely to alter their farming careers because it may be in the national interest for them to be agroforesters? What are their current attitudes to having trees on their land and what would it take to motivate them to become tree farmers? What is currently stopping them from doing just that?

A key factor in any decision of private landholders (including forestry companies) to engage in forestry is the expected level of financial returns. Commercial companies require a high level of certainty before committing their shareholders' resources to forestry. Ought anything less be expected of owners of private land? A factor that compounds the situation for small-scale landowners (farmers and lifestyle owners alike) is the impact such a decision has across a range of other dimensions – personal, social and aesthetic. Thus personal attitudes of landholders become a critical element in any decision about change from existing land use.

The research reported here explored the reasons that led some landholders to become involved in forestry. It examined the financial impact of including forestry as part of the property's activities, the factors affecting the type and extent of forestry activity undertaken, the factors limiting greater levels of forestry activity, and the attitudes and experiences of the landholder towards joint ventures and annuity payments. It also responds to a recent review

of agroforestry[1] research and development for northern Australia (Turvey and Larsen 2001), which indicated that the highest priority for research and development is to demonstrate the financial viability of agroforestry projects.

RESEARCH METHOD

The current study explored the motivations of landholders who have already made the decision to invest in establishing plantations. A series of case studies of farm forestry in eastern Queensland was undertaken, supported by the Rural Industries Research and Development Corporation[2]. Two study areas were chosen, one in south-east Queensland (the Fassifern and Lockyer valleys and adjacent areas and the Sunshine Coast Hinterland) and the other in the Far North Queensland Statistical Division (the Atherton Tableland and coastal areas).

Case study farms were selected from a Queensland Forestry Research Institute (QFRI) networking directory (QFRI 2002). Purposive sampling was used to obtain a balanced cross-section of plantation sizes and tree species, people with QDPI joint venture arrangements and private forestry plantings in various locations within each region. In FNQ, prospective participants were identified by DPI Forestry officers, and were selected on the basis of being representative of the region's forest growers. While most of the north Queensland participants have had involvement in the Community Rainforest Reforestation Program (CRRP) plantings or joint venture arrangements, there are also examples of self-funded forestry plantings and utilisation of private native forest.

Information was collected through a face-to-face interview with each landholder. A questionnaire was developed comprised of a series of both structured and unstructured questions. The initial questions sought background information about the landowner, the farm, its history and the nature of its operations. The landholders were then invited to tell their 'story' of why they became involved in farm forestry and the rationale they used for investing resources in this activity. This narrative was recorded and subsequently summarised by the researcher. Participants were then 'stepped through' structured questions which further explored their motivations for becoming involved in farm forestry and the impediments that they saw to further planting. Data on landholder attitudes were collected by asking respondents to rate the intensity of their feelings on a Likert scale. A total of 22 case studies was completed, 12 in the south-east and 10 in the far north of the state.

Calculations of financial viability were performed using the Australian Farm Forestry Financial Model (AFFFM). The AFFFM assesses the effect on whole-farm financial performance of 'with' and 'without' plantation scenarios. It incorporates the effect of partial substitution of forestry for agricultural enterprises, establishment and operating costs, tree growth rates, plantation thinning and final harvest, user-defined timber prices and discounting to account for time preference and risk. Strictly speaking, when used to examine plantations that have already been established, past cash inflows and outflows would be treated as *sunk costs* and not be included in the financial analysis. However, to represent the financial performance over the entire life of the forestry projects, a hybrid analysis based on a combination of past and projected cash flows was used. That is, net present value (NPV) and internal rate of return (IRR) were calculated to represent projected returns *as if* at the start of the project.

[1] The term 'agroforestry' is used in this report to refer to trees and agricultural enterprises on the same farm, not necessarily on the same plot of land.

[2] The RIRDC project *Farm Forestry Experiences in South East Queensland and North Queensland and Development of the AFFFM* was conducted in 2003-04. A report is pending.

Data Analysis

Demographic data were analysed using frequency distributions and other descriptive statistics. The characteristics of the respondents were then compared to the 'clusters' of demographic features obtained from previous related research in north Queensland, including Emtage *et al.* (2001) and Emtage (2004).

Descriptions of the land types allocated to small-scale plantations and of the types of plantations established were analysed from both quantitative data and from responses to open-ended questions, while details of motivations and attitudes of people who had planted trees were collected on Likert scales and analysed.

Financial analysis was performed using the Australian Farm Forestry Financial Model (AFFFM), based on cost information supplied by the landowners. Where respondents were unable to supply information on expectations of growth rates, harvest dates and timber prices, these were estimated by the researchers and used in financial analysis including sensitivity analyses. Other the key assumptions, discount rates and expected annual returns under grazing were also set by the researchers.

Finally, the findings of the above analyses were incorporated with themes that emerged from respondents' 'stories' to construct holistic descriptions of the cases studied, and were the basis of the discussion of policy implications.

MAIN FINDINGS FROM THE CASE STUDIES

Characteristics of People Who Have Planted Trees

The category of landholder who plants trees is of a different ilk from 'full-time farmers' who are noticeably absent from the ranks of those who plant trees. The typical profile and broad motivations of tree planters identified are that they:

- Are more than 50 years of age;
- Are well-educated;
- Have off-farm sources providing most of their income; and
- Are driven in their action of planting trees more by the non-monetary rewards than by the expectation of financial gain.

They fit into a category commonly labelled 'hobby farmers' or 'lifestyle owners', which corresponds with previously identified landholder 'types' of Emtage *et al.* (2001) and Emtage (2004).

Characteristics of the Land Owned by People who Have Planted Trees

Just as there are differences between the categories of people who plant trees and those who typically do not, there are also distinct differences between the types of land on which trees are planted. The main differences are that the land used by those planting trees:

- Has poorer soil than most in the region;
- Was once an operational farm but ceased to be financially viable; and
- After ceasing to be a farm unit, was sold as a subdivided parcel of land.

Commonly, the purchaser paid a higher price than could be justified by its use for agriculture. Specific attributes of rural land that encourage lifestyle owners to acquire such land include the property's proximity to centres of employment or recreational attractions, or where the land may be expected for any other reason to appreciate in value. Property sizes range from 16 to 170 ha. Cattle were run on 13 of the 22 case study properties, and cropping and horticulture on two.

Description of the Plantation Activities

The study found that eucalypts were planted in all but two cases, joint ventures were the vehicle by which trees were established in five cases and the Community Rainforest Rehabilitation Program (CRRP) in eight cases. Hoop pine or Caribbean pine had been planted by five of the study participants. The relationship between the owner's principal purpose and the characteristics of their plantings is shown in Table 1. Areas of plantation ranged from 1.5 to 25 ha, considerably less than the minimum area of 30 ha sought by the DPI in their private land rental program (DPI 2004).

Table 1: Principal purpose of landholders for planting trees and characteristics of their plantations.

Principal purpose[a]	Joint venture	CRRP participant	Eucalypts	Cabinet timbers	Hoop pine or Caribbean pine	Native forest details
Lifestyle			yes	yes		
Lifestyle and investment				yes		Heritage listed
Lifestyle and investment	yes		yes			Remnant
Lifestyle and environment			yes			On steep slopes
Lifestyle and environment			yes	yes	yes	
Lifestyle and environment			yes			yes
Lifestyle			yes			yes
Lifestyle and investment				yes		
Lifestyle			yes	yes		yes
Lifestyle and investment	yes		yes			On steep slopes
Lifestyle and investment				yes		
Lifestyle, investment and environment	yes		yes			yes
Investment		yes	yes	yes		
Environment		yes	yes	yes	yes	Regrowth
Investment and lifestyle	yes		yes		yes	
Environment		yes	yes	yes		
Investment forest income		yes	yes	yes	yes	155 ha old growth
Environment and lifestyle		yes	yes	yes	yes	
Lifestyle and income		yes	yes	yes		7.5 ha old growth
Lifestyle and environment		yes	yes	yes		32 ha old growth
Farming, environment and investment	yes		yes			
Investment and environment		yes	yes	yes		yes

[a] For land ownership and forestry project, as perceived by the researchers.

Lifestyle and environmental considerations were the principal purposes stated by landholders for planting trees, followed by 'investment'. Lifestyle reasons referred either to rural living *per se*, or to the opportunity to use the property as a retreat from the person's usual place of residence. Environmental reasons were based on the premise that in an age of pollution, growing carbon dioxide emissions and land degradation, planting trees was a worthy and noble contribution both to the person's immediate successors and to future generations in general. Most respondents indicated (financial) 'investment' was one of their purposes for planting trees, but subordinate to those of lifestyle and environment. Even then there was a blurring of their meaning, with capital growth from land ownership not clearly differentiated from that expected from future timber sales. In fact, many said that they felt the value of the timber would reside more in its enhancement to the value of the real estate as standing trees than as milled timber.

Motivations for Hobby Farmers to Plant Trees

Table 2 sets out in order of mean score responses given to the question 'How important were each of the following reasons in your decision to plant trees?', where one represents 'not important' and five 'very important'.

Environmental, personal and altruistic reasons headed the list, with those relating to receiving cash income from timber sales ranked much lower. Given the current age of tree growers and the expected age to maturity of plantation trees, it is not surprising that their motivations relate to the rewards they experience now while the trees are growing. Obviously such rewards will be non-monetary.

Table 2: Factors motivating respondents to plant trees.

Reason for planting trees	N	Minimum score	Maximum score	Mean score
To encourage native flora and fauna	20	3	5	4.30
A personal interest in trees	20	2	5	4.30
Aesthetic legacy	20	3	5	4.15
Environmental legacy	20	1	5	4.00
To restore the land	20	1	5	3.80
Commercial legacy	20	1	5	3.70
To increase capital value	20	1	5	3.70
As a commercial retirement investment	20	1	5	3.65
To improve property appearance	20	1	5	3.65
To diversify farm income	20	1	5	3.45
For additional farm income	20	1	5	3.35
To mitigate soil erosion	20	1	5	3.25

Note: Not all of the 22 respondents completed all questions.

Common motivational themes arising from the 'stories' told by respondents include:

- They want to own real estate for their heirs.
- Trees are perceived to be an 'easy to manage' form of land-use.
- Forests constitute a legacy for future generations.

- Forests are considered an environmentally responsible form of land-use.
- The landholders simply 'like trees'.
- They enjoy the rural lifestyle.
- They contend that trees will in any case increase the value of the land.

Factors that are not impediments for them include:

- A need to justify the project on strict financial grounds.
- Lack of certainty about growth rates and future timber prices.

The Need for a Trigger to Translate Attitude into Action

In 13 of the 22 cases, landowners with a favourable attitude towards planting trees only translated intention into action when some external trigger was available. Triggers that were effective were the Queensland Plantation Joint Venture Scheme (PJVS) and the Community Rainforest Reforestation Program (CRRP), indicating that these incentive programs successfully reached this particular category of landholder.

Constraints to Profitable Timber Production

One limitation of plantings not being profit-driven is that these landholders may not undertake the silvicultural practices required to produce high quality timber. Low intensity silviculture is common, and may preclude the achievement of positive financial outcomes either for themselves or for any future owner.

Another limitation is the lack of economies of scale. Most commonly, the land was purchased as a lifestyle block – subdivided from an original farm holding. Therefore the areas held by this category of landowner are usually much less than that of surrounding commercial farms. In addition, because landscape aesthetics is a strong component of their motivations, they prefer to plant only portions of the property to trees. This limits the plantation size and fragments planted areas. Moreover, lifestyle owners prefer mixed-species plantings, for which the requirement for selective harvesting is inherently less efficient than harvesting of a uniform monoculture, although positive interaction between species is sometimes argued.

Predicted Financial Outcomes for the Various Types of Plantation Venture

Given that a key motivation for the research was to demonstrate the level of financial viability of agroforestry projects and notwithstanding that the landholders in these case studies were found to be seeking predominantly non-monetary rewards, the likely financial outcomes of their projects were calculated for several of the ventures. Financial evaluation with the AFFFM was performed using cost data supplied by the respondents. Where landholders indicated the prices they expected to receive for their timber, those figures were used. In other cases the researchers estimated the prices currently being paid to producers of similar timber. A real discount rate of 7% was chosen by the researchers as being a reasonable compromise between rates that may be required by a commercial investor and those for whom non-monetary outcomes take precedence. Key performance criteria used were Net Present Value (NPV) and Internal Rate of Return (IRR). The calculations revealed that where the land, if not used for trees, would have been used for some other income-earning activity, positive financial returns can be expected only where several key factors co-exist:

- Establishment costs are low,
- Tree growth is rapid (high MAI),

- Harvest age is early (i.e. short rotation),
- Timber prices are high, and
- No cost allowance is made for the owner's labour.

With rare exceptions among the cases comprising the research study, all of these conditions could not be expected to co-exist.

Despite similarities in motivations for all who planted trees, there are also notable differences between them and hence in the form of plantation they chose to be the vehicle for their penchant. The main differences relate to their personal financial circumstances and in their ability to contribute labour. The financial situation for selected cases of the three types of small-scale plantations is now described.

Cabinetwood Plantings

The initial investment for this category of plantation was very high (up to approximately $20,000/ha). In these cases the landowners had sufficient capital and were strongly motivated by the expectation of financial gain (in addition to non-monetary rewards). They also sought a high level of personal involvement with the plantation's management. The owners are highly optimistic about the growth rates of the trees and of the prices to be obtained for the timber. In most cases, the trees are thriving and the growth expectations may be realised. In terms of timber prices, owners recognise that their timber cannot be sold profitably as a commodity but rather will need to be sold into niche markets, perhaps through cooperatives, and that in any case successful supply chains will need to be developed if their goal of financial gain is to be achieved.

Plantation Joint Ventures

Landowners who used a joint venture arrangement found this a means of getting trees planted promptly when they themselves did not have the necessary capital or labour to establish a plantation. In a number of these cases, use of the land for cattle grazing had presented difficulties due to either a lack of the owner's livestock management skills, time constraints, inadequate fencing or lack of stockwater. Some owners did not want to have exotic livestock on the property, preferring only native fauna. These various reasons led them to consider trees where no alternative land use existed or was planned. In situations where no alternative land use was planned, the land resource had a zero opportunity cost for the owner (i.e. no income was foregone through having trees). It is not surprising that under such circumstances a joint venture scheme can generate a financial return greater than the alternative (idle) land use.

Fully Private Eucalypt Plantations

Landowners who undertook this form of plantation did so without any external trigger for action. They planted species they felt best suited the property rather than basing their decision on expected financial gain. Notwithstanding the relatively low level of capital investment, it is difficult in most cases to foresee positive financial outcomes. The main reason relates to the timing of expenses vis-a-vis income from the project. Cash expenses necessarily occur early in the project life but the revenue occurs perhaps more than 30 years later at final harvest. Discounting of that future income (taking account of time preference and risk) means that forestry simply cannot compare well with using the land for enterprises generating a stream of annual cash inflows. Thus income from cattle would generally yield a higher return than a eucalypt timber project. If the cost of the owner's labour for plantation management is included, the predicted financial performance is even less favourable. Of

course, if no alternative land use was going to be practised, then forestry may yet prove to be a financially sound venture.

Linkages Between Motivations and Outcomes

Almost all surveyed landowners reported that they considered their projects to be highly successful in terms of the non-monetary rewards they experience. They feel that through their plantation they will not be leaving merely a financial legacy for their children. They will be leaving the world in an environmentally cleaner and 'greener' state for future generations in general.

In terms of financial evaluation, where the owners do not place a high value on financial outcomes, deriving instead high levels of satisfaction from performing the tasks of plantation establishment and maintenance, it is hardly appropriate to include their labour as a cost. Paradoxically, this increases the likelihood of satisfactory financial performance as well. Owners also invariably reported that even if the trees are not likely to be a profitable investment in terms of timber value, trees are considered to add significantly to the value of the real estate. They contend that their property value is increased because it has an aesthetically appealing balance of trees and other land use, for which a future buyer will pay more than for an equivalent property consisting only of open grassland. This contention contrasts with the findings of a study of impact of reforestation on land values reported by Harrison *et al.* (2003), who found that plantation establishment costs are not fully factored into land values.

RELATING LANDOWNERS' MOTIVATIONS, ACTIONS AND ACHIEVEMENTS TO POLICY

In terms of closing the gap between future timber demand and supply through attracting additional privately-owned land into plantation forestry, knowledge of how landowners view forestry could be used to shape policy development. This research revealed that there is a distinct category of landowner who are already predisposed towards having plantation trees on their land – the lifestyle or hobby farmer group.

Tailoring Incentives to Part-time or Lifestyle Farmers

When attitudes favourable to an idea are held, they are more easily moved further in the same direction than in the opposite direction – as demonstrated regarding the role of 'triggers' in translating tree-planting intention into action. Therefore, if a policy or incentive is intended to influence a category of landholder to use portion of their land for timber plantations, it would be much more efficient to target those whose attitudes are already favourable to that activity – the demographic category identified in this study – rather than seeking to influence those who hold neutral or negative attitudes – comprising existing commercial farmers and graziers. Factors which do not pose impediments for them include the need to justify the project on strict financial grounds and the lack of certainty about tree growth rates and future timber prices.

Knowing what motivated this landholder category to plant trees could inform new incentive triggers that would make sense to more owners of private rural land who fit the demographic and attitudinal profile of those who have already done so, encouraging them to translate latent predispositions into action. Examples of such triggers could be: promotion of the benefits of real estate as an investment vehicle for the inter-generational transfer of wealth; provision of extension advice and support to establish and manage forestry plots; and promotion of environmental responsibility and extolling the benefits of the rural lifestyle for older professionals.

Adequacy of the Land Area Held by Lifestyle Landholders

Even if many of this type of lifestyle landowner were to be galvanised into tree-planting action, does this category in aggregate really own sufficient land to make a difference to the national timber supply? Or could sufficiently more of this category be persuaded to invest in land for small-scale timber production? If the answer to both of these questions is 'No', then this may preclude following the path of small-scale forestry as a solution to Australia's timber deficit.

The Possible Role of 'Real Farmers'

If it is the case that the areas of suitable land held by the hobby or lifestyle farmer group are not sufficient, or that, coupled with other limitations they bring, such as a low standard of silviculture, they cannot make a substantial difference to timber supplies, then the only other potential source of land that can be used for small-scale forestry is that currently owned by full-time farmers. Although currently possessing negative (or at best neutral) attitudes to having their land used for timber plantations, this landholder category does have several important attributes with regard to forestry potential:

- They own larger areas of land both individually (and thus are more likely to achieve economies of scale) and collectively (and could therefore make a sizeable difference in terms of timber volume produced).
- They are more likely to demand that land use results in financial success, and therefore be more motivated to perform appropriate silviculture.
- They come equipped with practical rural skills and plant and machinery that could be utilised at least in the establishment phase of plantations.
- They comprise the long-term social backbone of their local rural communities and are more socially influential than are part-time farmers. Thus their status in the community could be harnessed to rapidly reshape community attitudes towards plantation forestry. A spin-off benefit for rural communities is that forestry could be beneficial in terms of social and regional stability.

Full-time farmers have not, by and large, been influenced by the same attitudes or triggers that make sense of forestry to part-time farmers. They come with a different set of values, attitudes and motivations, and bringing about change in these would require different triggers. Changing attitudes to forestry would be much more difficult, firstly because full-time farmers individually already hold negative attitudes and secondly because their social networks support such attitudes. However, this needs not be seen as an insurmountable impediment and could in reality be a key to widespread and rapid community acceptance. If for instance innovative opinion leaders in a stable rural community were to adopt plantation trees as a land-use practice, this could rapidly lead to widespread adoption at a regional community level.

Incentives that May Make Sense to 'Real Farmers'

What incentives would make forestry attractive to leading farming figures in a stable rural community? Profitability, certainty of returns, and some means of receiving an annual cash income while the timber-crop is growing are likely to be critical factors in their decision-making.

The opportunity for significant change in a region's industries occurs when there are downturns in competing industries. In recent years, in north Queensland this occurred with the dairying and tobacco growing industries and was the case with the sugar cane industry in

the early 2000s before a degree of industry restructuring and price recovery that might or might not persist. Circumstances such as these provide a fortuitous window of opportunity for a new, potentially stable and profitable timber industry to be established. Even when such circumstances occur, encouragement and support from each level of government would still be needed to make it happen. Where it is possible to piggy-back on the infrastructure of moderate-sized core plantation estate in the region, this would also be an advantage.

Impact of Contraction of Full-time Farming on Tree Planting

If rural industry restructuring does not happen, then it is likely that some of the current farms will become non-viable with the owners ceasing to conduct their former farming activities. Such farms are likely to be those that are uneconomic because they are the ones with poorer soil, have a smaller land area than required for economies of scale and may be located nearer to cities. Properties such as this may be regarded as a sound real estate investment by a type of landholder that is older, with a high (off-farm) income, who is seeking a rural lifestyle. If such a category of landowner acquires the land, this turns the wheel full-circle back to lifestyle owners who like trees and if something triggers them into action, they may establish areas to plantation trees for timber or other reasons.

CONCLUDING COMMENTS

It was found that overwhelmingly those who have undertaken forestry at a farm level are very pleased with the outcomes as they unfold. The main source of their satisfaction is the non-monetary rewards they obtain – environmental, personal and altruistic. Those for whom monetary rewards are a large component of the objectives are pleased with the growth rates and their prospects for financial gain. Nonetheless, on the basis of the survey information and financial analysis, it is difficult to demonstrate competitive rates of return on investment for many of the projects studied.

It became apparent early in the research that full-time commercial farmers are notably absent from the ranks of those who plant trees. Since the case studies were restricted to landholders who have established plantations, the project did not investigate attitudes of full-time farmers, nor did it examine any interrelationship between individual attitudes and the mores of the social groups and communities of which they are part. To examine the attitudes of those landholders who currently do not plant trees would therefore be a fruitful area of study.

In terms of policies aimed at increasing the participation of private landholders in establishing meaningful areas of plantations, it is clear that without strong intervention by various levels of government and without strong community support, it is unlikely that a strategy of small-scale forestry will be the mechanism by which Australia's future timber supplies are produced. The alternative is that for the Australian forest industry to develop in any meaningful way, it will be at an industrial scale with only a limited contribution by small-scale growers.

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7. A TREE GROWER'S VIEW ON FORESTRY IN NORTH QUEENSLAND: WHY ARE WE STILL ASLEEP?

E. Wiles

This paper presents a landholder's view of forestry plantations in north Queensland. The highly effective forest management before European settlement is described, and current views on forest conservation and forestry practices are challenged. Attention is drawn to unnecessary impediments imposed by government on timber production. It is clear that everyone gains from carefully planned and executed reforestation projects. There is a crying need for solid research, to overcome anti-forest prejudice and woolly thinking rife amongst policy-makers. There is a need for community 'wake up' to the opportunities for a sustainable and culturally and ecologically sensitive management of forests.

I am in a state of confusion. Now, there are those of you who are uncharitable enough to say, 'So, what's new?' Those of you not so ill-disposed towards me will recognise that opening sally as a cry for help, and will be able, perhaps, to aid me. My confusion stumbles around several areas of which I would like to mention – (a) the nature of forests, (b) our forestry practices, (c) Aborigines on Cape York Peninsula, (d) the Great Barrier Reef, and (e) money.

THE NATURE OF FORESTS

Forests ain't forests in the same way that *oils ain't oils*. The forests of eastern United States are not at all like the forests of Australia, but there are attributes of both which are similar, and what applies to one may apply to the other. The National Geographic of November (2002) states:

> *Can the eastern forest become what it used to be? Four centuries ago a great dark foreboding forest – a 'howling wilderness' as the pioneers called it – stretched across more than 650 million acres of eastern North America. The settlers looked at the forest and saw boards, shingles, and the masts of ships. They saw fuel with farmland underneath. Their axes got busy. A few uncut patches remain, such as Cathedral State Park in West Virginia. Nothing much seems to have changed there in four hundred years, except for the addition of rest rooms and playground equipment (today the definition of wilderness is a place without a gift shop). But most of the ancient forest is gone. Even before Europeans arrived, Indians had burned most of it to open the understorey for hunting. The strange thing is, the tree cover of the East is actually more extensive now than it was decades ago… So, will the new eastern forest return to its former self? Nice thought, but forests aren't like that. They're always in flux. There was no 'way it was'.*

What has that to do with us? Just before I was born, an agronomist informed the farmers in my district (South Johnstone) that the Basilisk Range was a vector for the cane beetle. During the depression the local farmers, with axes and crosscut saws, clear-felled the lot. The whole range grew nothing but blady grass, which was burnt – cane fires – every year for thirty odd years. Then, no more cane fires and bingo! Look at Basilisk Range now.

Aborigines traversed this land from coast to uplands for many thousands of years. From the (local) jungles they collected food and medicines, and must have 'lived in' for most of their lives. In travelling coast to uplands, they would have moved along creek lines and mountain ridges. Of course, they would not put up with lawyer vine, stinging tree, mosquitoes, ticks, lice and scrub itch mites. These embuggerances were kept at bay with both hot and smoky fires. Yes, they burnt the rainforest to maintain pathways, bora grounds and camping areas. These possibilities, plus the carrying of edible seeds, would account for the existence of certain species where they should not be. The historical fact that Europeans on the Atherton Tablelands could ride horses at speed through virgin forest displays plainly the results of thousands of years of Aboriginal disturbance. Look now at the rainforests between Babinda and Gordonvale. These have been disturbed by nothing but cyclones; have been 'managed' by being locked up by ignorant zealots. The result? Smothering vines are overwhelming the rainforest; canopy species are disappearing along with dependant life forms.

Clearly, as I see it – and I am happy to be corrected – the regularly Aborigine-disturbed rainforests show greater vitality and biodiversity than those we have locked up and destroyed – oops! Sorry! – 'preserved'. How else do we account for edge germinating and prospering species like hoop pine and red cedar in the middle of rainforests? I suggest that our broad-scale rainforest research is sadly lacking.

OUR FORESTRY PRACTICES

When I was a young man (how readily we all reach for the good old days), there were sawmills at Ravenshoe, Millaa, Tanzali, Malanda, Yungaburra, Tolga, Kairi, Mareeba, Kuranda, Stratford, Edge Hill, Cairns, Gordonvale, Mirriwinni, Innisfail, and every haystack beside the line to Brisbane. Of those, sawmills in Ravenshoe, Innisfail and Gordonvale remain. The rest have been 'Richardsonised'. Why was this done? Because there are other agenda that required that forestry be halted and propagandised perceptions of unsustainable practices were seized and exploited to that end successfully. No matter that the Queensland Forest Service was the world's most skilled manager of standing rainforests; no matter that the Queensland Forest Service had evolved increasingly stringent sustainability practices, in parallel with the public's concepts of sustainability; no matter that in the mid 1980s, when about sixty thousand cubic metres per annum were selectively harvested, research into this selective harvesting system generally indicated that with adherence to relatively simple guidelines, commercial harvesting could be conducted with minimal negative environmental impacts. We surely are the 'Smart State'!

To add insult to injury, the Queensland Forest Service was absorbed into the DPI, which has been, not decimated, but gutted. We have lost utterly irreplaceable forest knowledge. If a landowner needs some information about tropical rainforests, to whom does he or she refer for practical answers to practical questions? Worst of all, the forest management/harvesting system evolved by Queensland Forest Service, and killed by our anti-forest zealots, has been adopted by Papua New Guinea, Indonesia and Malaysia (perhaps too late), where it is considered close to sustainable forestry.

We, and our authorities, do not seem to realise that the tropics, both savanna and rainforests (and all in between), are host to the most exquisite and durable timbers on Earth; that Australia is the only first-world nation with tropical rainforests. Australia enjoys stable political, legal and economic systems; but, our politicians leave much to be desired. Some may object to, even resent, my rubbishing the quantity and quality of forest research. But tell me, how has the seriously and regularly disturbed Basilisk Range managed to reforest itself so successfully in a short time? Further, how has that self-regeneration managed to contain such a diversity of flora as to create a prime cassowary habitat – daily sightings practically guaranteed? What would result if other areas were left to self generate? What if humans got

stuck in, as a part of nature, to help Mother Nature with her chore? I argue that there are many accessible areas for worthwhile research.

On the down, even nonsense, side of forest research, the Cairns Post on 1 April 2004 reported (the date may be significant):

> *Removing contaminants from waterways and channelling them into food was like rearranging the deck chairs on the Titanic', a research consultant says. She said the proposal to use farmland as a kidney filter for municipal effluent had come from the DPI principal agronomist, Dr Mike Bell, and was supported by NRM Minister Stephen Robertson. Both believe human waste biosolids are a valuable resource to be returned to complete food production cycles. But this means farm crops could be grown on a cocktail of dissolved nutrients and anti-depressants, oestrogen, heavy metals and other hazardous materials that could compound and convert into ever more dangerous chemicals. The effects of these chemicals being taken up by plants and ingested by humans has not been assessed, but there are many hidden dangers and the effects could be irreversible.*

This researchers should consider Hungary and other Asian nations. Hungary has about 15 M people and is about the size of Tasmania with no ocean frontage and a thousand-plus years of industrial activity, and has been using effluent – human, animal and later industrial – and so of course has China and most of Asia. The alarmist balderdash announced by the research consultant should have been denounced by her peers. 'The effects have not been assessed but there are many hidden dangers'. Oh? You who are researchers should tell her about what is ingested by crabs, prawns and that splendid effluent-watered forest in Albany.

Four years ago, in opening the biennial AFG Conference in Cairns, I said, amongst other things, 'We should pressure our governments and government departments into realising that forestry – and I am not talking about rape, pillage and burn; I am talking about a sustainable and culturally and ecologically sensitive management of propagation of forests – is the means by which Aboriginal communities of the whole north can attain economic freedom. Expel the curse of welfare dependence!'. Have governments done anything in those four years to benefit Aboriginal groups? Yes, they brought in anti-grog laws that don't apply to some whites. Anything else? Nope! Aborigines are still the most lied to, exploited, misled, deprived, ignored people in Australia. They are misunderstood, ill-educated, in poor health and beset with horrifying social problems. What are we doing about the problems? Well, some of us would like to see the whole Peninsula set aside as a National Park, with maybe ten or twenty Aborigines as rangers. And the rather absurd EPA can continue to ignore the feral pigs and cats. When do our consciences click in? When do we recognise that these natural hunters and gatherers have an affinity for their forests; they have an understanding which could be readily turned, without alarming cultural sensitivities, to efficient and prosperous management. When do we wake up? When do we see the treasures on the communities' thresholds?

The Great Barrier Reef is, without doubt, the greatest pants-wetting quality icon we have. As with all icons, you know, like flying foxes and mahogany gliders, it is under threat. The Great Barrier Reef is subject to potential threat at three levels: local, regional and global.

Local threats include the direct damage caused by boat anchorage, jetty development, waste discharge and other people pressures at coastal city or high-density tourism sites. Australians should be proud that their environment and management agencies have had a high degree of success in controlling such local impacts, and in working successfully towards the sustainable use of current Great Barrier Reef tourist facilities.

Regional threats include the much-publicised crown of thorns starfish (COTS) outbreaks and the more recent fears expressed that increased sediment or nutrient yield caused by agricultural modification of coastal lands will damage the wide areas of the Great Barrier Reef. *It needs to be stressed that after more than twenty-five years of intensive research, no evidence has been published which demonstrates an anthropogenic influence on COTS outbreaks, or adverse regional effects on the Great Barrier Reef from increases in sediment or nutrient load.* Wait a minute! Does not the EPA protect all Australian wildlife? How then are those murderers able to mercilessly, using most painful methods, wantonly slaughter the crown of thorns starfish? And we all know that each mangrove is a sacred site. How is the Cairns City Council able to stop their colonising the Esplanade mud flats? I smell hypocrisy!

Global threats include the effects of sea level rise and sea surface temperature rise, which causes episodes of coral bleaching. Both those threats are popularly believed to be a consequence of greenhouse change, and coral bleaching in recent years has moved beyond a threat to become a damaging reality. Nevertheless, our understanding of climatic change is as yet inadequate to say that the observed SST warming is anthropogenic. Natural climate cycles work on many time scales and their effects may be manifest in apparently strange ways. For example, tropical SST warming and breakage of large icebergs from Antarctica may presage a global *cooling,* rather than warming, trend. As another example, local sea level change varies from place to place within the Great Barrier Reef. For instance, sea level is rising in Townsville, but static or gently falling in Cairns. It is unclear whether either change will have a deleterious effect on the reef and, in fact, a moderate sea level rise is most likely to be beneficial to reef growth.

The thoughts of Professor Robert Carter of James Cook University are relevant in dealing with the Great Barrier Reef. He commented in *The Way Forward*, that above all else we need to inject a much stronger element of broad-based impartial and excellent science reality into the management of the Great Barrier Reef and of future Great Barrier Reef research. *Taj Mahal Management*, which assumes that the current accidental snapshot that is the Great Barrier Reef must be preserved unchanged for eternity, coral by coral, is doomed to fail. Sharp distinction must be made between reefs of particular social or socio-economic importance, or those which nurture particularly precious ecosystem resources which should be afforded special protection, and those other reefs which for part of a wider changing whole, and which therefore should be allowed to change – even to die – in a 'hands off' fashion.

A further observation occurred as I drove to Mossman (in north Queensland) a couple of weeks ago for a similar workshop. The sea, as far to seaward as one could see, probably four miles, was a distinct Cadbury's dairy milk chocolate colour, and that without flooding or farmers' clear felling. Perhaps the constant 25-knot south-easterlies had something to do with it.

Here are some disparate facts that pester me constantly:

- When I was a boy, the populations of India and China were 400 M and 600 M respectively. They are now 1.1 billion and 1.3 billion, officially.
- There are more millionaires in China than there are people in Australia.
- China has five thousand years of history and cultural development. They are superb craftsmen and artists in wood.
- In the East, red is a very warm and lucky colour.
- Although effecting vast reforestation projects, China will have nowhere near enough wood now or in the foreseeable future. The rest of the world is plus.
- Our tropics produce timbers of superb colour, quality and durability.

- We are stupidly allowing governments, for spurious reasons and at the behest of the ratbag element of the green movement, to impose impediment on impediment even to prohibition on our growing trees and we wonder why farmers say NYET! We surely are the 'Smart State'.

Nevertheless, the financial possibilities of prime quality timber exports, carbon credits, salinity credits, environmental credits and domestic consumption are so great that I have no choice but to be planting. What about you? When are you going to wake up?

SUMMARY

Everyone gains from carefully planned and executed reforestation projects. Why are we not up to our armpits in new projects? Firstly, we don't know enough, but importantly, we have plenty of information but we lack enough factual information. We need more *solid science research*. I have no interest as to why the three-legged wombat always produces two offspring. We need the research to overcome the anti-forest prejudice and woolly thinking rife amongst those who inhabit Melbourne, Sydney and Brisbane. And get governments to *remove all impediments* and try *realistic incentives*. Good outcomes, even salvation, are possible but the track record is poor. *Time for us all to wake up*!

8. ECONOMIC PERFORMANCE OF TIMBER UTILISATION POLICIES THAT GENERATE EMPLOYMENT AND INCOME FOR WIK PEOPLE ON CAPE YORK PENINSULA

T.J. Venn

A forestry industry based on the native Darwin stringybark forests of Cape York Peninsula has been identified as a potential generator of employment and income for Wik people. Information appropriate for examining potential Wik timber utilisation strategies is scarce, necessitating primary data collection activities in north Queensland. A mathematical programming approach has been used to identify appropriate timber utilisation strategies from the perspective of Wik people. The analysis suggests that, in general, relatively low-technology forestry activities are likely to best satisfy Wik forestry objectives.

INTRODUCTION

Wik, Wik-Way and Kugu peoples (referred to here as Wik people) living in Aurukun Shire, Cape York Peninsula (CYP), aspire to be economically independent and self-reliant (Balkanu Cape York Development Corporation c1999), a vision shared by the Queensland and Federal Governments (CYRAG 1997, Department of the Premier and Cabinet 2000). The High Court's *Wik Judgement* in 1996, confirming the existence of native title on pastoral leases on CYP, and the granting in October 2000 of native title over a portion of the Wik land claim, have been major steps toward fulfilment of this vision. However, Wik people remain dependant on government welfare, including the Community Development Employment Program (CDEP) for income. The *Cape York Partnerships Plan* has committed the Queensland government to developing a strategy to drive a regional economy on CYP, which builds on the strengths of the region – its people, culture, history and extensive range of natural resources.

Balkanu Cape York Development Corporation (Balkanu) representatives of Wik people have identified the native forest timber resources in and adjacent to Aurukun Shire as one potential engine with which to drive the elders' vision of economic independence. Balkanu defined a study region on the western coast of CYP covering about 841,500 ha, highlighted in Figure 1, which is approximately 30% of the Wik native title claim area. It was suggested to the author that a large financial grant could become available from government to assist establishment of a Wik timber industry and, therefore, a range of forestry opportunities should be evaluated, including large-scale, high-technology operations. Representatives of Wik people are particularly interested in exploring the potential for manufacture of high-value dried and dressed finished products, including strip flooring and furniture, which are regarded as 'respectable' forestry activities that could raise the pride and self-esteem of Wik people. Wik elders have expressed particular interest in opportunities to export woodchips or supply logs to sawmills.

The author was asked to assess the financial feasibility of a Wik forestry industry and provide information to support Wik decision-making about what types of forestry activities are likely to be appropriate given the available timber resources and the socio-economic environment of the region. The paper describes the collection of forestry information relevant to the study region and a mathematical programming model that has been developed to support Wik

decision-making processes about potential forestry opportunities on traditional land. Optimal timber utilisation strategies from the private perspective of Wik people are discussed.

COLLECTION OF INFORMATION TO SUPPORT WIK FORESTRY DECISION-MAKING

Supporting the forestry decision-making of Wik people requires information about the region and its resources, including:

- Wood properties of timber species, harvestable area of native forests with commercially valuable stands of timber, and harvestable volumes of merchantable timber;
- Potential timber processing opportunities;
- Markets for timber;
- Property rights of Wik people to timber resources; and
- The forestry objectives of Wik people.

Timber Resources of the Study Region

The Queensland Department of Primary Industries - Forestry (DPI Forestry) considers the native forests on CYP to be the largest remaining native forest resource in Queensland with potential to make a major contribution to future timber supplies (Wannan 1995). While the Peninsula has extensive areas of rainforest and *Melaleuca* forests, it is the 1.7 M ha of tall (canopy height ≥ 30 m) *Eucalyptus tetrodonta* (Darwin stringybark) forests outside of National Parks that is regarded by DPI Forestry[1] as being of interest for commercial sawmilling operations (Wannan 1995). Analyses in ArcView geographic information system (GIS) software of spatial data provided by the Queensland Department of Natural Resources, Mines and Water (NRMW) indicate that the study region contains about 0.42 M ha of this resource. In addition, there are 0.16 M ha of shorter (canopy height < 30 m) Darwin stringybark forest types in the study region that may contain timbers in commercially attractive qualities and quantities.

The timber species of commercial importance in Darwin stringybark forests are Darwin stringybark, Melville Island bloodwood (*Corymbia nesophila*) and Cooktown ironwood (*Erythrophleum chlorostachys*). These species each have high density, high natural durability and aesthetically pleasing timbers, which are suitable for a wide range of internal and external uses (Bootle 1983, Smith *et al.* 1991, Hopewell 2001, Annandale *et al.* 2002). Nevertheless, little effort has been directed toward quantifying and qualifying the timber resource on CYP (Annandale and Taylor 2000). The only published estimate of standing volume of merchantable timber in Darwin stringybark forests on CYP is 2 m^3/ha (Wannan 1995). However, Wannan's study has been criticised by DPI Forestry as an overly simplistic analysis. Anecdotal information suggests that merchantable 'compulsory sawlog'[2] volumes were estimated at between 6 m^3/ha and 10 m^3/ha on the site of the Scherger Air Force Base near Weipa (Davis 2001). Forestry operations during 2000 in Darwin stringybark forests at the Lily Vale pastoral lease on the east coast of CYP reportedly yielded an average of 6 m^3/ha of Darwin stringybark logs (Davis 2001).

[1] DPI Forestry has been discontinued from the beginning of May 2006, with its activities divided between Forestry Plantations Queensland (a government-owned corporation independent of the Department of Primary Industries and Fisheries) and the Department of Natural Resources, Mines and Water.

[2] DPI Forestry defines a compulsory sawlog to be a log with a minimum small-end diameter of 30 cm, greater than or equal to 2.4 m in length and with little defect (Department of Primary Industries Forest Service 1994). .

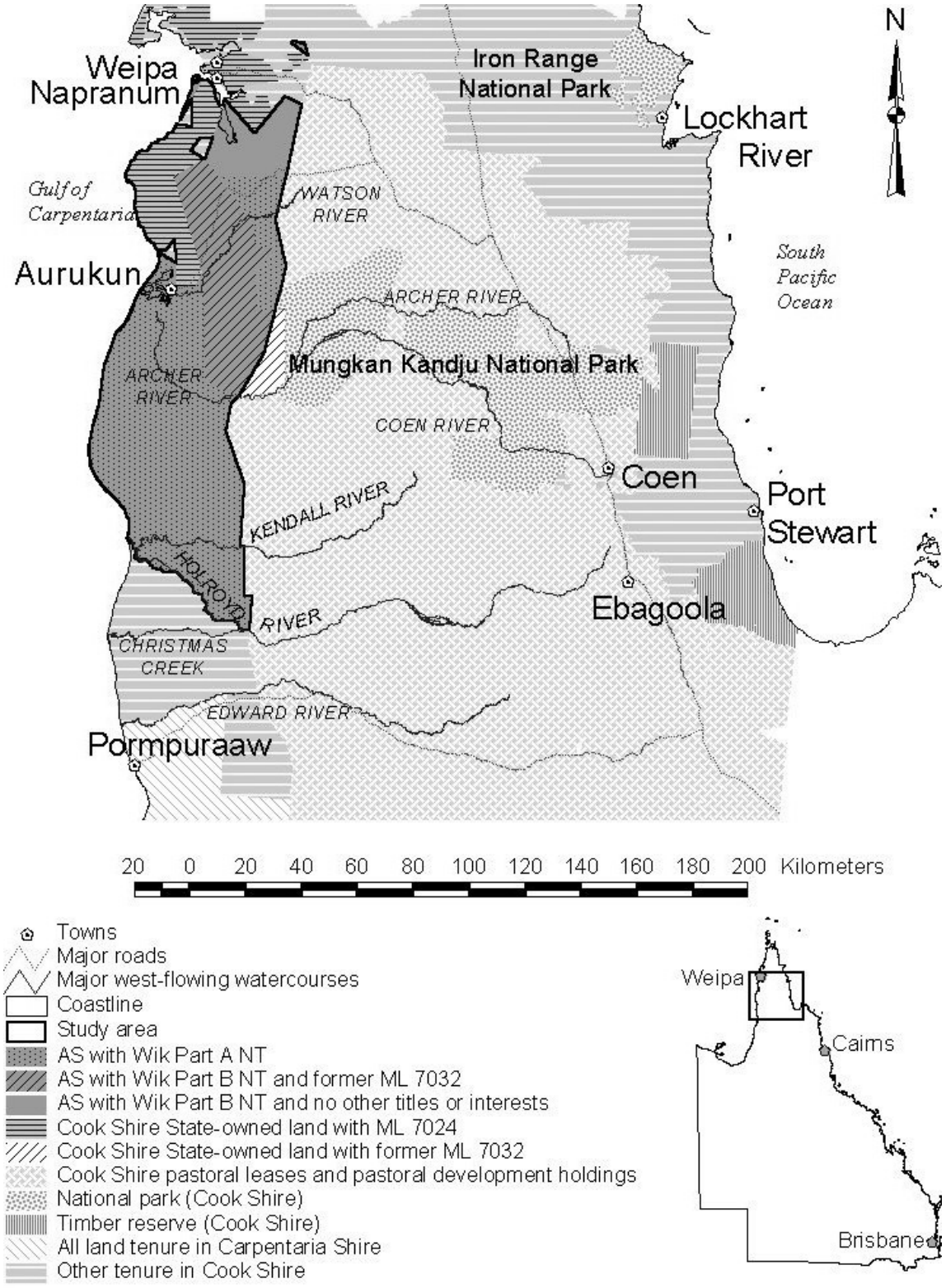

Figure 1: The study area and surrounding land tenure on central CYP.

Notes: AS = Aurukun Shire Special Lease land; NT = Native Title; ML = mining lease. Only Native Title land within the study area is illustrated. The Part A and Part B determination areas include land outside the study area.
Source: Generated by the author using ArcView geographic information system software. Spatial data were provided by the Queensland Department of Natural Resources, Mines and Energy in 2000.

The Darwin stringybark forests of the study area were stratified into five types on the basis of floristics, structure and previous management, and a point-sampling inventory of the standing timber resource was undertaken. Plots were distributed among the five forest types on the basis of total area of the forest type and the relative volume of merchantable timber per hectare. Plots were located by a combination subjective and systematic plot location techniques in ArcView. A global positioning system was used to find the plot sites in the field. Within each plot, sample trees were identified by species, had their diameter at breast height and crown break, and total height measured. A Method of Assessment of Recoverable Volume by Log types (MARVL) approach (as developed by Deadman and Goulding 1979) was adopted to enable estimation of volume by timber quality. In total, 220 point-sweeps were conducted and 1,782 sample trees measured.

A polynomial under bark volume equation, and diameter over bark and under bark models, were developed for Darwin stringybark from 42 destructively sampled trees. The Darwin stringybark models were used as proxy models for Melville Island bloodwood. The volume of Cooktown ironwood trees have been estimated using Smalian's formula, with a constant rate of diameter taper assumed for logs of this species between DBH and crown break.

Together, the taper and volume functions, and timber inventory data provide estimates of merchantable volume per hectare by forest type for any log specification. Table 1 presents the volume of 'compulsory sawlog' by species and forest type. Pictorial representations of inventoried Darwin stringybark forests have been generated with Stand Visualization System software (developed by McGaughey 1997) to convey timber inventory information to Wik people.

Table 1: Under bark 'compulsory sawlog' volume per hectare by forest type in the study region.

Forest type	Harvestable forest area (1000s ha)[a]	Mean compulsory sawlog volume under bark by species (m^3/ha)			
		DSK [b]	MBW [b]	CKI [b]	Total
1	334	4.67	1.69	0.40	6.75
		(0.18)	(0.06)	(0.04)	(0.17)
2	148	0.00	0.80	0.00	0.80
		(0.00)	(0.34)	(0.00)	(0.34)
3	64	0.26	3.44	0.04	3.74
		(0.04)	(0.21)	(0.01)	(0.22)
4	0.2	0.00	0.99	0.00	0.99
		(0.00)	(0.57)	(0.00)	(0.57)
5	1.6	2.68	0.80	0.00	3.48
		(1.18)	(0.57)	(0.00)	(0.61)

Notes: Standard errors of volume estimates are in parentheses.

[a] Harvestable forest area is the area of forest that can be harvested in accordance with the Code of Practice for Native Forest Timber Production from Crown lands (excludes forests in watercourse protection zones and on steep slopes).

[b] DSK = Darwin stringybark; MBW = Melville Island bloodwood; CKI = Cooktown ironwood.

Potential Forestry Activities for Wik People

Discussions were held with Wik elders, representatives of Wik people, DPI-Forestry officers and managers of private forestry industries in Queensland to identify a range of appropriate forestry activities for the native forest resources of the study region. Recent research by CSIRO has indicated that the dominant commercial timber species of Darwin stringybark forests are unsuitable for pulp or reconstituted wood products with current technology (Clark 2003), so these possibilities are not considered. Table 2 lists the 25 forestry activities examined for potential inclusion in a Wik forestry industry. The table also lists production capacities, capital costs, variable costs and levels of employment generated by each activity. Cost and employment estimates have been derived from several published and anecdotal private industry sources, but modified to account for the cultural setting of Aurukun. In particular, it is assumed full-time employees in Aurukun work five hours per day, five days per week, 48 weeks per year. This is referred to as a culturally appropriate full time equivalent (CAFTE). The hourly productivity of Wik labour is assumed to be 70% of the private industry level (Venn 2004).

North Queensland Timber Markets and Wik Forestry Industry Opportunities

A lack of information about timber markets for Darwin stringybark, Melville Island bloodwood and Cooktown ironwood led to the undertaking of a timber market survey in north Queensland, as reported in Venn (2004). Unstructured telephone and in-person discussions were held with 46 north Queensland sawmillers, furniture manufacturers and other users of timber, local governments, and government agencies. Potential market prices and quantities demanded for 13 product types, including electricity poles, structural timbers and strip flooring, were estimated for Darwin stringybark and Cooktown ironwood. Cooktown ironwood is anticipated to achieve market prices higher than Darwin stringybark in appearance applications. Few interviewees were willing to comment on the market potential of Melville Island bloodwood. Several indicated that this species is inferior to Darwin stringybark and Cooktown ironwood, largely because of the prevalence of loose gum veins, which result in low usable sawnwood recovery (see Annandale *et al*. 2002).

Property Rights of Wik People to Timber in the Study Region

The size of a Wik forestry industry, its potential profitability and ability to raise capital will depend on factors such as: whether permits are necessary for commercial harvesting; whether royalties for harvested timber are payable to government; the regulations on timber harvesting; and the duration, exclusivity, transferability and divisibility of Wik peoples' rights to timber. However, the legal rights of Wik people to timber resources have not previously been analysed methodically. A comprehensive assessment has been made and the findings reported in Venn (2005).

On land where they have been granted native title, Wik people have rights to utilise timber resources that are commensurate with freehold title holders in Queensland. Subject to particular environmental and other legislation, and the forthcoming Code of Practice for Native Forest Timber Production on Private Lands, Wik people can harvest and process timber from native title land without a permit or payment of royalties to the Queensland Government. Throughout the remainder of the study area, Wik people do not have the right to commercially utilise timber resources. DPI Forestry indicated that it is highly likely a permit to facilitate commercial harvesting of timber would be issued upon receiving an application from Wik people. However, the Queensland Government has the power to charge royalties for timber harvested under such a permit. Harvesting would be subject to environmental and other legislation, the Code of Practice for Native Forest Timber Production from Crown lands, and agreement with the holders of mining leases that harvesting will not interfere with their rights and obligations.

There are several endangered, vulnerable and rare (EVR) species within the study area, including the red goshawk (*Erythrotriorchis radiatus*), which necessitates the retention of up to eight habitat and recruitment trees per hectare. Harvesting exclusion zones are required around watercourses and this will reduce the area of harvestable forest. The timber inventory data is suitable for estimating the effect of habitat tree retention and watercourse exclusion zones on harvestable volumes.

Table 2: Wik forestry activities examined and selected characteristics.

Activity	Capital cost ($ M)	Annual production capacity [a]	Total variable costs ($/m^3) [b]	Employment generated (CAFTEs)	Maximum number of activity [c]
Forest management for Wik industry	0.075		d	≥ 3	na
Forest management for 'outsider' industry	0.055		d	3	1
Harvesting (labour intensive)	0.075	0 to 3,000 m^3 of log	22.9	0 to 2	10
Harvesting (capital intensive)	0.110	0 to 6,000 m^3 of log	18.8	0 to 3	10
Hauling logs to Aurukun town or Weipa	0.150	0 to 6,000 m^3 of log	0.35 e	0 to 1	na
Portable sawmilling on-country	0.039	0 to 325 m^3 of log	135.1	0 to 1.5	5
Transporting GOS timber to Aurukun town from portable sawmills	0.070	0 to 1,625 m^3 of log	0.35 e	0.2 per p-sawmill on country	1
Portable sawmilling in Aurukun town	0.024	0 to 600 m^3 of log	164.8	0 to 4	1
Fixed-site sawmilling 1	1.200	425 to 2,200 m^3 of log	171.8	3 to 15	1
Fixed-site sawmilling 2	2.000	2,200 to 4,400 m^3 of log	142.5	12 to 23	1
Fixed-site sawmilling 3	3.800	4,400 to 11,000 m^3 of log	103.7	16 to 41	1
Fixed-site sawmilling 4	4.800	11,000 to 20,000 m^3 of log	71.1	25 to 45	1
Chemical treatment of poles	0.500	0 to 2,880 m^3 of log	45.1	0 to 1.5	1
Soak chemical treatment of sawntimber	0.005	0 to 140 m^3 green-off-saw	42.4	0 to 0.16	10
Vacuum chemical treatment of sawntimber 1	0.260	0 to 1,680 m^3 green-off-saw	33.5	0 to 1	1
Vacuum chemical treatment of sawntimber 2	0.500	0 to 2,880 m^3 green-off-saw	34.0	0 to 1.5	1
Vacuum chemical treatment of sawntimber 3	0.600	0 to 5,760 m^3 green-off-saw	29.5	0 to 1.5	1

Activity	Capital cost ($ M)	Annual production capacity [a]	Total variable costs ($/m^3) [b]	Employment generated (CAFTEs)	Maximum number of activity [c]
Air-drying sawntimber	0.064 / 1,000 m^2	A: 1,255 m^3 / 1,000 m^2 of shed space S: 1,560 m^3 / 1,000 m^2 of shed space	70.7 64.0	1.4 / 1,000 m^3 sawntimber	4,000 m^2 shed area
Solar kiln drying sawntimber	0.035	A: 0 to 130 m^3 S: 0 to 65 m^3	115.1 161.8	2.2 to 3.3 / 1,000 m^3 sawntimber	10
Combination gas and solar kiln drying sawntimber 1	0.065	A: 0 to 198 m^3 S: 0 to 109 m^3	113.4 146.0	1.7 to 2.3 / 1,000 m^3 sawntimber	10
Combination gas and solar kiln drying sawntimber 2	0.110	A: 0 to 590 m^3 S: 0 to 326 m^3	99.1 121.6	1.0 to 1.1 / 1,000 m^3 sawntimber	10
Combination gas and solar kiln drying sawntimber 3	0.165	A: 0 to 985 m^3 S: 0 to 543 m^3	94.5 115.4	0.83 / 1,000 m^3 sawntimber	10
Strip flooring manufacture 1	0.9	0 to 1,050 m^3 appearance boards	205.3	0 to 6	1
Strip flooring manufacture 2	1.1	0 to 3,940 m^3 appearance boards	169.7	0 to 6	1
Small-scale furniture manufacture [f]	0.6	0 to 90 dining table and chair kits	4,520 g	0 to 6	1

[a] Two annual production capacities are listed for all sawntimber drying activites. A is for appearance boards. S is for structural timber. Appearance timber is dried to 12% moisture content and structural timber to 20%.

[b] Total variable costs are total labour and non-labour (e.g. equipment and machinery) operating expenses expressed in dollars per unit of annual production capacity. For example, strip flooring variable costs are $/$m^3$ of appearance boards.

[c] Maximum number of activity is the total number of times the particular activity may enter any given timber utilisation strategy.

[d] Forest management does not directly produce timber products so it is not appropriate to report costs per unit of output. Variable forest management costs comprise the labour costs of forest managers (see Table 3), annual vehicle expenses of $6,240/vehicle and other expenses equivalent to 5% of total forest management labour costs.

[e] Log and GOS timber haulage costs are expressed in $/$m^3$ of log/km and $/$m^3$ GOS/km respectively.

[f] Owing to the high cost of freight for assembled furniture over large distances, it is assumed that furniture manufacturing in Aurukun would produce a product in 'kit' form, which could then be assembled closer to market.

[g] 0.2 m^3 of appearance boards and 0.2 m^3 of structural boards are utilised in each dining table and chair kit.

Wik Forestry Objectives

Informal discussions were held with Wik elders and non-indigenous managers in the Aurukun Shire Council about what Wik people would like to achieve through the establishment of a forestry enterprise. Most discussions with Wik elders were conducted 'on country' while they were undertaking other activities including fishing, hunting, lighting forest fires to 'clean' country, checking the camping permits of tourists, harvesting timber for local consumption and performing forest inventory. These discussions revealed the following hierarchy of forestry objectives in decreasing order of importance:

1. Maximise total employment generation;
2. Maximise employment generation on-country (i.e. outside of Aurukun town);
3. Maximise income generation;
4. Maximise forest area excluded from timber harvesting south of the Archer River; and
5. Maximise forest area excluded from timber harvesting north of the Archer River and outside of mining leases.

Objectives 4 and 5 reflect the desire of Wik people to preserve their cultural heritage, protect the environment and retain the option of managing these forest areas for other economic purposes, including ecotourism.

DEVELOPMENT OF A DECISION-SUPPORT TOOL TO SUPPORT WIK FORESTRY DECISION-MAKING

A decision-support tool was developed to generate a suite of timber utilisation strategies that best satisfy the (private) forestry objectives of Wik people. Wik people have multiple, non-commensurate and conflicting forestry objectives. Multi-criteria analysis (MCA) techniques can accommodate these complexities and assist the decision-making processes of stakeholders and policy-makers. Venn and Harrison (2001) reviewed several MCA approaches and concluded that goal programming (GP) is particularly well-suited to provide decision-support to Wik people about forestry in the study region. Essentially, the aim in GP is to minimise unwanted deviations from aspiration levels[3] of management goals subject to resource and technical constraints. A mixed integer, single-period GP model of forestry opportunities in the study region was developed to support the decision-making of Wik people with the General Algebraic Modelling System (GAMS) software package.

Six capital budget constraints for a Wik forestry industry have been considered, namely $0.25M, $0.5M, $1M, $2M, $5M and $10M. It is assumed in the analysis that these funds are obtained as grants from governments (federal and state) and philanthropic investors. Obtaining a $10 M grant to facilitate the purchase and development of forestry infrastructure, buildings, machinery and equipment may appear improbable. However, the Federal Government pays millions of dollars in welfare benefits (through CDEP and other pensions) to Wik people in Aurukun annually[4]. Viewed in this context, a multi-million dollar grant that creates private sector forestry employment and income for some Wik people, who currently receive all of their income in the form of welfare benefits, may be a socio-economically rewarding investment for Wik people and Australian taxpayers generally.

Expressing Wik Forestry Objectives as Goals

To transform Wik forestry objectives into goals for GP, aspiration levels must be determined for each objective. It was not possible to elicit specific aspiration levels for the set of forestry objectives identified from Wik elders. However, it was judged that the elders have a desire to employ as many 'young people' as possible, while generating as much income as possible and limiting harvesting outside of mining leases (particularly south of the Archer River) to as close to zero as possible. Aspiration levels for total employment, on-country employment and income generation goals have been obtained by transforming the Wik Forestry GP Model

[3] The aspiration level represents a target performance level for an attribute of a management option.

[4] Dale (1993) indicated that in the financial year 1988-89 the Federal Government paid $2.5 M in CDEP wages to 233 recipients in Aurukun (excluding on-costs of administering CDEP and other welfare payments such as pensions for the elderly, disabled, and to single mothers). At the time of writing, there are still essentially no employment opportunities for Wik people in Aurukun that are not funded by the CDEP.

into a series of linear programming problems in which the performance level of each goal is maximised separately while ignoring all other goals. This identified the maximum feasible levels for each goal. The aspiration levels for harvesting exclusion areas south of the Archer River and outside of mining leases north of the Archer River have been set to the total forest area in each of these regions (implying zero area harvested).

Goals in the objective function of a GP are prioritised and weighted to reflect the preference structures of stakeholders and decision-makers. Although Wik preference structure information is scarce, it appeared appropriate to examine several potential preference structures with lexicographic goal programming (LGP) and weighted goal programming (WGP) approaches. The preference structures implied in the LGP objective functions assume that no trade-offs are possible between the performance levels of goals of different priorities. That is, goals of higher priorities must be satisfied as fully as possible before lower priority goals are considered. In WGP, all goals have the same priority level. Goal weights dictate the rate at which trade-offs can be made between the performance levels of goals in WGP. Four objective functions have been specified, representing four different stakeholder preference structures:

1. LGP employment
   lexmin $AllJobund^{(1)} + OCJobund^{(2)} + NPVund^{(3)} + HarvSAR^{(4)} + HarvNAR^{(5)}$

2. LGP NPV
   lexmin $AllJobund^{(2)} + OCJobund^{(3)} + NPVund^{(1)} + HarvSAR^{(4)} + HarvNAR^{(5)}$

3. WGP absolute
   min $0.13278\ AllJobund^{(1)} + 0.06639\ OCJobund^{(1)} + NPVund^{(1)} + 0.01328\ HarvSAR^{(1)} + 0.00133\ HarvNAR^{(1)}$

4. WGP percentage
   min $AllJobund^{(1)} + OCJobund^{(1)} + NPVund^{(1)} + HarvSAR^{(1)} + HarvNAR^{(1)}$

where

lexmin is the lexicographic minimum (of an ordered vector) and superscripted numbers in parentheses indicate goal priority order;
AllJobsund is the negative deviation from the total employment aspiration level (CAFTEs);
OCJobsund is the negative deviation from the employment on-country aspiration level (CAFTEs);
NPVund is the negative deviation from the aspiration level of net present value ($M);
HarvSAR is the negative deviation from the harvest exclusion zone south of the Archer River aspiration level (ha); and
HarvNAR is the negative deviation from the harvest exclusion zone outside of mining leases north of the Archer River aspiration level (ha).

The first two objective functions are LGP approaches to solving the GP model where maximising total employment and maximising NPV are the highest priorities, respectively. In the third objective function, the weights represent an attempt to convert the non-commensurate goal deviations into units of millions of dollars in present value terms. No research evidence is available on which to base precise estimates of weights for the objective function; however, it is not the absolute magnitude of these weights that is critical, but their relative orders of magnitude. The *AllJobsund* weight is the approximate annual income of a CDEP worker ($10,000) multiplied by the present value factor (*PVfactor*)[5]. On-country employment is preferred by Wik people to employment in town, so underachievement of on-country employment (*OCJobsund*) is additionally weighted by half the *AllJobsund* weight. Weights for *HarvSAR* and *HarvNAR* are $1,000/ha and $100/ha, respectively, multiplied by the *PVfactor*.

Objective functions 1 to 3 seek to minimise absolute prioritised or weighted deviations from goal aspiration levels. However, objective function 4 minimises the weighted percentage deviations from goal aspiration levels (where all weights equal 1). Therefore, the preference structure implied by this function is, for example, that a 1% underachievement of the aspiration level for harvesting exclusion area north of the Archer River is equivalent to a 1% underachievement in the NPV aspiration level.

OPTIMAL TIMBER UTILISATION POLICIES FOR WIK PEOPLE

The goal aspiration and performance levels for a total of 24 optimal timber utilisation strategies – one for each combination of capital budget constraint level and goal preference structure – are reported in Table 3. The information in Table 3 can also be presented graphically, as in Figure 2, which displays the relative goal performance levels, area of forest harvested, volume of logs harvested and output of finished products for the optimal timber utilisation strategies for a budget constraint of $2 M. The particular forestry activities associated with each optimal timber utilisation strategy can be summarised, as in Table 4 for a budget constraint of $2 M. Timber utilisation strategies generated by the model for all budget constraints are detailed in Venn (2004).

Predictably, higher budget constraint levels facilitate the establishment of optimal Wik forestry industries capable of generating higher levels of employment and net present value (NPV). However, the performance level columns highlight that this is often at the expense of a reduction in the area of the harvesting exclusion zones north and south of the Archer River. Sensitivity analyses have revealed that NPV is highly sensitive to several model parameters, especially sawntimber recovery rates and market prices. Consequently, optimal Wik Forestry strategies are unstable for the preference relation implied by the LGP NPV objective function. However, optimal timber utilisation strategies generated with the preference structures implied by the LGP employment, WGP absolute and WGP percentage objective functions, are robust.

The performance level columns of Table 3 indicate that the preference structure implied by the objective function has a large effect on the optimal solution. The LGP employment objective function results in the generation of optimal timber utilisation policies with the highest level of employment for a particular budget constraint. The LGP NPV preference structure generates the forestry strategy with the highest NPV level. Table 3 highlights large trade-offs between employment generation and NPV when lexicographic preference structures are examined in the GP model. For example, at the $2 M budget constraint level, the LGP employment objective function generates an optimal timber utilisation policy that

[5] The *PVfactor* converts a constant annual cost or revenue over a specific planning period, at a particular discount rate, into a present value in units of millions of dollars. In this study the *PVfactor* is 1.3278×10^{-5} for a project with a 30-year life at a 7% discount rate.

creates employment for 34.9 culturally appropriate full-time equivalents (CAFTEs) and returns a NPV of $3.2 M. However, the optimal policy generated by the LGP NPV objective function for the same budget constraint level creates employment for only 22.3 CAFTEs, while returning a NPV of $9.6 M. The large differences in employment and NPV performance levels between the LGP preference structures can be explained with reference to Table 4. The LGP employment strategy includes labour intensive (less cost-efficient) harvesting operations and a 2,200 m^3/annum fixed-site sawmill. The LGP NPV strategy has cost-efficient harvesting operations and chemical treating of electricity poles, which employs fewer persons and produces more valuable products than sawmilling.

Table 3: Goal aspiration and performance levels for optimal timber utilisation strategies.

Budget constraint ($M)	Goal	Aspiration level	Performance level by objective function			
			LGP employment	LGP NPV	WGP absolute	WGP percentage
0.25	G1 (CAFTEs)	6.8	6.8	5.1	5.1	6.8
	G2 (CAFTEs)	5.8	5.8	3.9	3.9	5.8
	G3 ($M)	-0.8	-1.1	-0.8	-0.9	-1.1
	G4 (ha/year)	1,975	1,975	1,975	1,975	1,829
	G5 (ha/year)	1,207	1,061	1,045	1,207	1,207
0.5	G1 (CAFTEs)	19.0	19.0	14.2	14.2	14.2
	G2 (CAFTEs)	12.1	11.6	11.6	11.6	11.6
	G3 ($M)	2.3	1.1	2.3	2.1	2.1
	G4 (ha/year)	1,975	1,613	1,614	1,975	1,975
	G5 (ha/year)	1,207	757	757	1,207	1,207
1	G1 (CAFTEs)	24.2	24.2	14.7	14.7	16.1
	G2 (CAFTEs)	13.2	11.6	11.4	11.4	13.2
	G3 ($M)	7.4	0.3	7.4	6.9	6.1
	G4 (ha/year)	1,975	1,612	1,399	1,975	1,975
	G5 (ha/year)	1,207	757	757	1,207	1,207
2	G1 (CAFTEs)	34.9	34.9	22.3	22.3	30.1
	G2 (CAFTEs)	15.2	14.2	13.6	13.6	15.2
	G3 ($M)	9.6	3.2	9.6	9.2	7.4
	G4 (ha/year)	1,975	1,399	1,399	1,975	1,975
	G5 (ha/year)	1,207	757	757	1,207	1,207
5	G1 (CAFTEs)	72.1	72.1	70.3	70.4	72.1
	G2 (CAFTEs)	23.8	23.8	20.3	20.3	22.3
	G3 ($M)	17.1	15.3	17.1	16.3	15.3
	G4 (ha/year)	1,975	1,399	1,399	1,975	1,975
	G5 (ha/year)	1,207	755	755	1,207	1,207
10	G1 (CAFTEs)	115.4	115.4	99.0	99.0	108.1
	G2 (CAFTEs)	36.7	36.7	29.7	29.7	36.7
	G3 ($M)	46.9	28.8	46.9	46.7	42.8
	G4 (ha/year)	1,975	787	1,859	1,975	1,975
	G5 (ha/year)	1,207	644	670	672	1,207

Notes: G1 = total employment goal; G2 = the employment on country goal; G3 = the NPV goal; G4 = the timber harvesting exclusion zone south of the Archer River goal; and G5 = the timber harvesting exclusion zone north of the Archer River and outside of mining leases goal.

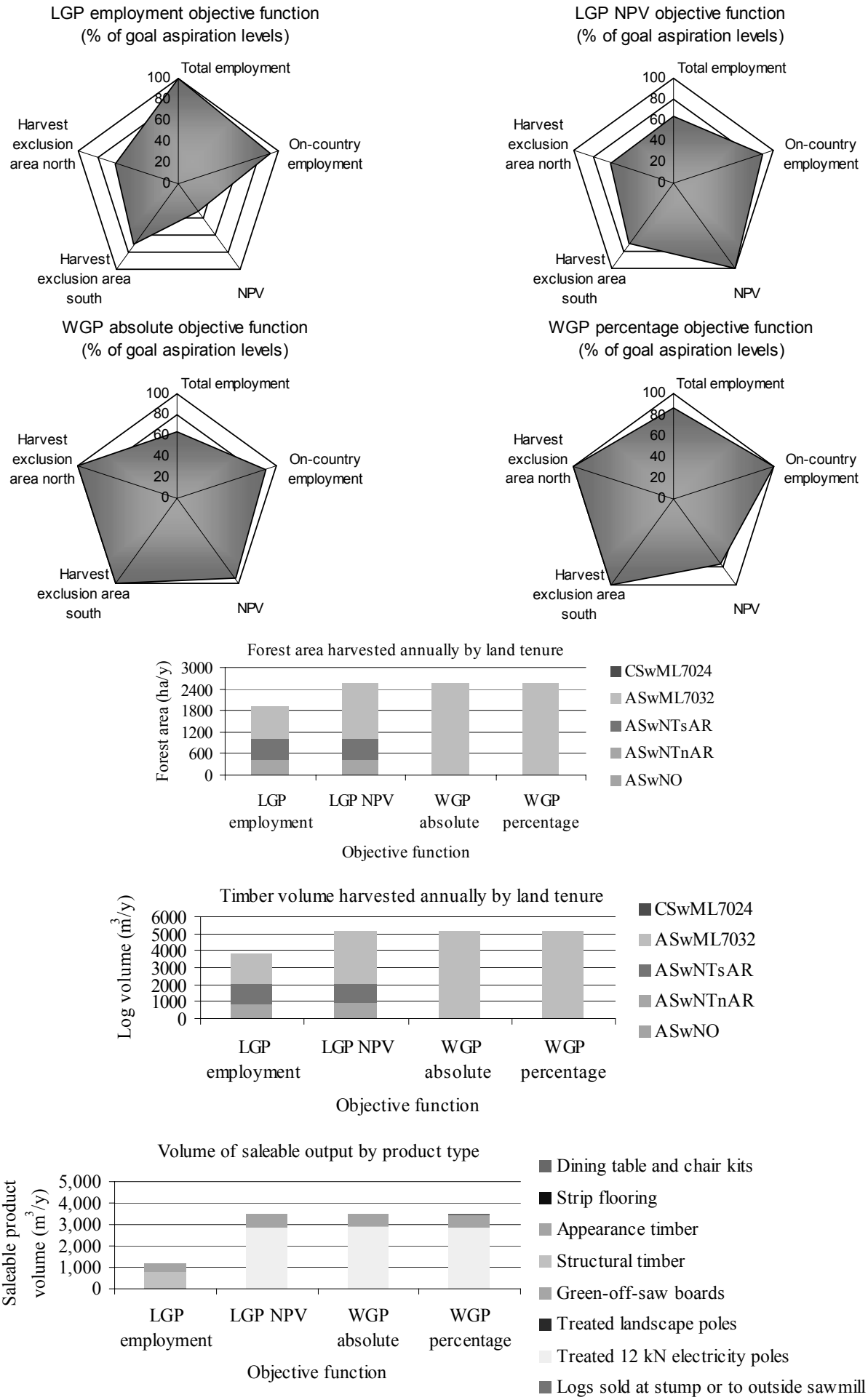

Figure 2: Relative goal performance levels, areas and volumes harvested, and output volume by product type for a $2 M budget.

Table 4: Optimal timber utilisation strategies for a $2 M capital budget constraint.

Forestry activity	Optimal timber utilisation strategies by implied goal preference structure			
	LGP employment	**LGP NPV**	**WGP absolute**	**WGP percentage**
Forest management	Yes	Yes	Yes	Yes
Oversee 'outsiders' harvesting				
Timber harvesting	2 x labour intensive	1 x capital intensive	1 x capital intensive	2 x labour intensive
Portable sawmilling on country	5 portable sawmills	5 portable sawmills	5 portable sawmills	5 portable sawmills
Hauling logs to Aurukun town	1 haulage truck	1 haulage truck	1 haulage truck	1 haulage truck
Chemical treatment of electricity and landscape poles in town		Yes	Yes	Yes
Sawmilling in town	1 x 2,200 m^3 capacity sawmill	Portable sawmill	Portable sawmill	Portable sawmill
Chemical treatment of sawn timber in town	10 soak treating facilities	6 soak treating facilities	7 soak treating facilities	6 soak treating facilities
Seasoning of sawn timber in town	160 m^2 air drying shed, 4 solar kilns	680 m^2 air drying shed	680 m^2 air drying shed	680 m^2 air drying shed
Manufacturing strip flooring in town				
Manufacturing dining table and chair kits in town				Yes

The preference structures implied by the weighted goal programming (WGP) objective functions tend to predict optimal Wik forestry industries that provide goal performance levels in between the extreme levels of employment and NPV generated by the LGP objective functions. Generally, the WGP absolute objective function generates outcomes that are more directed towards NPV maximisation than the WGP percentage objective function. The latter produces forestry strategies that are more focussed on employment generation. For all scenarios, the two WGP objective functions also tend to generate optimal timber utilisation strategies that fully achieve or are closer to achieving the harvesting exclusion area aspiration levels than the two LGP objective functions.

Potential Timber Utilisation Strategy 'Winners'

Drawing upon knowledge acquired about the forestry aspirations of Wik people, an attempt has been made to highlight a subset of forestry policies likely to best satisfy Wik forestry objectives. Overall, the preference relation implied by the WGP percentage objective function is judged to most closely reflect the forestry objectives of Wik people. The strategies generated by this preference structure achieve a combination of high total and on country employment levels, large harvesting exclusion areas for forests outside of mining leases and relatively high NPV levels. The forestry activities undertaken in these 'winning' optimal timber utilisation policies are presented in Table 5.

Wik elders aspire for their people to be economically independent. No optimal timber utilisation policy with a budget constraint of $0.25 M generated a positive NPV, which indicates that the implementation of these forestry strategies would require continuing financial assistance. This is not a desirable outcome for Wik people and suggests that the minimum level of financial resources necessary to establish a successful timber industry in Aurukun Shire exceeds $0.25 M.

INSIGHTS PROVIDED BY THE GOAL PROGRAMMING MODEL INTO THE OPTIMAL STRUCTURE OF WIK FORESTRY OPERATIONS

When employment generation is specified as greatly more important than other forestry goals, then labour intensive harvesting operations best satisfy Wik goals. On the other hand, when NPV is specified as more important than employment, financially more efficient capital-intensive harvesting operations are more appropriate. The GP model predictions suggest that, regardless of the actual forestry preference structure of Wik people, portable sawmills are likely to figure prominently in the optimal timber utilisation strategy. This is because portable sawmills can generate relatively high levels of on country employment with relatively low log input volumes (small areas harvested) and low fixed costs.

Fixed-site sawmilling in town, and chemical treatment of poles, are predicted by the GP model to be the major timber output generating activities of an optimal Wik forestry industry when the budget constraint is at least $1 M, not value-added floorboard or furniture manufacture. As a high capital cost activity, with sawmilling and kiln-drying as prerequisite activities, manufacture of strip flooring becomes financially feasible at a budget constraint of $2 M; however, other forestry activities better satisfy Wik forestry objectives at this capital budget constraint level. Strip flooring enters the optimal timber utilisation strategy only at a budget constraint of $10 M, when the combination of high-value output and high employment generation results in this activity being optimal for all preference structures examined.

Table 5: Optimal timber utilisation strategies for the preference relation implied by the WGP percentage objective function.

Forestry activity	WGP percentage timber utilisation strategies by budget constraint level ($M)				
	0.5	**1**	**2**	**5**	**10**
Forest management	Yes	Yes	Yes	Yes	Yes
Timber harvesting	1 x labour intensive	1 x capital intensive	2 x labour intensive	3 x labour intensive + 1 x capital intensive	9 x labour intensive
Portable sawmilling on country	5 portable sawmills	5 portable sawmills	5 portable sawmills	5 portable sawmills	5 portable sawmills
Hauling logs to Aurukun town		1 haulage truck	1 haulage truck	2 haulage trucks	4 haulage trucks
Chemical treatment of electricity and landscape poles in town		Yes	Yes		Yes
Sawmilling in town			Portable sawmill	11,000 m^3 capacity sawmill	20,000 m^3 capacity sawmill
Chemical treatment of sawn timber in town	5 soak treating facilities		6 soak treating facilities	10 soak treating facilities	1 x 24 m^3 capacity vacuum pressure treatment facility
Seasoning of sawn timber in town	440 m^2 air drying shed	200 m^2 air drying shed	680 m^2 air drying shed	3,040 m^2 air drying shed	3,960 m^2 air drying shed, 1 solar kiln, 1 x 8m^3 and 7 x 24 m^3 capacity combination gas and solar kilns
Manufacturing strip flooring in town					3,940 m^3 capacity flooring plant
Manufacturing dining table and chair kits in town			Yes		

Note: There are no ‘winners’ at the $0.25 M budget constraint level.

Small-scale dining table and chair kit manufacturing was also found unlikely to best satisfy Wik forestry objectives. This is somewhat surprising given furniture manufacturing provides a low capital cost means for generating a relatively large number of jobs in town and produces high-value output. However, small-scale furniture manufacture is a low throughput activity, exacerbated in Aurukun by low labour productivity, such that production costs are high relative to finished product price. Chemical treatment of poles, which has a capital requirement similar to furniture manufacturing, is more financially lucrative and additional investment in sawmilling machinery is capable of generating more jobs per dollar of capital invested than furniture manufacture.

No optimal timber utilisation strategy includes sawntimber chemical treatment facilities that are capable of treating all the sawntimber predicted to be produced in the strategy. Vacuum pressure chemical treating of sawntimber is predicted to only be optimal in large-scale sawmilling strategies possible when the capital constraint is $10 M. The model suggests that a large proportion of harvested logs should be sawn such that all sapwood is removed. This indicates that the financial and employment generation benefits of chemically treating timber against lyctid susceptibility, which facilitates the legal the sale of timber with sapwood, are small.

Kilns for seasoning sawntimber rarely feature in optimal timber utilisation strategies generated by GP model for Wik people. Air-drying is the optimal seasoning method due to the relatively low fixed and variable costs compared with the other seasoning methods examined. Generally, kilns are only predicted in the optimal forestry policies for the preference structure implied by the LGP employment objective function[6] and where sawntimber production exceeds the maximum capacity of air-drying sheds, which can occur when the budget constraint is at least $5 M (total area of air-drying sheds is constrained to less than or equal to 4,000 m^2).

Some implications for timber harvesting in the Aurukun area can also be drawn from the model:

1. Except for large-scale forestry operations facilitated by capital budget constraints of $5 M or $10 M, it is optimal to confine timber harvesting to forest type 1, which has high standing volumes of merchantable timber compared with forest types 2 to 5.
2. Timber utilisation strategies generated by the GP model indicate that harvesting Melville Island bloodwood is unlikely to be commercially attractive. This is due to the low recovery of sawntimber from this species due to loose gum veins.
3. The optimal timber harvesting strategies generated by the GP model generally involve harvesting all merchantable Cooktown ironwood logs in a hectare and sufficient volume of high-quality Darwin stringybark logs (poles and 'compulsory sawlogs') to attain the minimum harvest allowed by the model of 2 m^3/ha, before moving the harvesting operation into the next hectare of forest 'chasing' more Cooktown ironwood logs.
4. An interesting exception to the harvest of Cooktown ironwood and high-quality Darwin stringybark logs occurs when employment generation is the highest priority goal (i.e. the LGP employment objective function). In that case, the harvest of low-quality logs is predicted to be optimal. Low-quality logs yield a lower percentage of sawntimber, meaning that a higher volume of logs are required to manufacture a particular volume of finished sawntimber products. This has the potential to generate more employment (while increasing operating costs) in forest management, timber harvesting, hauling and sawmilling than is possible when utilising high-quality logs.

[6] Kiln operation generates more employment than air-drying.

CONCLUDING COMMENTS

A financially viable Wik forestry industry that satisfies Wik forestry objectives could be developed on CYP. Optimal timber utilisation strategies for the study region are found to only infrequently involve the production of dressed, finished products with high-technology equipment and skilled labour, which some representatives of Wik people have advocated. Instead, this analysis suggests relatively low-technology production methods (e.g. portable sawmilling, chemical treatment by soaking and air-drying) are likely to better satisfy Wik forestry objectives. A social analysis of privately optimal timber utilisation strategies for Wik people, which accounts for transfer payments, the social order and self-esteem benefits of 'real economy' employment in Aurukun and the costs of ecosystem services foregone through the selective harvesting of Darwin stringybark forests has been performed and is the subject of a forthcoming paper.

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9. FACILITATING AND PROMOTING SUSTAINABLE FOREST-BASED INDUSTRIES IN CENTRAL QUEENSLAND

B. Williams and H. Norris

This paper briefly reviews the evolution of Private Forest Development Committees (PFDCs) in Australia, and the role that these committees can play in promoting forestry. Current activities of the Central Queensland Forest Association (CQFA) are outlined, and threats to forestry development in Central Queensland are identified. Great potential exists in Central Queensland for the development of an environmentally sound Eucalypt plantation resource of at least 15,000 ha supporting a commercially viable hardwood sawmilling industry.

INTRODUCTION

The National Forest Policy Statement was developed in 1992, which led to the strategy 'Plantations for Australia: the 2020 Vision'. This was developed in 1997 to establish a strategic partnership between the Australian, State and Territory governments and the plantation timber growing and processing industry. The overarching principle of this strategy is to enhance regional wealth creation and international competitiveness through a sustainable increase in Australia's plantation resources based on a national target of trebling the plantation estate by 2020 (Plantations 2020, 1997). The first five years of this strategy have resulted in the establishment of an average of 85,000 ha per annum of plantation estate nationally (Plantations 2020, 2002). Queensland now has a total 216,500 ha of plantation estate, of which 85% is located in south-east Queensland (DPI 2004). Most of the plantation estate in Central Queensland (8,000 ha) is Caribbean pine. This is located at Byfield and is owned and managed by Department of Primary Industries and Fisheries.[1] There is significant potential to develop an industry within the Mackay region and there are currently 160,000 ha of land that could support a forestry industry. Much of this is under alternative resource uses such as cane farming (DNRW 2004).

The 2020 Vision strategy promoted the need for Regional Plantation Committees (RPCs) to promote regional plantation development, and these were formed across Australia during the period 1997-2001, with three of the 18 committees in Queensland. These were funded through the Natural Heritage Trust Farm Forestry Program.

The National Action Plan for Salinity and Water Quality (NAPSWQ) was implemented in 2002, and the Natural Heritage Trust 2 (NHT2) in 2003. At this time, the regional Plantation Committees were renamed Private Forest Development Committees (PFDCs) and funded under NHT2.

Queensland PFDCs are jointly funded by the Australian Government though NHT2 and the Queensland Government through the Department of Primary Industries and Fisheries. Their outcomes are driven through the terms of reference for PFDCs and their national action plan. They are also driven by NAPSWQ and NHT2 outcomes, and the Farm Forestry National Action Statement developed by the Private Forestry Consultative Committee. PFDCs are the

[1] The ownership is changing with the establishment of Forestry Plantations Queensland as a government-owned corporation independent of DPI&F.

pivotal body facilitating private forestry development in their regions, developing key relationships with NRM groups, the community, private growers, local government, and the investment, processing and training sectors.

NATIONAL OBJECTIVES FOR PRIVATE FOREST DEVELOPMENT COMMITTEES

The National Action Plan for PFDCs states that 'in collaboration with all levels of government, industry and the community, PFDCs will be composed of both private and public sector representatives and provide a platform for the two sectors to interact and exchange information. In this role they will act as an independent and autonomous 'honest broker''.

The private forestry industry is undergoing substantial internal restructuring. There are a number of key drivers for changes. The transition from public native forest to private forests (native and plantation) is accelerating. A transformation is taking place in plantation investment structures, with a premium on land availability for plantation development. Substantial community and environmental pressures are being exerted on the commercial plantation industry.

A draft Farm Forestry National Action Statement has been developed and endorsed in principle by both the Primary Industries and Natural Resource Management Ministerial Councils. At the time of writing, both councils had requested that an options paper be prepared for full implementation, and the draft plan was awaiting endorsement. Major challenges face development of farm forestry in Australia. Critical amongst these is the development of a supportive government framework. It will be necessary to develop a marketable farm forestry resource that delivers a long-term sustainable future for growers and processors. There is a need for assistance to farmers to identify tree-growing options. Also, there is a need to demonstrate to all stakeholders that farm forestry systems can deliver commercial and environmental outcomes and this is a vital step for industry promotion.

CENTRAL QUEENSLAND PRIVATE FORESTRY PROJECTS

The Central Queensland Forestry Association (CQFA) is involved in various forestry projects. Two of these projects are reported in this paper.

Mackay Whitsunday High Value Forestry Project

CQFA is working closely with the Mackay Whitsunday Regional Economic Development Corporation to investigate the potential for development of a high value forestry operation in the region, targeting cleared areas including ex-dairy land and marginal cane land.

This project investigated the feasibility of establishment of a sustainable forestry plantation driven industry for the Mackay Whitsunday region, and opportunities for private forestry growth in the hinterland shires on seasonally flood prone watercourses.

Potential locations for development are:

- Mirani Shire – Eungella primarily on ex-dairy land;
- Whitsunday Shire;
- Mackay and Sarina region; and
- Hinterland shires of Nebo and Broadsound.

The *major tasks* of the feasibility study were:

- Situational SWOT analysis of the business concept and current operations;
- Determination of attitude and concerns of the current landowners;
- Identification of:
  - available input factors;
  - potential products including downstream opportunities;
  - proposed capacity;
  - possible markets;
  - possible constraints;
  - preliminary financial analysis; and
  - recommendations as to the overall viability of the project.

The *findings* of the feasibility study were:

1. There is potential for development of an environmentally sound Eucalypt plantation resource of approximately 5,000 ha supporting a commercially viable hardwood sawmilling industry with annual log intake of 50,000 m^3. The mill will integrate with existing sugar milling infrastructure.
2. This forestry project requires $15M of working capital plus $1.5M in harvesting equipment and financing costs.
3. There is potential for a parallel project growing 6,000 to 10,000 ha of Eucalypt for pulp to enhance the viability of the saw-log concept. Alternatively opportunities exist for thinnings to be utilised in ethanol production or co-generation in conjunction with sugar milling diversification.
4. This project is showing enormous potential, with a potential investor looking at doing a more detailed feasibility study in the near future.

Forest Red Gum (*E. tereticornis)*

There is a substantial resource of Forest Red Gum, estimated at 192,000 ha (DPI&F 2005) in Central Queensland, primarily on flooded country throughout the Fitzroy Basin.

There is the potential for development of higher-valued markets including furniture production or appearance grade products such as veneer. There is the need for coordination of supply of products from freehold land to support development of new markets.

Existing impediments include the requirement for riverine permits for harvesting within the 'high bank' under the *Water Act 2000*; and lack of a code of practice for harvesting native forest on freehold land. There is now an interim code being adopted and this process should be finalized by October 2005.

THREATS TO ONGOING FORESTRY DEVELOPMENT IN CENTRAL QUEENSLAND

A number of threats to forestry development in Central Queensland have been identified by the CQFA. These include:

- Cessation of logging in state native forests and associated potential reduction in the processing sector;
- Rainfall limitations which preclude prime plantation development opportunities in most of the Central Queensland region; this excludes prime land with potential for plantation forestry near Mackay, Byfield and Calliope (DNRM 2004);
- Lack of environmental services schemes, particularly tradable carbon offsets;
- The threat to the right of harvesting in private native forests;
- A lack of an economically viable code of practice for private forestry (plantation and native);
- A tension between the long lead time and need for an immediate investment return for many landholders;
- A lack of access to markets;
- A paucity of data related to species performance and provenances best adapted to Central Queensland; and
- A lack of data collection, storage and dissemination system for Central Queensland.

What can be done to address these threats? A number of measures have been identified, including:

- Continued development of high value markets included value added niche markets;
- A campaign for environmental services schemes, particularly carbon credits as foreshadowed under the Kyoto agreement;
- Formation of a group to pool environmental services from landowners into saleable blocks to attract premium prices;
- Conducting feasibility studies for potential plantation areas and continue research into suitable species for lower productivity areas;
- A campaign for sustainable multiple use of all native forests;
- Identifying specific research and development needs and activate projects to address these.

CONCLUDING COMMENTS

The development of plantation forestry in Central Queensland has been traditionally confined to pine plantations managed by Department of Primary Industries at Byfield on the Capricorn Coast. To date, there have been no significant plantings other than these in Central Queensland[2].

[2] Indicative planting schedules indicate that the total plantation forestry estate in Central Queensland [pine and eucalypt] could reach 20,000 ha by December 2006.

There is now significant potential for development of an environmentally sound Eucalypt plantation resource of at least 15,000 ha in the Mackay Region of Central Queensland. This has been defined within the Mackay Whitsunday High Value Timber Forestry Project. The development of this plantation resource would support a commercially viable hardwood sawmilling industry, which would be pivotal in integrating with existing sugar milling infrastructure and the restructuring currently occurring in the cane industry.

PFDCs will play a pivotal role facilitating private forestry development in their regions, developing key relationships with NRM groups, the community, private growers, local government, and the investment, processing and training sectors.

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10. BIODIVERSITY FUTURES UNDER ALTERNATIVE FOREST INDUSTRY SCENARIOS IN NORTH QUEENSLAND

J. Kanowski, C.P. Catterall and G.W. Wardell-Johnson

North Queensland is a major repository of biodiversity in Australia. From the perspective of industry proponents, the impacts of plantation developments on biodiversity deserve consideration because these impacts are likely to influence public acceptance of proposals and whether proposals can attract environmentally-linked funding and marketing opportunities. At the same time, plantations offer a unique opportunity for broadscale reforestation, and if designed and managed appropriately may be a cost-effective way of restoring biodiversity to cleared land. Plantations may have positive or negative impacts on biodiversity at a range of scales, depending on the species used in plantations, and other aspects of plantation design, management, harvesting and location. This paper examines the potential consequences for biodiversity of a number of broadscale plantation scenarios proposed for cleared rainforest landscapes of the Queensland Wet Tropics. Of the scenarios examined, a mosaic of plantations and restoration plantings was considered to have the highest value for rainforest biota. Three scenarios based on plantations of rainforest trees (monocultures of hoop pine, mixed species plantings and a mosaic of monocultures) were considered to have moderately positive impacts on biodiversity, while plantations of non-rainforest trees (eucalypts and exotic pines) had the least positive consequences for biodiversity in the region. All scenarios potentially have negative impacts on biodiversity, depending on where they are located, and how they are designed and managed. Plantations of exotic rainforest trees (and non-local provenances of native species) have the potential to invade native rainforests. In practice, the ranking of scenarios may vary according to landscape forest cover. Scenarios having the most positive consequences (e.g. a mosaic of plantations and restoration plantings) would be favoured in heavily cleared areas, while scenarios with few negative consequences in rainforest landscapes (e.g. a mosaic of hoop pine plantations and restoration plantings, or plantations of hoop pine, local rainforest species, or even exotic pines) would be favoured for cleared land in well-forested areas. Optimising synergies and managing trade-offs between biodiversity conservation and other objectives of plantations will require investment in large-scale, long-term research, ideally as an integral component of broadscale plantation projects.

INTRODUCTION

The rainforests and associated forest types of the Queensland Wet Tropics are extraordinarily significant biologically, providing habitat for 25% of Australia's plants, 35% of its mammals, 40% of its birds and 60% of its butterflies, including many endemic taxa (Wet Tropics Management Authority 2004). This rich biodiversity underpins a vibrant tourism industry, which in recent years has become the major economic activity in the region (Driml 1997).

Prior to the declaration of the Wet Tropics World Heritage Area (WTWHA) in 1988, the rainforests of north Queensland also supported a substantial timber industry (Gould 2000). Following the cessation of logging in state-owned rainforests in the region, the timber industry collapsed, with the few remaining mills sourcing rainforest timber from private land and from the relatively small area of state forest plantations. While state and federal governments subsequently funded the Community Rainforest Reforestation Program

(CRRP) between 1992 and 1996 in an attempt to create a plantation-based cabinet timber industry on private land, only about 2,000 ha of a projected 30,000 ha of plantations were established under the program (Herbohn, K.L. *et al.* 2000, Lamb *et al.* 2001). Nevertheless, there has been continued interest in the establishment of broadscale timber plantations on marginal or otherwise unproductive farmland in the region, partly stimulated by the declining fortunes of traditional agricultural industries (see Annandale *et al.* 2003, Killin 2004).

Plantations have typically been established and managed primarily for timber production. However, the potential impacts of plantations on biodiversity and also conservation deserve consideration from plantation proponents, because these impacts may affect both the feasibility and profitability of plantations. For example, impacts on biodiversity may affect: (i) the willingness of landholders to participate in plantation schemes (Emtage *et al.* 2001); (ii) investment in plantation schemes from governments or large corporations; (iii) regulatory approval; (iv) the eligibility of plantations for certification, which can provide access to niche markets (Lindenmayer and Hobbs 2004); and (v) the eligibility of plantations for environmental credits or other incentives proposed for conservation-orientated land management in the region[1].

Timber plantations also deserve consideration from individuals, groups and management agencies interested in nature conservation in the Queensland Wet Tropics. Timber plantations have the potential to reforest large tracts of cleared land, and if located, designed and managed appropriately, may constitute a cost-effective means of helping restore biodiversity to cleared land (Keenan *et al.* 1997, Lamb 1998). Over the last two decades, landholders and government agencies in the Wet Tropics have devoted over $20 million to reforestation aimed primarily at nature conservation (Erskine 2002, Catterall *et al.* 2004). However, the scale of restoration plantings to date has been low (less than 0.5% of the area of cleared land in the Wet Tropics), largely because they are expensive and offer little direct financial return.

This paper examines the potential consequences for biodiversity conservation associated with a number of broadscale plantation development scenarios in north Queensland. First, some of the impacts of timber plantations on biodiversity are reviewed, drawing primarily on the results of recent surveys of rainforest timber plantations and other types of reforestation in eastern Australia (Kanowski *et al.* 2003a, Catterall *et al.* 2004, 2005, Kanowski *et al.* 2005b, 2006, Wardell-Johnson *et al.* 2005). Second, the likely impacts on biodiversity of plantation scenarios proposed for north Queensland are assessed. In places, this assessment involves considerable extrapolation from the available data, because most types of established rainforest plantations differ in important ways from broadscale reforestation scenarios. Nevertheless, an assessment based on the best available information is required, given the possible expansion of timber plantations in north Queensland in the near future.

IMPACTS OF PLANTATIONS ON BIODIVERSITY

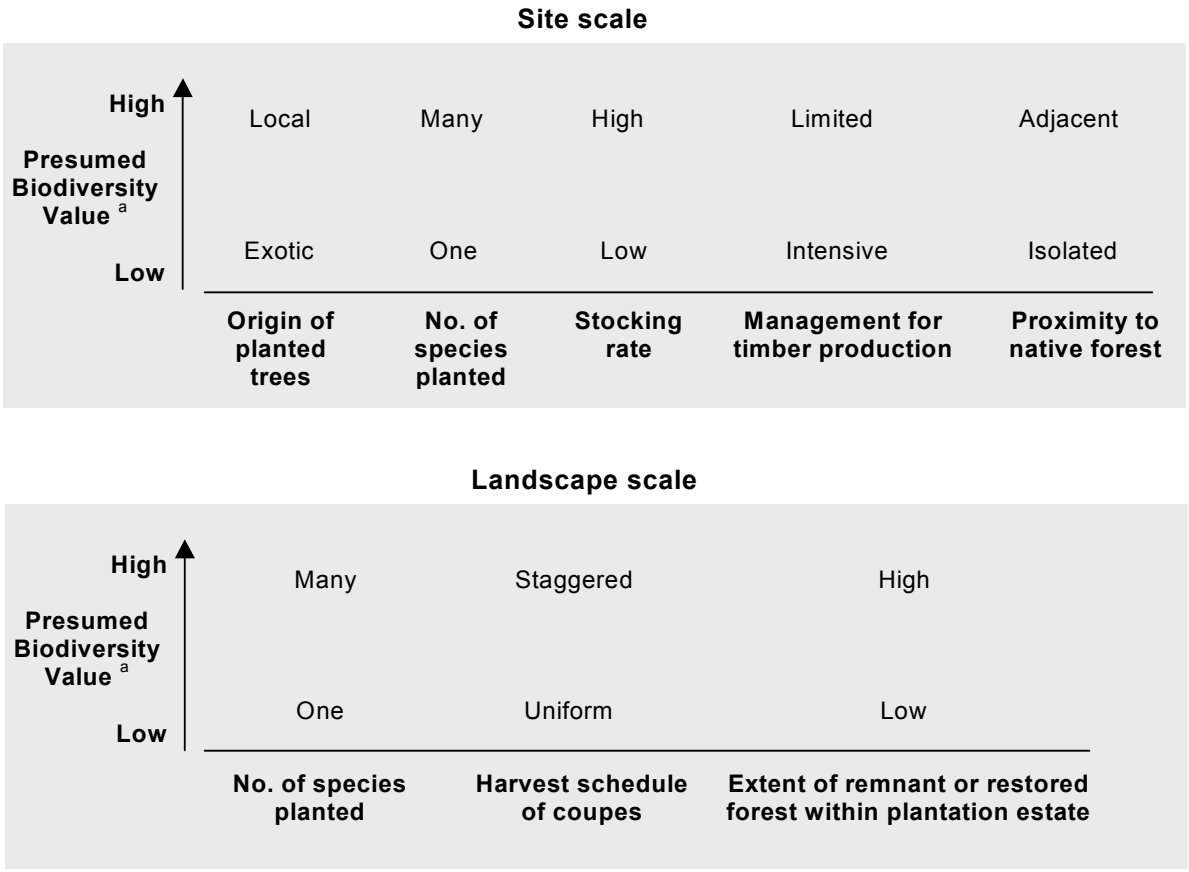
Plantations may have both positive and negative impacts on biodiversity at a range of scales. Examples of these impacts have been reported by a number of studies, including several conducted in north Queensland (e.g. Keenan *et al.* 1997, Lamb *et al.* 1997, Catterall 2000, Herbohn *et al.* 2000, Kanowski *et al.* 2003a, Catterall *et al.* 2004, Tucker *et al.* 2004, Catterall *et al.* 2005, Kanowski *et al.* 2005a, 2005b, 2006) and elsewhere (Parrotta *et al.* 1997 and references therein, Lamb 1998, Norton 1998, Richardson 1998, Ashton *et al.* 2001, Hartley 2002, Lindenmayer 2000, 2002, Lindenmayer and Franklin 2002, and Lindenmayer and Hobbs

[1] The Wet Tropics Management Authority (2004) has proposed an incentives scheme for private landholders to compensate them for conserving important habitat or for providing ecological goods and services. The potential for such a scheme is to be investigated by a project within the recently established Marine and Tropical Sciences Research Facility (MTSRF 2006).

2004). For example, plantations may 'catalyse' the regeneration of native plants and provide habitat for native animals. At a broader scale, plantations may increase population sizes of native species as a result of additional habitat or resources, facilitate the dispersal of native species between remnant forest patches, and improve downstream water quality. At regional to global scales, plantations may lead to reduced pressure to harvest of forests elsewhere and, by sequestering carbon, help to mitigate climate change. Plantations may also have a range of negative impacts on biodiversity. For example, they may replace valuable remnant or regrowth forest, and the species used in plantations may in some cases invade native forests.

The impacts of plantations on biodiversity depend on a range of factors (Figure 1). For example, the various tree species used in plantations differ in attributes such as canopy cover, branch architecture, bark, foliage, litter, flower and fruit characteristics (Parrotta 1995, Harrington and Ewel 1997, Keenan *et al.* 1997, Lamb *et al.* 1997), all of which may influence their habitat value for wildlife. Variation in the design and management of plantations including stocking rates, the control of understorey species, the location, size and heterogeneity of coupes, rotation lengths and harvest schedules will also affect their biodiversity value (Hartley 2002, Lindenmayer and Franklin 2002, Lindenmayer and Hobbs 2004). Some impacts will also vary with locality, such as whether plantations replace remnant or regrowth forest, and the proximity of plantations to native forest (Lindenmayer and Franklin 2002, Lindenmayer and Hobbs 2004). All plantations are likely to buffer adjacent forests against some climatic extremes, sequester carbon and reduce the pressure to harvest native forests, although their actual contribution will differ according to factors such as the species planted, and the location, design and management of plantations.

Prediction of the impacts of any particular plantation development is difficult, because many of the factors affecting the biodiversity value of plantations interact in complex ways (Catterall *et al.* 2004, Lindenmayer and Hobbs 2004). For example, a densely planted monoculture of an exotic species might prove a better 'catalyst' of rainforest regeneration than a widely-spaced mixed species plantation of native trees, if the monoculture provided better canopy cover than the mixed species plantation (Kanowski *et al.* 2003). Further, different components of biodiversity may be affected in different ways. For example, a structurally complex, floristically diverse plantation may provide good habitat for rainforest birds, but not necessarily for some invertebrate taxa (Kanowski *et al.* 2005b). Finally, the value of plantations for biodiversity can vary with scale and the frame of reference. For example, plantations established in well-forested areas are likely to support more biota than plantations in extensively cleared areas (Lindenmayer and Hobbs 2004). At the landscape scale, however, the establishment of plantations in extensively cleared areas may provide greater marginal benefits for biodiversity conservation than the establishment of plantations in already well-forested landscapes.



a. Sources: see text

Figure 1: Factors thought to influence the biodiversity value of rainforest plantations at the site and landscape scales.

IMPACTS OF PLANTATION SCENARIOS ON BIODIVERSITY IN NORTH QUEENSLAND

Proposals to establish broadscale timber plantations on cleared agricultural land in north Queensland have a long history (Gilmore and Riley 1970, Kent and Tanzer 1983, Tracey 1986, Shea 1992, Lamb *et al.* 1997, Gould 2000, Herbohn *et al.* 2000, Lamb and Keenan 2001, Lamb *et al*. 2001, Annandale *et al.* 2003, Tucker *et al.* 2004). This paper examines six scenarios (Table 1) which the authors consider potential candidates for broadscale plantations schemes in north Queensland. Some of these schemes have previously been attempted in the region, while others have been promoted as having benefits for production and biodiversity (e.g. by Lamb *et al.* 1997, Lamb 1998, Lamb and Keenan 2001, Tucker *et al.* 2004, Catterall *et al.* 2005).

This paper focuses primarily on those impacts on biodiversity which vary with the type of species used in plantations, under likely management regimes. The discussion of impacts is concerned mainly with the utility of plantations for rainforest-dependent wildlife, because these are the taxa of particular conservation significance in cleared rainforest landscapes (see also Catterall *et al.* 2004, Kanowski *et al.* 2005b). While plantations with little value for rainforest wildlife may still provide habitat for other native species (e.g. eucalypt plantations might be used by wildlife associated with eucalypt forests: Borsboom *et al.* 2002), these values are not considered further in this paper. The impacts of plantations on biodiversity are evaluated mostly by comparison with cleared land (including abandoned agricultural land,

and cleared land with some remnant or regrowth forest): the typical situation into which broadscale plantations would be established. Some comparisons are also made with native forest, which provides an 'ideal' reference condition for biodiversity value (Catterall *et al.* 2004).

Table 1: Possible broadscale plantation scenarios for north Queensland.

Scenario	Examples of occurrence in the Queensland Wet Tropics [a]
Hoop pine	1,000 ha in State Forests, mostly established on ex-forest site[b]. 50 ha in joint venture plantations on private land.
Exotic pine	12,000 ha in State Forests, mostly established on ex-forest sites [b]. Also numerous small woodlots and windbreak plantings on private land.
Eucalypts	100 ha established by the Community Rainforest Reforestation Program (CRRP) on private land. A few plots in State Forests.
Mixed species cabinet timber plantations	About 2,000 ha of mixed species plantings (including native and exotic rainforest trees and eucalypts, mean = 11 species) established on private land by the CRRP, mostly as small plots (< 5 ha). Some older plots in State Forests, mostly as simple mixtures.
Mosaic of monocultures	State Forest plantations (e.g. Gadgarra, Wongabel, Danbulla) comprise mosaics of plantations of various rainforest species and exotic pines, although these have mostly been established on ex-forest sites[b].
Mosaic of plantations and restoration plantings	There are no examples of broadscale reforestation using this approach in north Queensland, but State Forest plantations have typically been established within a network of retained rainforest ('scrub breaks') to control the spread of fire.

[a] Sources: Gould 2000, Lamb *et al.* 2001, DPI Forestry 2003; Lamb *et al.* 2005; Vize *et al.* 2005.
[b] Ex-forest sites are those cleared of native forest for the purpose of plantation establishment. Plantations on private land typically have had intervening decades of use for pasture or cropland.

Potential Positive Impacts of Plantations on Biodiversity in North Queensland

Intrinsic Value of Plantations

The plantation scenarios proposed for north Queensland vary greatly in 'intrinsic value', or the number of locally endemic rainforest trees planted (Figure 2). Exotic pine plantations and most eucalypt plantations would have no intrinsic rainforest biodiversity value in the Wet Tropics. Plantations of native rainforest trees would have some intrinsic biodiversity value, certainly more than pasture, but their value would be 'very modest' compared with native rainforest. For example, the mean number of species planted in the mixed-species CRRP plantations was just 11 tree species, including eucalypts and exotic species (Lamb *et al.* 2005). The typical size of CRRP plots was 1 to 5 ha (Vize *et al.* 2005). In comparison, McKenna (2004) recorded over 400 species of native trees, vines, shrubs and epiphytes from 4 ha of rainforest on the Atherton Tablelands. While the intrinsic value of timber plantations could be increased by the use of more endemic tree species, rare species and other plants of conservation significance (Tucker *et al.* 2004), there are practical and economic reasons to limit the number of species grown in timber plantations to a few high value species (Lamb *et al.* 2005). The use of rare tree species in plantations can also pose risks to the genetic integrity of native populations, unless careful seed collection protocols are followed (Boshier 2004). A mosaic of timber plantations and restoration plantings would have much higher intrinsic value than timber plantations alone. Often, 50-100 locally-occurring rainforest plant species are planted in restoration projects in the Wet Tropics (Goosem and Tucker 1995).

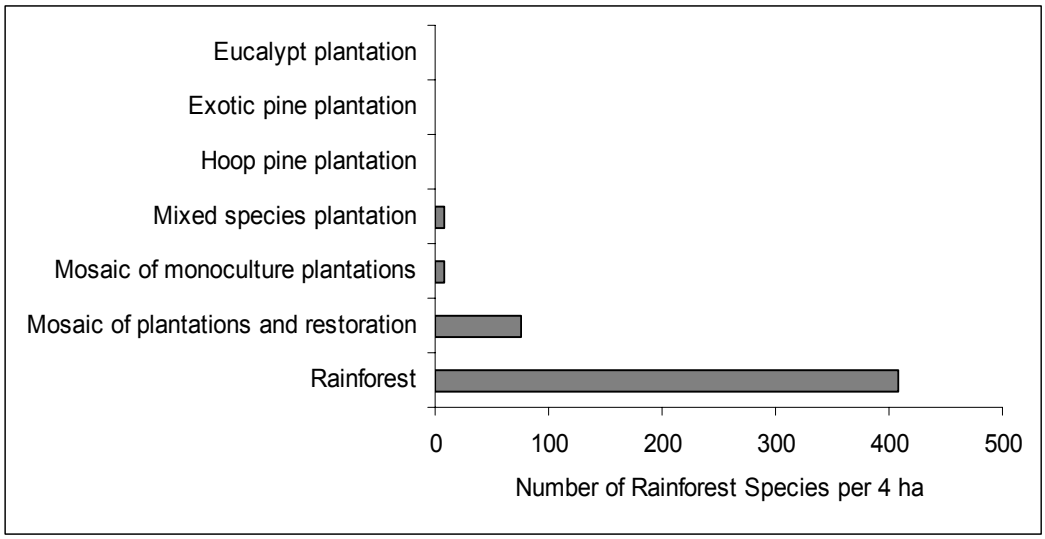


Figure 2: The number of native rainforest plant species to be established in various plantation scenarios, compared with plant species richness of native rainforest.

Rehabilitation of Degraded Land by 'Catalysing' Rainforest Regeneration

Many different types of plantations have been found to promote the recruitment of native plants to cleared land (see papers in Parrotta *et al.* 1997), provided they attract seed-dispersing fauna, create a suitable microclimate for seed germination and growth, and shade out grasses and weeds which can compete with seedlings. For these reasons, and because plantations offer a financial return on establishment costs, it has been suggested that plantations may be a cost-effective means of restoring native forest to heavily cleared landscapes (Lugo 1997, Lamb 1998).

The capacity of plantations to 'catalyse' the recruitment of native plants can vary considerably. For example, in north Queensland, Keenan *et al.* (1997) found that more species of native plants were recruited to plantations of Queensland maple *Flindersia brayleyana*, a broadleaf tree, than to hoop pine *Araucaria cunninghamii* or the exotic *Pinus caribaea*. These results were attributed to differences in canopy cover, litter characteristics and perhaps attractiveness to frugivores amongst plantation species, although the plantations were also managed differently: the maple plantations, for example, were never thinned. The extent of canopy closure seems to be a particularly important factor in determining the capacity of plantations to catalyse rainforest recruitment (Kooyman 1996, Kanowski *et al.* 2003a, Wardell-Johnson *et al.* 2005). Plantations with a relatively open canopy, such as eucalypt plantations or rainforest plantations stocked at a low density, tend to have a grassy or weedy understorey (e.g., lantana), which can effectively suppress the recruitment of rainforest plants.

To the extent that recruitment varies under different types of plantations, a mosaic of monocultures would be expected to recruit more species than an extensive monoculture. In support of this argument, Keenan *et al.* (1997) presented data which suggested that monoculture plantations of hoop pine, kauri pine *Agathis robusta*, red cedar *Toona ciliata* and Queensland maple in north Queensland tended to support relatively distinct plant assemblages. However, the methodology used by Keenan *et al.* (1997) is likely to have exaggerated the differences between plant assemblages in plantations, because only small plots were surveyed (ranging from 0.0024 ha, for seedlings, to 0.06 ha, for larger plants, per site). Surveys of slightly larger areas (0.08 ha) in a similar suite of plantations at Gadgarra State Forest, north Queensland, found fewer differences in the composition of plants

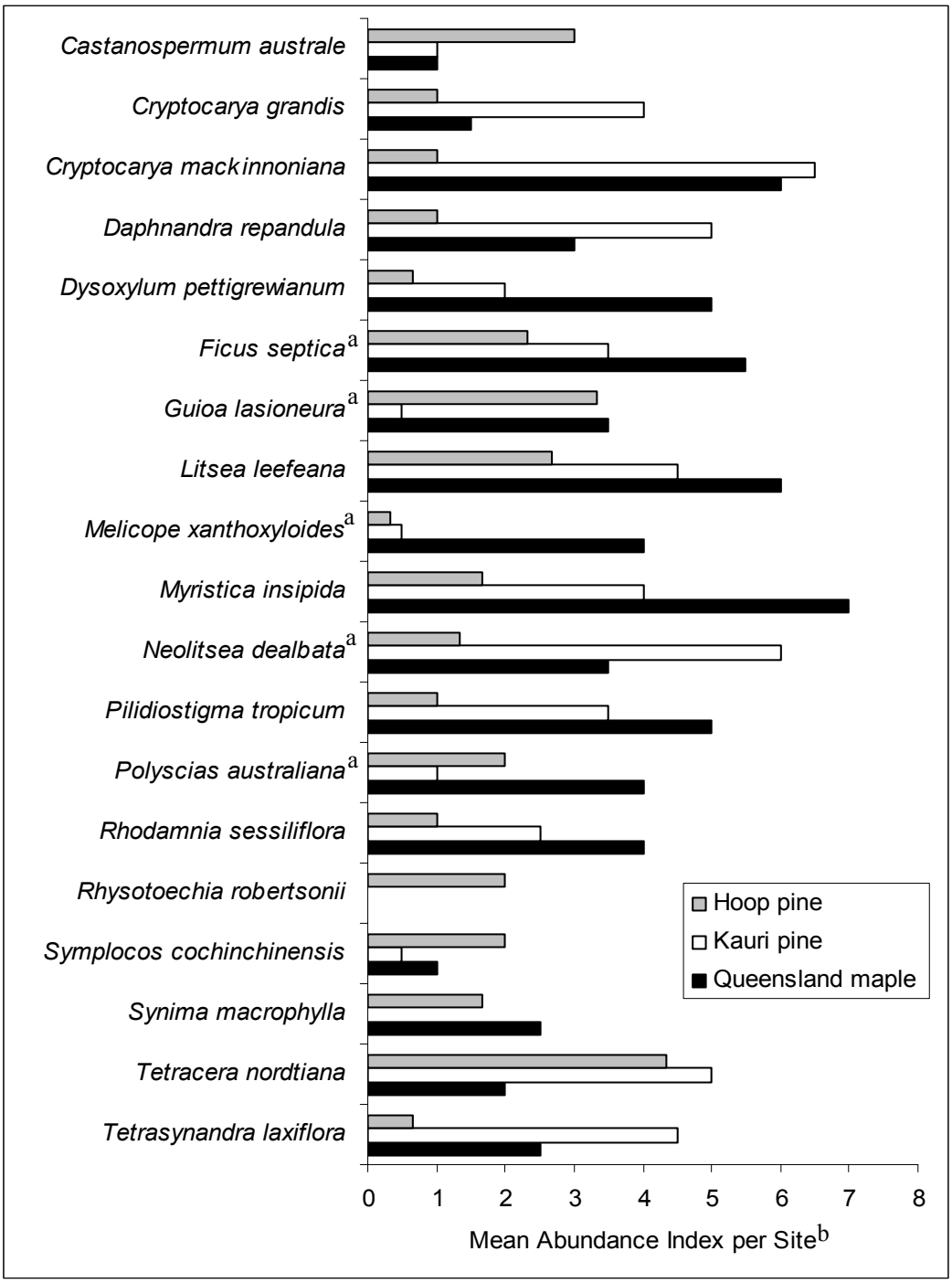
recruited beneath a similar range of plantation species (Kanowski *et al.* 2005a). Even in these surveys, sampling artefacts are likely to inflate apparent differences between sites. When only the most frequently recorded (and, therefore, most adequately sampled) tree species recruited to each plantation are considered, nearly all were recorded in each type of plantation (Figure 3). Note that while the commonly recorded trees include some pioneer species, which are likely to be catholic in their habitat requirements, a number of mature phase trees are also included in the list.

A caveat to interpreting the results presented by both Keenan *et al.* (1997) and Kanowski *et al.* (2005a) is that all the plantations surveyed in these studies were of wind-dispersed trees. Now, most rainforest trees are fleshy-fruited and are dispersed by fruit-eating birds, bats and other fauna (Willson *et al*. 1989). While frugivorous birds and bats may readily use wind-dispersed trees as perches when they are located in close proximity to remnant forest (Toh *et al.* 1999), the use of wind-dispersed trees by frugivores is likely to decline rapidly with increasing distances from remnant forest (Da Silva and Vickery 2002). Consequently, in heavily cleared landscapes, the recruitment of rainforest plants is likely to be much higher under plantations of fleshy-fruited timber trees than plantations of wind-dispersed species, because fleshy-fruited trees can attract fruit-eating birds and bats across cleared land (Wunderle 1997, Neilan *et al.* 2006).

The composition, as well as the richness, of the plants recruited to plantations may be affected by proximity to native forest (Fisher 1980, Hopkins 1990, Keenan *et al.* 1997). Many of the studies which have shown that plantations can 'catalyse' the recruitment of native plants have been conducted in plantations located close to native forest (e.g. Fimbel and Fimbel 1996, Harrington and Ewel 1997, Keenan *et al.* 1997, Lemineh *et al.* 2004). However, where plantations are to be used for the broadscale reforestation of cleared land, recruits may be largely restricted to a small pool of pioneer or generalist species, because these tend to be more widely-dispersed than mature phase species (Haggar *et al.* 1997, Da Silva and Vickery 2002, Kanowski *et al.* 2003a, 2005b). In these circumstances, the inclusion of restoration plantings within the plantation estate may be necessary to promote the dispersal of mature phase rainforest plants to plantations (Lamb 1998, Tucker *et al.* 2004).

Provision of Habitat for Rainforest Biota

The Wet Tropics rainforests of north Queensland support a rich and distinctive fauna, including many endemic species (Winter 1988, Williams *et al.* 1996). Most rainforest animals are dependent on a particular suite of habitat attributes characteristic of rainforest. For example, leaf-eating marsupials (possums and tree-kangaroos) and frugivorous birds and bats require a diverse range of plants in their diet, often from particular 'rainforest' plant families (Jones and Crome 1990, Kanowski *et al.* 2003b), while invertebrates and the animals that eat them are often strongly associated with characteristic structural features of rainforest such as vine tangles, epiphytes, and rotting logs (Kikkawa 1982, Grove 2002, Catterall *et al*. 2004). The use of plantations by rainforest fauna would therefore be expected to be strongly dependent on the occurrence of rainforest-like habitat attributes in plantations. Indeed, Kanowski *et al.* (2005b) found that the richness of rainforest birds and lizards in reforested sites in north Queensland was positively correlated with rainforest habitat attributes including plant species richness, structural complexity, canopy cover and stocking rate, while plantations with an open canopy and grassy understorey supported few rainforest biota.



[a] Pioneer trees (Goosem and Tucker 1995).
[b] Abundance is the sum of occurrence in three strata (canopy, midstorey, ground layer) at five 78.5 m^2 quadrats per site (details of survey in Wardell-Johnson *et al.* 2005). Number of plantations: Queensland maple (n = 2), kauri pine (n = 2), and hoop pine (n = 3). Plantations were 38-68 years old.

Figure 3: Comparison of the abundance of rainforest tree species most commonly recruited to old monoculture plantations of Queensland maple, kauri pine and hoop pine, Gadgarra State Forest, North Queensland.

For these reasons, plantations of eucalypts or exotic pines are unlikely to provide habitat for many rainforest animals. While no relevant surveys have been conducted in these types of plantations in north Queensland, studies conducted in other parts of Australia support this contention. For example, Borsboom *et al.* (2002) found that plantations of *Eucalyptus cloeziana* in south-east Queensland supported few rainforest-dependent vertebrates. Kikkawa (1968) reported that an exotic pine plantation in northern New South Wales supported a bird fauna more closely associated with eucalypt forest than with rainforest, while Lindenmayer and Hobbs (2004) concluded that exotic pine plantations in general provided poor habitat for most forest vertebrates. Sparsely-canopied eucalypt plantations could also be expected to be hotter and drier than closed canopy rainforest plantations. This would further reduce their habitat value for endemic fauna of the Wet Tropics, most of which are considered adapted to a moist, relatively cool climate (Winter 1997, Williams *et al.* 2003, Kanowski 2004).

Many plantations of hoop pine and other rainforest timbers in north Queensland and elsewhere in eastern Australia have recruited a complex rainforest understorey and are known to provide habitat for rainforest-dependent wildlife (Fisher 1980, Keenan *et al.* 1997, Bentley *et al.* 2000, Kanowski *et al.* 2003a, Catterall *et al.* 2004, Kanowski *et al.* 2005b). Important caveats in interpreting these data are that most existing plantations have been established by conversion of native forest and are located adjacent to remnant rainforest. Plantations located away from remnant rainforest would be expected to support fewer rainforest biota (Bell 1979, Catterall *et al.* 2004, Kanowski *et al.* 2005b, 2006). However, the inclusion of restoration plantings within the plantation estate may facilitate the dispersal of rainforest animals to plantations, particularly if restoration plantings were designed to form a linked network of high quality habitat between plantations and remnant forest (Tucker 2000, Tucker *et al.* 2004, Kanowski *et al.* 2005a).

Some authors have suggested that a mosaic of monocultures could have considerably more value for wildlife than extensive monocultures (Herbohn *et al.* 2000; Lamb and Keenan 2001). However, the benefits of plantation mosaics are likely to be less pronounced for fauna (at least for vertebrates) than for plants. This is because most rainforest vertebrates require a diverse suite of floristic and structural resources within their home range (Winter 1988, Kikkawa 1990, Jones and Crome 1990, Kanowski *et al.* 2003b). Even if plantation mosaics were to provide a greater diversity of floristic resources than monocultures at the landscape scale, only wide-ranging fauna would be able to utilise those resources, assuming plantations were in the order of 10 to 100 ha in size, as is presently the case. For example, most arboreal marsupials in north Queensland utilise a home range no larger than 1 to 2 ha in size (Newell 1999, Wilson 2000). Furthermore, a mosaic of monocultures would not necessarily provide any more of the structural resources required by fauna than an extensive monoculture.

A proper test of the suggestion that a mosaic of monocultures would have more value for wildlife than an extensive monoculture requires a contrast of these scenarios at the landscape scale, and such data are not available. However, site level data can be used to partly test the argument. For example, one way that a mosaic of monocultures could have more value for wildlife than an extensive monoculture would be if each type of monoculture plantation supported a different fauna, and hence together the mosaic would support a richer fauna than an extensive plantation of any single species. However, surveys of old plantations of hoop pine, kauri pine and Queensland maple in Gadgarra State Forest, north Queensland (the same plantations surveyed for plants recruitment, above) found that these plantations do not support distinct faunal assemblages. In these surveys, 70 to 80% of bird species and 60 to 80% of mite taxa recorded in any one type of plantation were also recorded in another (Kanowski *et al.* 2005a). Furthermore, some of the apparent differences between plantations are likely to be sampling artefacts. When only the most frequently recorded bird species are considered, for example, nearly all were recorded in all plantation types (Figure 4).

Despite being in a highly favourable situation for the recruitment of rainforest plants and animals, the plantation mosaic at Gadgarra appeared to support only a subset of the species found in nearby rainforest. A comparison of seven plantations at Gadgarra with two adjacent rainforest sites (all surveyed using the same methodology: Catterall *et al.* 2004, Wardell-Johnson *et al.* 2005) found that, of the 149 species of plants recorded in the two rainforest sites, 52 were not recorded in any of the seven plantations surveyed in the study. While 32 of the 35 species of birds recorded in the two rainforest sites were observed in at least one of the plantations, many rainforest birds appeared relatively uncommon in plantations. For example, there were considerably fewer records of the wompoo fruit-dove *Ptilonopus magnificus*, superb fruit-dove *P. superbus*, Macleay's honeyeater *Xanthotis macleayana* and Victoria's riflebird *Ptiloris victoria* in plantations than in adjacent rainforest sites. The paucity of these frugivorous birds has important implications for patterns of seed dispersal and hence plant recruitment in the plantations (Kanowski *et al.* 2004, Moran *et al.* 2004).

Plantations Facilitate Dispersal of Rainforest Species

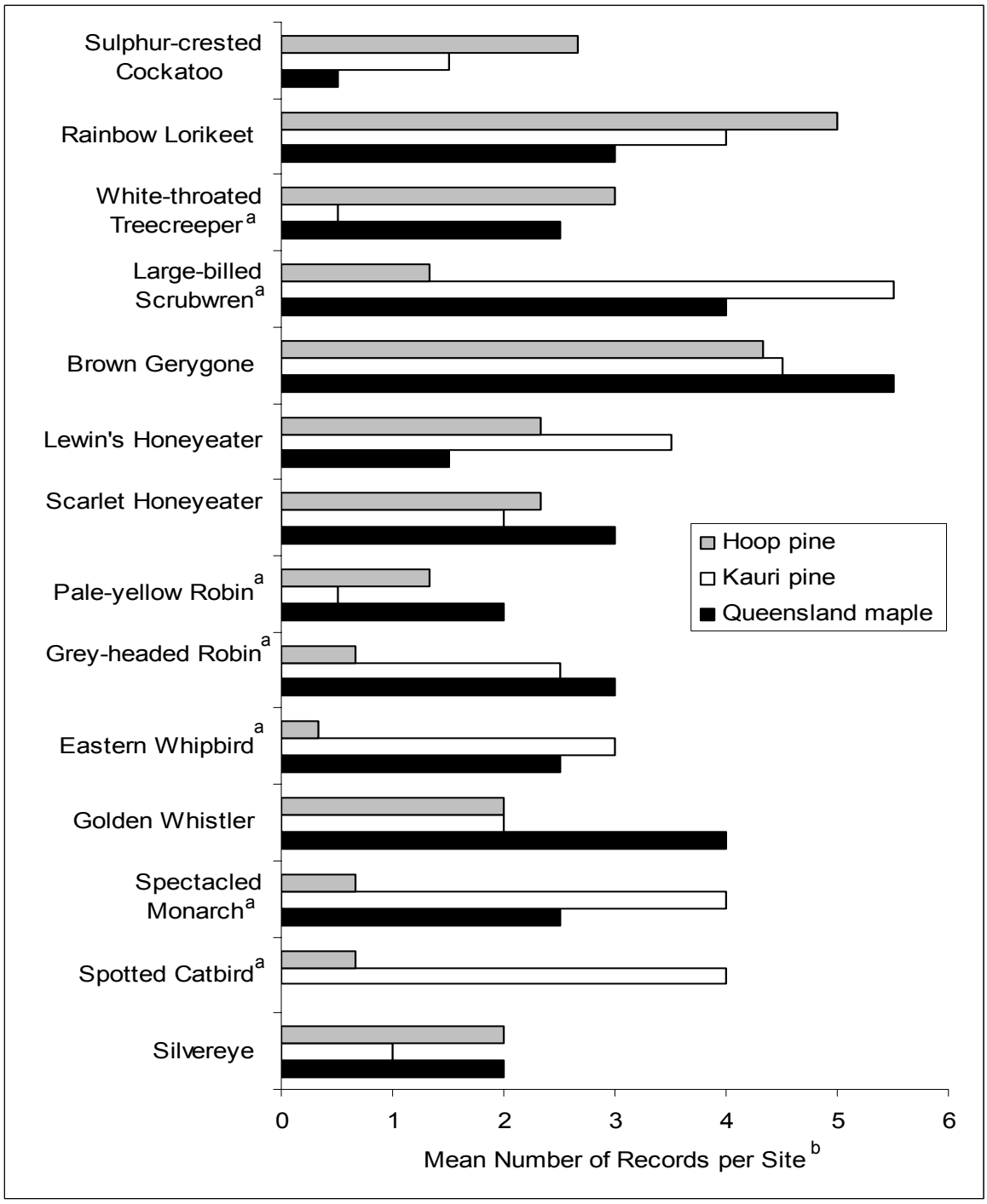
Little is known about the dispersal of rainforest wildlife through plantations. In general, it can be expected that the habitat requirements of dispersing fauna - which, by definition, are passing through a site - will be less exacting than the requirements of resident fauna. For example, Lindenmayer (2000) found that some forest vertebrates used exotic pine plantations to disperse between remnant forest patches, even though they did not regularly inhabit the plantations. Another generalisation is that there are likely to be considerable differences between taxa in their dispersal requirements. For example, amongst the arboreal mammals of north Queensland rainforests, tree-kangaroos (*Dendrolagus bennettianus and D. lumholtzi*) will readily disperse between isolated trees or even traverse open country, whereas the lemuroid ringtail possum (*Hemibelideus lemuroides*) requires a continuous forest corridor to disperse between remnants (Laurance and Laurance 1999, Kanowski and Tucker 2002).

Nevertheless, it can reasonably be speculated that plantations with a closed canopy will better facilitate the dispersal of rainforest fauna than plantations with an open canopy and grassy understorey. The latter type of plantations may even inhibit dispersal of some taxa, e.g. small rainforest mammals may not readily disperse across a plantation with a dense grassy understorey, particularly if it has been colonised by grassland mammals (Goosem and Marsh 1997). Of the plantation scenarios considered here, a mosaic of plantations and restoration plantings is most likely to assist the dispersal of rainforest biota across the landscape, especially if plantings form a linked network between plantations and remnant rainforest.

Potential Negative Impacts of Plantations on Biodiversity in North Queensland

Potential Invasion of Native Forests by Plantation Tree Species

Plantations could potentially have negative impacts on biodiversity if plantation trees invade native forests. For example, the seedlings of exotic pines are serious weeds in many parts of southern Australia (Lindenmayer and McCarthy 2001), although they are intolerant of shade and do not appear to recruit under rainforest. However, many rainforest trees used in plantations are relatively shade tolerant. Some of the exotic rainforest trees used in timber plantations in north Queensland are considered potential weeds. For example, *Chukrasia tabularis* has spread into native forests from plantations at Gadgarra (Tucker *et al.* 2004). A number of other exotic species which were widely planted in CRRP plantations may yet turn out to be invasive, but this will only become apparent after they mature, produce seed and attract dispersal agents (Richardson 1998).



[a] 'Rainforest' birds, i.e. species apparently dependent on, or closely associated with, rainforest and adjacent habitats in the Wet Tropics (Catterall *et al.* 2004; Kanowski *et al.* 2005b).

[b] Birds were recorded during eight 30 minute surveys of a 0.3 ha plot per site. Abundance is the number of records per site. For details of plantations, see Figure 3.

Figure 4: Comparison of the abundance of birds most frequently recorded in old monoculture plantations of Queensland maple, kauri pine and hoop pine, Gadgarra State Forest, north Queensland.

Potential Invasion of Native Forest Genetic Integrity by Plantation Tree Species

Plantations could also potentially have negative impacts on biodiversity if genes from plantations of native, but not locally-endemic, trees invade local gene pools (Boshier 2004). For example, there is a potential risk of genetic introgression from plantation hoop pine to native stands, because hoop pine has been subject to a breeding program which has included genetic material from a number of provenances, including New Guinea (Nikles 1996). This is probably not an important issue in the Wet Tropics, since hoop pine has a restricted distribution in the region, but it may be a more significant problem elsewhere in Queensland, where hoop pine occurs in extensive native stands. There is also the potential for genetic introgression to local populations in cases where non-local provenances of rainforest trees have been used in plantations. For example, Tasmanian provenances of blackwood *Acacia melanoxylon* were used in some CRRP plantings because of their superior form (Sexton 2000). There is substantial risk of genetic introgression from eucalypt plantations to regional eucalypt forests, due to the widespread use of hybrids and non-local provenances in eucalypt plantations and the potential for long distance dispersal of eucalypt pollen by bats and birds (Potts *et al.* 2003, Southerton *et al.* 2004).

Summary of the Impacts of Plantation Scenarios on Biodiversity

The potential impacts of the plantation scenarios on biodiversity are summarised in Table 2. Of the six scenarios considered in this paper, that of a mosaic of plantations and restoration plantings has by far the most number of positive impacts on biodiversity. Plantations of other rainforest trees (including hoop pine monocultures, mosaic of monocultures and mixed species plantations) have moderately positive impacts on biodiversity, while plantations of non-rainforest trees (eucalypts and exotic pines) have the least number of positive consequences for biodiversity.

All scenarios could potentially have negative impacts on biodiversity if plantations replace native forest, but other negative impacts vary from low to high, depending on the species used in plantations and the context in which they are established. Plantations of exotic rainforest trees are potentially invasive, while plantations of local species which utilise non-local genotypes (whether of rainforest trees or eucalypts) risk genetic introgression to local populations. The negative impacts of plantation scenarios using multiple species (mixed species plantings, a mosaic of monocultures and a mosaic of plantations and restoration plantings) would be dependent on the particular mix of species used in these plantations.

The relative importance of positive and negative consequences of plantations for biodiversity is likely to vary with landscape forest cover. In well-forested parts of the Wet Tropics, it may be more important to minimise the potential negative impacts of plantations on native forests than to maximise the positive impacts. On the analysis presented here (see Table 2), a monoculture of hoop pine, or a mosaic of hoop pine monocultures and restoration plantings, would be favoured over other scenarios in well-forested landscapes, at least in terms of minimising negative impacts on biodiversity. Nevertheless, plantations of other locally-occurring rainforest trees, and even exotic pines, either as a mosaic of monocultures or mixed species plantations may also have few negative impacts on biodiversity in well-forested landscapes. Non-local rainforest species may carry too high a risk of becoming invasive to be used in plantations in well-forested landscapes of the Wet Tropics.

Conversely, in heavily cleared areas in the Wet Tropics, plantation scenarios that provided habitat or dispersal corridors for rainforest wildlife would be strongly favoured in terms of biodiversity outcomes. Again, on the analysis presented here, this would entail the establishment of a mosaic of plantations and restoration plantings in heavily cleared landscapes (Table 2). No other type of plantation considered here approaches this scenario in terms of positive impacts on biodiversity.

Table 2: Summary of potential impacts of broadscale plantation scenarios on rainforest biodiversity in the Queensland Wet Tropics.

Impact	Monocultures:			Mixed species plantations	Mosaic of monocultures	Mosaic of plantations and restoration
	Eucalypts	Exotic pines	Hoop pine			
Positive Impacts						
(i) Site scale:						
Intrinsic value of species planted	Nil	Nil	Low	Med	Med	High
'Catalyse' rainforest regeneration	Low	Low	Med	Low	Med	High [a]
Habitat for rainforest wildlife	Low	Low	Low	Low	Low	High [a]
(ii) Landscape scale:						
Buffer remnants from adjacent environment	Med	High	High	High	High	High
Facilitate dispersal of rainforest species	Low	Low	Med	Med	Med	High
Increase populations of rainforest species	Low	Low	Low	Low	Low	High
Improve water quality downstream	?	?	?	?	?	High [b]
Reduced pressure to harvest rainforests	Low	Low	Med	Med	Med	Med
Carbon sequestration [c]	High	High	Med	Med	Med	Med
Negative Impacts						
(i) Site scale:						
Plantations replace native forest	?	?	?	?	?	?
(ii) Landscape scale:						
Plantation species invade native forest	Low	Low	Low	Low-high[d]	Low-high[d]	Low [a]
Genes from plantations invade native forest	High [e]	Nil	Low[f]	Med	Med	Low [a]

[a] Impacts of the 'mosaic of plantations and restoration' scenario based on the use of hoop pine as plantation species; impacts may vary with other species.
[b] Assuming riparian zones are targeted for restoration.
[c] Based on growth rates.
[d] Depending on species used in plantations.
[e] Potential impact on regional eucalypt forests due to genetic introgression from pollen transfer
[f] Risk of genetic introgression from hoop pine would be higher in other regions of eastern Australia where hoop pine occurs in extensive natural stands
[?] Consequences largely independent of scenario, dependent on design, management or location.

INTEGRATING ENVIRONMENTAL AND PRODUCTION OBJECTIVES IN PLANTATION DEVELOPMENT IN NORTH QUEENSLAND

This paper has attempted to evaluate the biodiversity values of broadscale plantation scenarios which might be implemented in north Queensland. In practice, plantation schemes will have to satisfy a range of social and economic objectives, as well as addressing biodiversity considerations (Harrison *et al.* 2000, Vize *et al.* 2005). Integrating the biodiversity and production objectives of plantation developments will be a complex task, for several reasons. First, there is still too little information on long-term growth rates of most rainforest species, or their responses to silvicultural treatments, to predict the value of timber produced by most plantation scenarios (Lamb and Keenan 2001, Erskine 2004, Erskine *et al*. 2005). Second, there is still only limited understanding of the biodiversity values of plantation scenarios (Catterall *et al.* 2004, Kanowski *et al.* 2005b). Third, there is little knowledge of synergies and trade-offs between the production and biodiversity objectives of timber plantations (e.g. Catterall 2000, Harrison *et al.* 2000, Catterall *et al.* 2005; Erskine *et al.* 2005). For example, while it can be reasonably concluded that a mosaic of plantations and restoration plantings would have the greatest number of positive benefits for biodiversity of the plantation scenarios considered here (Table 2), the proportion of a plantation estate that would need to be allocated to restoration plantings to achieve particular conservation goals is unknown. This question is fundamental to achieving outcomes for production and biodiversity under this scenario, but an optimal answer may vary with the amount and spatial configuration of remnant forest, both in the immediate vicinity of the plantation and in the wider landscape (Lindenmayer and Franklin 2002). Resolving these types of questions will require investment in large-scale, long-term research and monitoring programs in reforestation projects, aimed at assessing both timber production and the consequences of plantations for biodiversity (Catterall *et al.* 2005).

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11. POTENTIAL FINANCIAL RETURNS FROM HOOP PINE AND AN ASSESSMENT OF THE LIKELY IMPACTS OF VARIOUS SUPPORT MEASURES ON LANDHOLDER WILLINGNESS TO PLANT

J.L. Herbohn

The question of whether hoop pine can be profitably grown is central to the expansion of the hoop pine estate on the Atherton Tablelands. This paper presents the results of a discounted cash flow analysis of establishing additional hoop pine plantations as part of continuing agricultural activities. The base case NPV at a discount rate of 5% is $732, which indicates that the project would be accepted. The LEV is $823 which represents the maximum amount that could be paid per hectare of land for the project still to be viable. The discount rate applied has a strong impact on the NPV and LEV, which is typical for long timeframe of log production projects. For discount rates around 5.5% and less, an investment in hoop pine plantations would be accepted. Stumpage price also has a major impact on NPV but marginal tax rate does not. In addition, the use of lower values for landholder labour costs yields substantially higher NPVs.

INTRODUCTION

The question of whether hoop pine can be profitably grown is central to the expansion of the hoop pine estate on the Atherton Tablelands. For companies, the goal of the firm is generally considered to be wealth maximisation and is measured by net present value (NPV) of future cash flows associated with a project. The same principles also can be applied to government and private investors; however, often these two groups take into account many other factors in making their investment decisions. Discounted cash flow analysis is used to calculate NPV. Land Expectation Value (LEV) – in effect the NPV of an infinite chain of tree rotations – provides another useful financial performance criterion, particularly when the objective is to compare species with different rotation lengths. Importantly, LEV represents the maximum amount that an investor could pay for land for plantation establishment and still obtain a positive financial return for the plantation investment.

The techniques for undertaking financial analysis of timber plantations are well established (e.g. Herbohn 2002, Herbohn and Harrison 2002, Herbohn *et al*. 2002, Dayandra *et al*. 2002). This is not to say that predicting financial returns from plantations is not a challenging task, because there are many uncertainties associated with the key cash flow variables. Sensitivity and risk analysis techniques are typically used to explore the likely impacts of these uncertainties.

The steps in undertaking a financial analysis of hoop pine plantations can be divided into:

- Specifying the basic hoop pine silvicultural system to be analysed;
- Estimating the cash outflows associated with the system;
- Estimating the cash inflows associated with the system;
- Developing a financial model; and
- Undertaking sensitivity analysis.

In financial appraisal, there is often a distinction drawn between capital cash flows and operating cash flows. In the case of a hoop pine plantation, capital flows would be cash inflows associated with the establishment of the plantation (e.g. purchase of land, costs of establishing the plantation, sale of the land at the end of the project). Operating cash flows are associated with the management of the plantation and the sale of timber.

A standard hoop pine silvicultural system is adopted for the financial analysis, from which performance estimates are derived. Also, gaps in information and limitations of the analysis are highlighted. A sensitivity analysis is provided. No comparison of the financial performance in relation to plantation ownership type) (e.g. corporate, self-financing landholder, joint venture) is attempted, and no allowance is made for subsidies. It is envisaged that revisions to the financial analysis may be needed during preparation of the business case.

The Proposed Hoop Pine Silvicultural System and Estimated Cash Outflows

A silvicultural system has been specified, as the framework for the development of a financial model for hoop pine production. This system involves the establishment of a hoop pine plantation with moderate site preparation and an initial planting density of 500 seedlings per ha. This system was developed based on discussions with DPI Forestry staff and relevant literature. The key activities associated with the establishment of hoop pine plantations are presented in Table 1. These activities are those which have typically been undertaken by DPI Forestry when establishing hoop pine plantations. Estimates of the cost of each activity are provided.

After establishment hoop pine plantations typically require aggressive weed control until the seedlings reach 1.3 m in height. Pruning is undertaken to produce a high quality butt log. Plantations are typically thinned to 400 or fewer stems per ha through a non-commercial thin. No commercial thins are generally undertaken. The continuing maintenance activities, their timing and estimated costs are presented in Table 2.

Table 1: Establishment activities and estimated costs.

Activity	Estimated cost ($)
Final survey with global positioning system	250
Slash and spray	600
Site cultivation	600
Seedlings (500 sph, $1.50 each)	750
Planting labour costs	400
Total establishment expenses	2600

Table 2: Continuing maintenance activities, timing and estimated costs for a stand hoop pine plantation.

Activity	Estimated cost ($/ha)	Timing (year)
Post plant spray (supply and apply)	450	1
Prune - contract (3 m lift)	650	4
Post plant spray (supply & apply)	300	1
Post plant spray (supply & apply)	150	2
Pre-commercial thin (400 stems/ha)	500	3
Prune - contract (5.4 m lift)	850	6
Resource assessment (timber inventory plots) – 1	80	5
Resource assessment (timber inventory plots) – 2	80	10
Resource assessment (timber inventory plots) – 3	80	25
Annual expenses (yrs 1-20)	40	1-20
Opportunity cost of land	a	1-45
Rates	a	1-45

[a] No cost allocation made.

The cash outflows for maintenance activities are based on the system adopted by DPI Forestry. An integral part of that system is the regular monitoring of plantation growth as part of a continuing research effort. The resource assessment expenses in years 5, 10 and 25 are associated with these research and monitoring activities. In some circumstances, these expenses would not be incurred by private investors.

The relevant cash outflows associated with the opportunity cost of land and rates will vary, with their amounts being determined according to the opportunity cost principle (as described in Dayanandra *et al*. 2002). If land is purchased to establish a plantation, then the opportunity cost of the land is the cost of investing in the next best investment. All of the costs associated with holding the land (including rates) would also be included in the analysis. If on the other hand a farmer decided to plant trees on an existing piece of productive land then the opportunity cost of using the land would be the income forgone from current production. Rates would not be included in the analysis however, because these are a sunk cost which would have been incurred irrespective of whether hoop pine was planted. If the land on which the trees are planted was non-productive, then the opportunity cost would be zero. Thus, costs such as rates and the opportunity cost of land could vary from being zero (i.e. when currently non-productive land on an existing farm is planted) to being significant (i.e. when high-value agricultural land is purchased for forestry). Whether rates and opportunity cost of land should be included in the analysis will be dependant on the scenario being analysed. Clearly, identifying the scenarios to be analysed is therefore an essential step in the financial modelling process.

Estimates of Cash Inflows

Cash inflows from plantations arise from thinning and final harvest. In the case of hoop pine on the Atherton Tablelands, there is currently no market for thinnings, the only cash inflows being from a one-off final harvest. Cash flows from the final harvest are a function of harvest volume and stumpage price.

Estimates of growth rate are made according to 'site index', defined as the height of the dominant trees at a specified age. In the case of hoop pine, site index is the height (expected) in metres at age 25. A site index of 30 thus means that at that particular site, trees would be expected to reach a height of 30 metres at age 25 years. This index is then related to final predicted yield.

There has been substantial research into developing growth models for hoop pine. These growth models are best developed for south-east Queensland due to the large areas of plantation that have been established. Less well developed models exist for north Queensland sites and there is scant data outside the 'heartland' (i.e. where most of the data lies). Keady (2006) has recommended the use of the growth model for Imbil/Amamoor as being more accurate over a broad range of site indices than the model developed from data from the Atherton Tablelands. He further maintained that the growth rates predictions using the Imbil/Amamoor model will be within 5% of accuracy for similar site indices in north Queensland.

The potential hoop pine plantation yields by SI class for the Atherton Tablelands are presented in Figure 1. These estimates are based on the Imbil/Amamoor yield equation (DPI Forestry 2005, p. 12). Keady (2006) has also generated predictions of yield by log class for five site indices (15, 20, 25, 25, 30, 35) relevant to the Atherton Tablelands, three final stocking rates (300, 400 and 500 stems per ha) and six harvest ages (35, 40, 45, 50, 55 and 60 years).

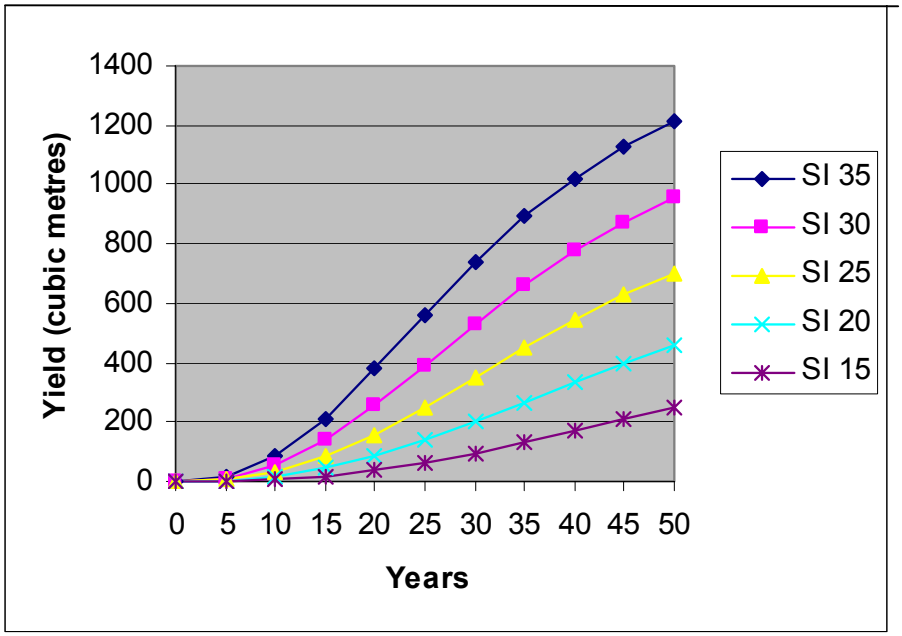

Figure 1: Yield versus age for hoop pine, as a function of site index.

The stumpage price that will be received for hoop pine is difficult to estimate. The current royalties charged by DPI Forestry are considered commercial in confidence and could not be obtained to use in this analysis. Discussions with various industry people suggest that the current royalty in SEQ is about \$70/m^3, while the royalty in north Queensland is about \$50/m^3, in part associated with lower log quality and, perhaps, allowance for the greater distance from markets. For the purpose of this analysis, a stumpage of \$70/m^3 has been used.

The Financial Model

A tentative financial model has been constructed in Excel using the net present value (NPV) model presented in Equation 1. In addition, land expectation value is calculated using Equation 2.

$$NPV = \sum_{t=1}^{n} \frac{C_t}{(1+k)^t} - CO \qquad \text{Equation 1}$$

where CO = the capital outlay at the beginning of year 1 (or where t = 0);
k = the risk adjusted real discount rate; and
Ct = net cash flow at the end of year t.

$$LEV = NPV_r + \frac{NPV_n}{[(1+k)^n - 1]} \qquad \text{Equation 2}$$

where LEV = land expectation value;
NPV_r = NPV of initial replication; and
NPV_n = NPV of each replication at year n

The analysis is done on for a representative 1 ha of plantation, and all results are presented on a per-hectare basis.

The Base-Case Financial Analysis

The base case analysis assumes a stumpage of \$70/m^3, approximating the royalty currently paid by purchasers in south-east Queensland. Mr Simms from Ravenshoe Timbers has indicated that he would be willing to pay this amount if the quality of timber he could obtain was sufficiently high. The base case also assumes a site index of 30. This equates to a MAI of 19.4 m^3/ha/year, with a final harvest volume of 872 m^3. The rotation period is 45 years. A 30% tax rate is applied in the analysis. This is the current company tax rate and the most common marginal tax rate for individuals.

The model adopts a *real* and *risk-adjusted* discount rate. There is much discussion about what discount rate is appropriate to use for forestry investments. The rate used in the base case is 5%. This represents a mid-range value in terms of what is used in reported forestry financial evaluations. Typically rates selected range from 4% to 7%. For instance, Row *et al*. (1981) recommended that the US Forest Service use a rate of 4% based on the analysis of the long-term opportunity cost of capital in the private sector of the US economy. While this rate was developed for a public sector organisation, the fact that it is based on the cost of capital to the private sector makes it relevant for use in the private sector. McKillop and Hutchinson (1990) have used portfolio theory and the Capital Asset Pricing Model (CAPM) to determine the appropriate risk for private sector forestry investment. Importantly, they argued that forestry investment for a private sector investment firm would represent only part of a well-diversified portfolio of investments. As a consequence, the accept or reject decision would not be based on the cost of capital for the specific forestry project (e.g. bank lending

rates or rate of return available in the equity markets). The rate of return must compensate the investor for the forestry project's marginal contribution to the risk of the investor's overall portfolio. Based on these principles, McKillop and Hutchinson (1990) estimated the discount rate for private sector forestry investment to be 4.77%. In contrast, various Australian State Government forest services (including Queensland and Tasmania) use discount rates of around 7%.

The base case NPV at a discount rate of 5% is $732, which indicates that the project would be accepted. The LEV is $823, which represents the maximum amount that could be paid per hectare of land for the project still to be viable.

Sensitivity Analysis with Respect to Key Cash Flow Parameters

Discount Rate

The discount rate applied has a strong impact on the NPV and LEV, which is typical for long timeframe of log production projects. The impact of discount rate on NPV is illustrated in Figure 2.

For discount rates around 5.5% and less, an investment in hoop pine plantations would be accepted. Clearly, however, if the required real rate of return from investors is 7%, as is reportedly the case for Queensland DPI Forestry, then the standard hoop pine plantation system that has been assessed would not be accepted as a viable investment.

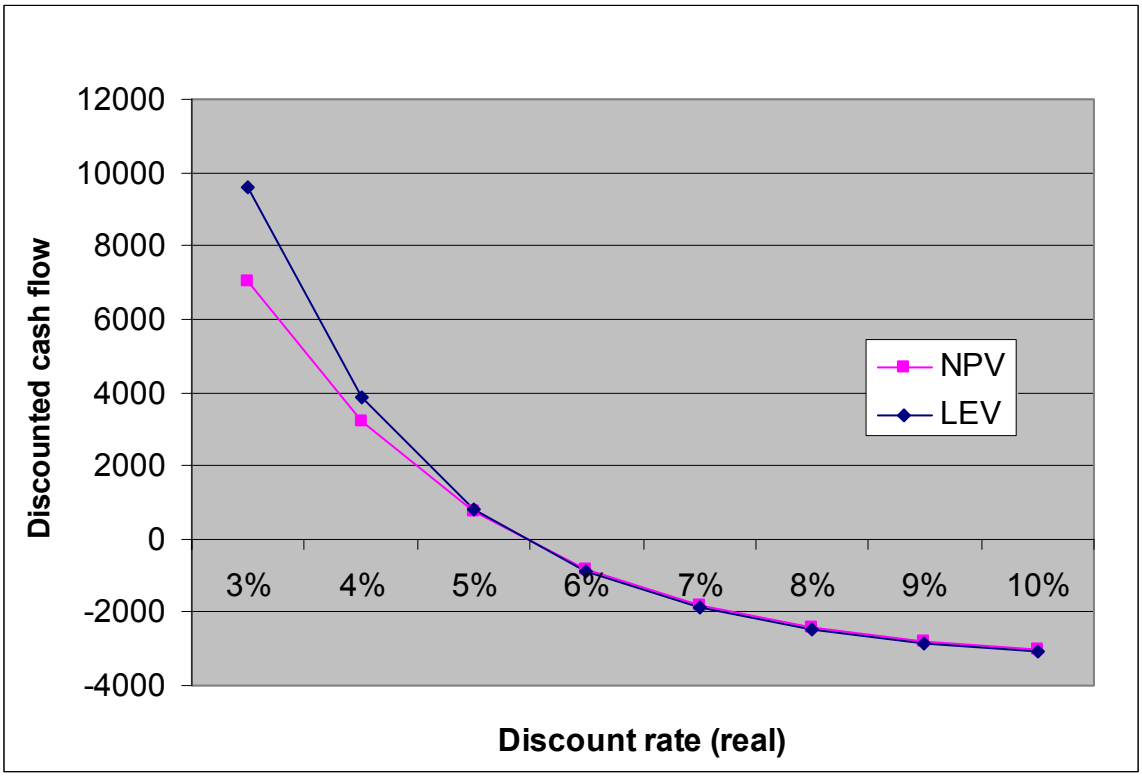

Figure 2: Net present value and land expectation value for hoop pine for a site index of 30 and stumpage of $70 ($/ha).

Stumpage Price of Hoop Pine

The stumpage price has a major impact on the NPV. The base case stumpage price used in the financial analysis is an approximation of the current royalty received by DPI&F in south east Queensland. At various times, higher royalty rates have been achieved, approaching nearly $100/m^3$ several years ago. Given predicted long-term shortages of high quality timber, it is feasible that higher prices could be achieved. The sensitivity of NPV to two levels of higher stumpage ($90/m^3$ and $110/m^3$) is presented in Table 3 and Figure 3. Higher stumpage prices shift the NPV curve to the right, i.e. profitability increases strongly. Importantly, higher stumpage prices mean that hoop pine plantations remain profitable at higher required rates of return.

Table 3: Estimated NPV of hoop pine on the Atherton Tablelands in relation to discount rate and stumpage price ($/ha).

Discount rate	Stumpage price ($/m^3)		
	70	**90**	**110**
0.04	3183	5274	7365
0.05	732	2091	3450
0.06	-821	66	953
0.07	-1801	-1220	-638
0.07	-2415	-2033	-1650

The Impact of Rate of Tax on Outlays and Timber Revenue

While the Australian company tax rate of 30% has been taken as the base case tax rate, it is possible that individual investors could pay a higher marginal rate. The current 2005-06 marginal tax rates for income from $63,001 to 95,000 and for income in excess of $95,000 are 42% and 47% respectively. The marginal tax rates have been found to have little impact on estimated NPV (Figure 4). Plantation expenditure attracts tax deductions, while revenue incurs tax, and to some extent these offset each other. At lower discount rates, the NPV for the base case tax rate of 30% is slightly higher than for the higher marginal rates. This situation reverses for higher discount rates. This is simply due to the increased benefits of tax deductions in early years relative to income tax paid in later years at higher discount rates. The overall impact of tax rates is however negligible and can be largely ignored.

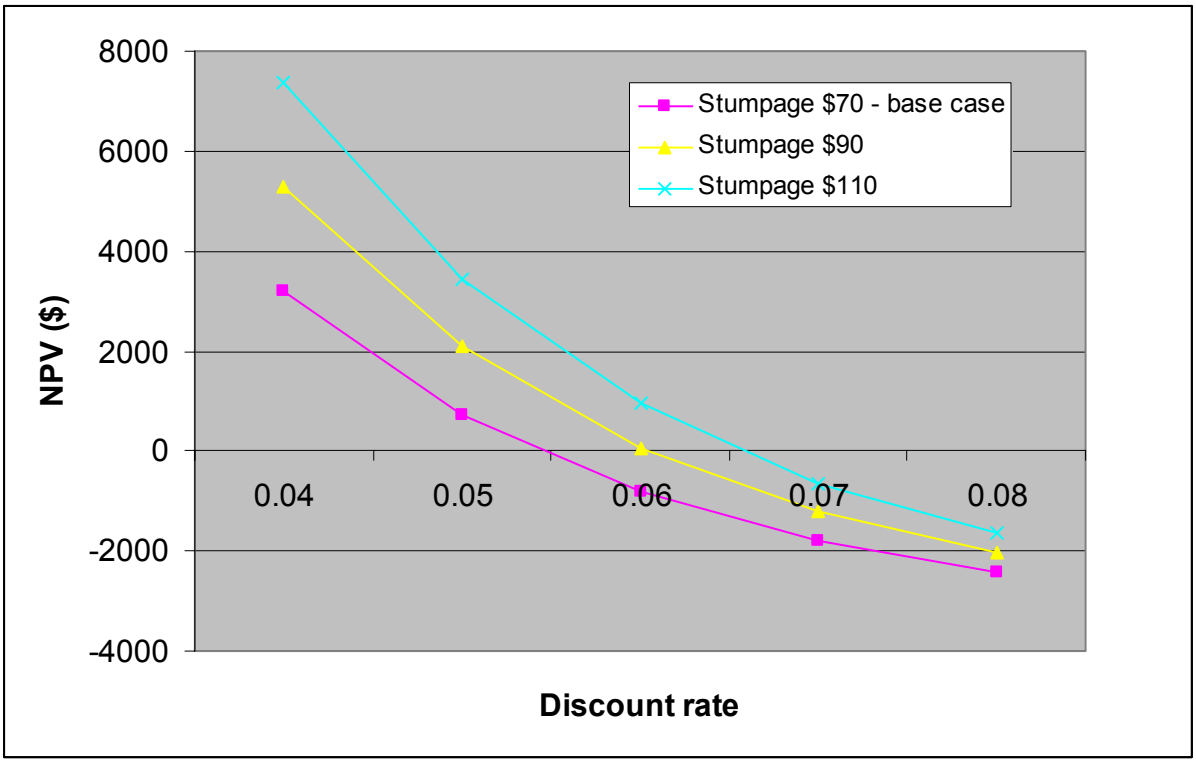

Figure 3: Estimated net present value versus stumpage price.

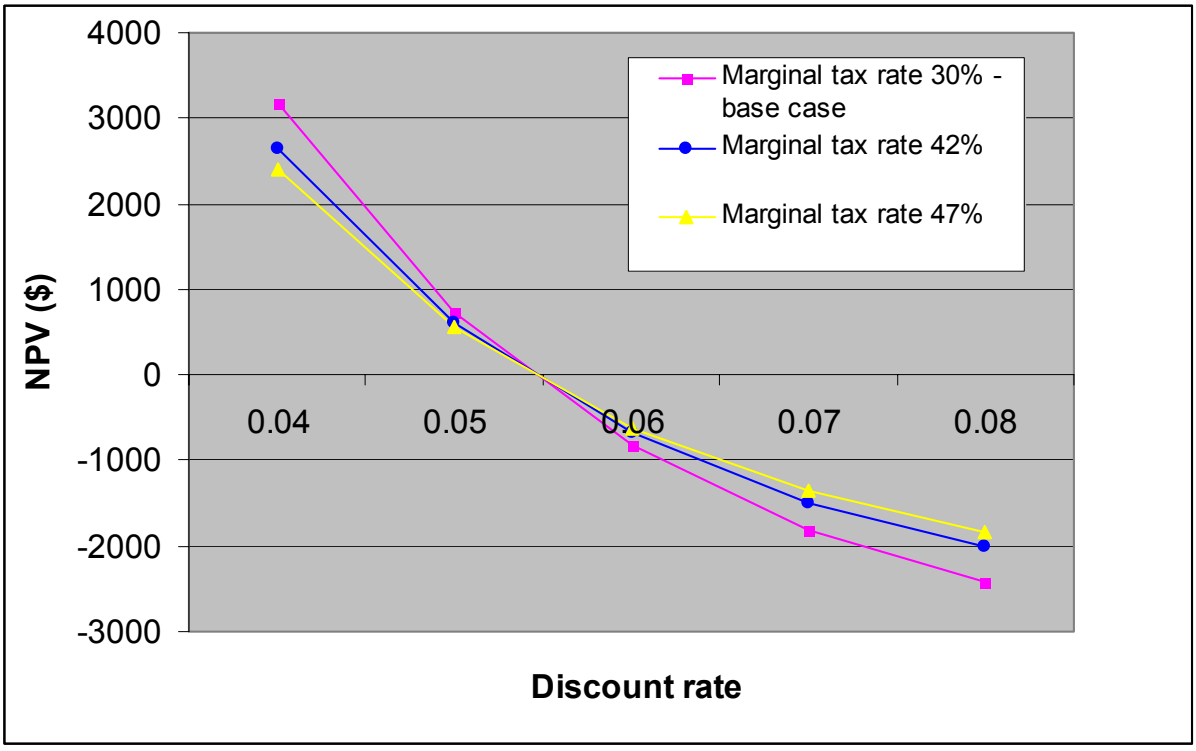

Figure 4: Estimated net present value versus the marginal rate of tax.

Scenario Analysis of Lower Cash Input Costs

The base case has been developed with the assumption that all labour involved in the establishment and management of the plantation (i.e. planting, weed control, thinning and pruning) is provided on a commercial contract basis with a similar cost structure to that of DPI Forestry. Implicit in the use of the DPI Forestry costs for assessing hoop pine plantations on farms is that farmers will contract out the work. However, landholders establishing hoop pine on part of their existing property may decide to undertake part or all of the work themselves. For instance, a landholder may undertake these activities in periods of low activity in other farm operations and the opportunity cost of other income forgone may be very low. Some landholders even view the growing of trees as a recreational activity (Maczkowiack in press). In these cases, attributing a lower value to many of the input items would be appropriate.

Two scenarios have been developed, namely where the labour-intensive inputs are valued at half of the corresponding costs in the base case, and where labour costs are valued at zero (with a small expenditure retained for other inputs including herbicides). The cost levels used in these two scenarios are presented in Table 4. Compared with the base case, reduced expenditure on landholder labour improves the NPV markedly, both for the reduced cost and minimum cost scenarios (Figure 5). This is significant in that hoop pine plantations become highly attractive for landholders who place a low or negligible value on their labour inputs. It is also significant in that these lower labour costs make hoop pine attractive on sites of lower productivity, i.e. site index 20 and 25 (Figure 6).

Table 4: Costs used in reduced cost and minimum cash input cost scenarios.

Activity	Base case costs ($/ha)	Reduced cost ($ ha)	Minimum cost ($ ha)
Establishment			
Slash and spray	600	300	50
Site cultivation	600	300	50
Planting labour costs	400	200	0
Continuing maintenance			
Post Plant Spray (supply and apply)	450	225	50
Prune - contract (3 m lift)	650	325	0
Post Plant Spray (supply and apply)	300	150	50
Post Plant Spray (supply and apply)	150	75	25
Pre-Commercial Thin (400 stems/ha)	500	250	0
Prune - contract (5.4 m lift)	850	425	0

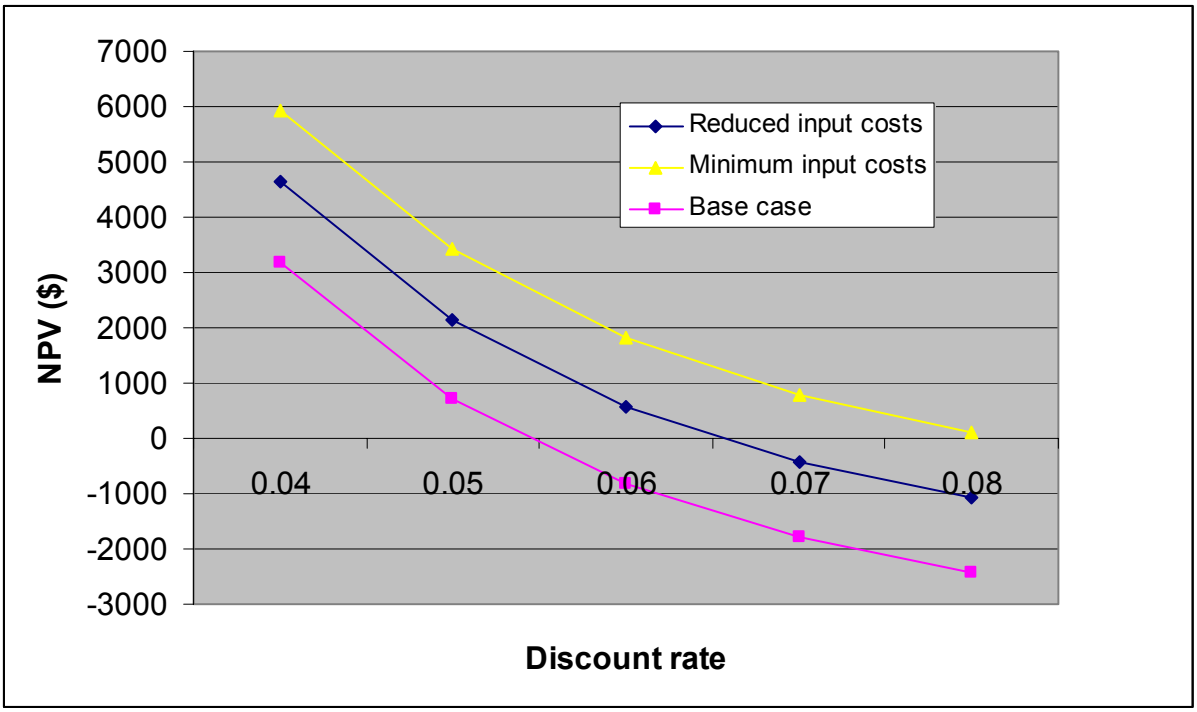

Figure 5: Estimated net present value versus landholder labour input cost.

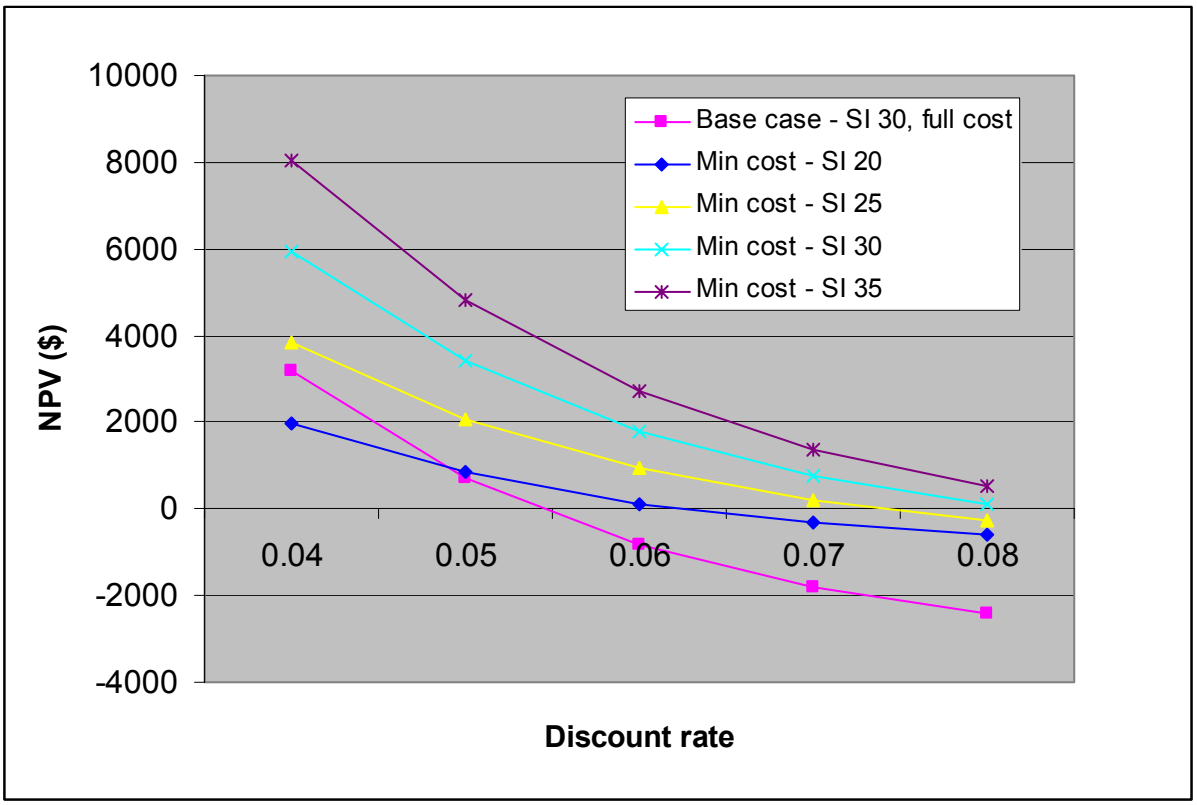

Figure 6: Estimated net present value versus site index.

Summary of Financial Analysis Findings

The financial analysis indicates that a 1 ha plantation would yield a NPV of $732/ha, which indicates that the forestry investment would be financially viable. The sensitivity analysis indicates that discount rate and stumpage price have major impacts on NPV but marginal tax rate does not. In addition, the use of lower values for landholder labour costs yields substantially higher NPVs. It is envisaged that further development of the financial analysis will be undertaken before the business case is finalised. In particular, financial estimates will change when the plantation scenarios to be recommended are identified in more detail.

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12. VISITOR ATTITUDES TO A PROPOSED HOOP PINE PLANTATION ESTABLISHMENT ON THE SOUTHERN ATHERTON TABLELANDS

J. Suh, R. Lwanga, S.R. Harrison and J.L. Herbohn

A survey was undertaken to examine visitors' attitudes to the hoop pine plantations on degraded pastureland on the Southern Atherton Tablelands. In total, 506 respondents were interviewed, of which 285 were classified as tourists and the remainder as local residents. Face-to-face interviews were undertaken at six visitor sites, namely Lake Barrine, Lake Eacham, Mount Hypipamee National Park, Lake Tinaroo, Barron Falls and Yungaburra township. The questionnaire used in the interviews contained a set of pairwise comparisons of distinct landscape scenarios for the tablelands and contingent valuation questions with respect to the hoop pine plantation option. The study revealed that visitors prefer the 'mixed rainforest' option to the hoop pine plantation option and grazing land with plantation option. Nevertheless, the contingent valuation application indicated that 181 (63.5%) of tourists and 102 (46%) of local residents interviewed were willing to pay an average of A$13.82 and A$5.53 respectively to support the proposed hoop pine plantation.

INTRODUCTION

Tropical North Queensland attracts up to two million visitors annually and tourism has become the fastest growing industry in Far North Queensland (Huybers and Bennett 2002). This implies the importance of visitors as stakeholders to the region's environmental management and economy. The southern Atherton Tablelands are famous for their pastoral landscape, crater lakes and waterfalls, and include some of the most popular tourist destinations for inland-based tourism around the Wet Tropics of Queensland World Heritage Area (WTWHA).

Forestry and agriculture have shaped the landscape characteristics of the region for about 150 years. Forestry developed in the region through the harvesting of red cedar (*Toona ciliata)* that was a popular tree with timber harvesters during the 1870s. Although red cedar was the most popular tree at the time, other trees were harvested and the opening up of the rainforests in the region for dairy production in 1882 accelerated the rate of forest clearing on the Atherton Tablelands (Wet Tropics Management Authority 2003). The harvesting of timber from the rainforest continued until the designation of the remaining forest as a World Heritage Area in 1988. As well as conserving the remaining rainforest, the world heritage listing brought about a shortage in timber in north Queensland (Harrison *et al*. 2003). Agriculture has been practised on the Atherton Tablelands for about 100 years (Skerman *et al.* 1988, Malcolm *et al*. 1999) and the tablelands are renowned for maize and pasture production, while diary farming is also a major industry and injects over $70 M dollars into the region's economy annually (Malcolm *et al*. 1999). Harrington (1990) reported that agriculture has accounted for a large part of land clearing on the Atherton Tablelands such that the only patches of native forest now exist, mostly on those areas too steep for farming.

To make up for the shortage of timber in the state, there has arisen an interest in re-establishing the timber industry in north Queensland through plantation establishment, especially on previously deforested land. The soils and climate of the southern Atherton Tablelands are ideal for expanding the softwood plantation area, and this has attracted the attention of local governments and other policy-makers. The federal government aims to

treble timber production in Australia through plantation establishment under Vision 2020, with an emphasis placed on plantation establishment on previously cleared land (Federal Government of Australia 1997). Various studies have indicated that a large area of suitable land now used for grazing is available on the Atherton Tablelands where forestry is an appropriate use (of the order of 20,000 to 40,000 ha).

Ironically, this deforested or cleared land gives the unique landscape value to the Atherton Tablelands and is one of the factors that have contributed to growth of tourism (including ecotourism). In light of this, some residents and visitors from elsewhere may value highly the aesthetic qualities of the southern Atherton Tablelands and prefer to preserve the landscape in its present state (Huybers and Bennett 2002). Forestry expansion might have implications insofar as the region's aesthetic landscape values are concerned, thereby having an effect on tourism on the Atherton Tablelands. Therefore, before any further environmental policies are developed for the region, visitors' attitudes towards any plantation establishment need to be investigated.

This paper examines visitors' perceptions of the current landscape of the southern Atherton Tablelands and their reaction to the possible change in the aesthetic landscape of the tablelands region associated with plantation establishment.[1] The research methodology and paradigm adopted are first reported, and then development of the survey questionnaire is describe. The visitors' perception of the aesthetics of the study area analysed. Next, insights into the landscape scenarios more preferred by the visitors are presented. The paper finally reports the non-market values of a hoop pine plantations proposal on the degraded pastureland on the southern Atherton Tablelands.

RESEARCH METHOD

A survey was administered through face-to-face interviews. The interviewees were randomly selected from those who happened to visit the survey sites at the time when a team of interviewers undertook the fieldwork. The survey sites were limited to visitor 'hot spots' in the southern Atherton Tablelands because it was relatively easier to access an adequate number of survey subjects to obtain data suitable for statistical analysis.

The possible affected parties were classified into two groups, i.e. tourists and local residents. The rational of this classification was that they were expected to have a different structure of preferences for environmental setting on the Atherton Tablelands. A criterion to determine which people would qualify as tourists or local residents to the Atherton Tableland was set based on their place of origin. All people from outside the Far North Queensland Statistical Division (running south to north from Townsville to Cape Tribulation) were taken as tourists to the Atherton Tableland.

Questionnaire Design

A questionnaire was drafted which was designed to gather information on the visitors' perception of the southern Atherton Tablelands and to estimate the value of the hoop pine plantation plan in terms of landscape amenity improvement. A test was conducted to check the viability of the questionnaire's application at a public picnic park at Mary Cairncross Park near the town Maleny. The Maleny district in the Sunshine Coast hinterland region near the Glasshouse Mountain has landscape characteristics similar to those of the Atherton Tableland. In interviewing 17 local residents or visitors, the interview team focused on three

[1] This research formed part of Project 5.3 (Social and Economic Aspects of Reforestation) of the Rainforest Cooperative Research Centre (Rainforest CRC) and the Hoop Pine Production Project supported by the federal Department of Transport and Regional Services (DOTARS).

main issues, namely the time taken for each respondent to complete the questionnaire, the clarity of the pairwise comparison questions, and the plausibility of the willingness-to-pay (WTP) bid amounts and payment vehicle. Comments noted during testing the questionnaire were incorporated into the final version, as described below.

Visitors' Perception of the Rural Landscape

Respondents were asked whether they had seen any landscape similar to that of the southern Atherton Tablelands, and if so to name the areas they think had similar landscapes. They were then requested to rank the beauty of the landscape of the southern Atherton Tablelands on a 5-point Likert scale. Two following open-ended questions asked the respondents to state the features they found most attractive or unattractive on the southern Atherton Tablelands. The visitors were then asked to rank the importance of various elements in determining the beauty of a landscape. Importantly, the respondents were asked to indicate how negative or positive the effect of plantation establishment on their enjoyment of the landscape would be.

This section of the questionnaire also presented respondents with four different landscape scenarios, namely degraded pasture land, hoop-pine plantations, mixed rainforest plantations and grazing land with plantations. The respondents were requested to compare two of the landscape scenarios at a time. The four landscape scenarios made up six combinations of two scenarios. For each pairwise comparison, the respondents were asked to indicate their preferred landscape by marking one of five circles provided against their choice. Photographs of the four landscapes were provided to provide a focus for the comparison and to assist those who were not familiar with some types of landscape. The photos were designed to be typical of areas on the tablelands.

Valuation of the Landscape Amenity Associated with the Hoop Pine Plantation Option

The contingent valuation method (CVM) was employed with an intention of eliciting visitors' WTP amounts to support the hoop pine plantation option on the Atherton Tablelands if they thought this option would increase their landscape enjoyment. The CVM section of the questionnaire first describes the size and characteristics of the area on which the proposed plantations would be established. The importance of establishing the plantations for timber, wildlife habitat protection, carbon sequestration and watershed protection is then outlined. The information statement included in the CVM section is as follows.

> *The Atherton Tablelands was first cleared for dairying and cropping about 100 years ago. Over time, some of the land has deteriorated, with pastures replaced by poorer grasses and weeds. This land is well suited to growing trees.*
>
> *It is proposed that an area of about 500 ha of degraded land on the southern Atherton Tablelands be planted to Hoop Pine (Araucaria cunninghamii) trees. This is an Australian native conifer tree species, grown in plantations by the Queensland Department of Primary Industries, which has high quality timber.*
>
> *The Hoop Pine plantations would result in a permanent change in landscape appearance (with annual small areas logged after about 40 years and immediately replanted), and produce timber and provide wildlife habitat, watershed protection and carbon sequestration benefits.*

The payment vehicle employed for tablelands residents is a landscape improvement fund. Tourists from outside north Queensland were asked to imagine staying in commercial accommodation where they would be charged an extra fee per room per visit in addition to

what they would otherwise pay. The use of compulsory a payment mode was intended to minimise the chances of overestimating WTP.

The double-bounded CVM bid technique was used where the respondents were presented with three bid amounts, i.e. the initial bid, a higher bid and a lower bid. The double-bounded question format has been widely used amongst the CVM practitioners during the last decade. The respondents who stated that they were willing to pay the initial bid were then presented with a higher amount. Those who rejected the initial bid were offered a lower bid. The respondents who rejected both amounts presented to them were asked to state their reason for rejection. To allow a wide range of variation for the statistical accuracy and efficiency, four different questionnaire formats were used each with different bid amounts. The four versions of bid amounts were set as indicated in Table 1. A sample of the questionnaire is provided in at the end of this paper.

Table 1: Alternative bids for the hoop pine plantation program.

Version	First bid	Higher bid	Lower bid
1	5	7	3
2	10	15	5
3	20	30	10
4	40	50	30

The WTP estimate sought in this study is a Hicksian measure of welfare, as illustrated in Figure 1. Each indifference curve in Figure 1 depicts a distinct level of welfare, with V_N denoting a higher level than V_C. In other words, the welfare level on V_N at a given income level is greater than that at on V_C, which results from the higher level of the environmental amenity at the given income. Suppose that an individual is initially at Point '*a*' with money income at M_0 and environmental quality enjoyed at E_0. The welfare level at Point '*a*' is indicated by the indirect utility curve V_C. All else being equal, a rational person would prefer the situation at Point '*b*' because the person can enjoy more environmental amenity without any deduction from the initial income. Put another way, a decrease in income exactly by the vertical distance of '*bc*' will leave the person neither better nor worse off, compared to V_C. This implies that the person would be willing to pay a maximum of $M_0 - M_1$ to enjoy an enhanced level of the environmental amenity E_1. This study has aimed to measure the mean WTP that can be expressed by the difference $M_0 - M_1$ for the hoop pine plantations on the southern Atherton Tablelands.

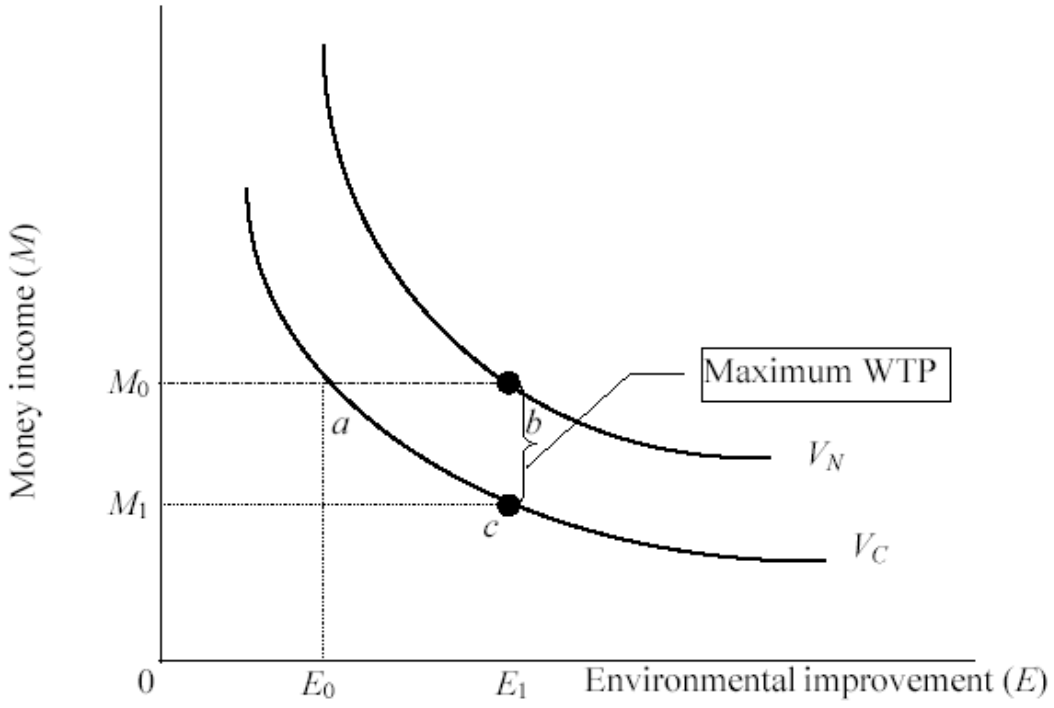

Figure 1: Graphic illustration of the maximum willingness-to-pay amount for an environmental improvement associated with hoop pine plantations.

Administering the Survey

The survey was conducted between 22 August and 6 October 2005. A reconnaissance of possible intercept locations was undertaken on the day of the fieldwork so as to determine where tourists would best be approached to fill in the questionnaire and also for the research team to familiarise themselves with the selected interview sites on the Atherton Tablelands.

Potential respondents (both tourists and local residents) were approached at six visitor sites. They are Lake Eacham, Lake Barrine, Mount Hypipamee National Park, Lake Tinaroo, Yungabbura historic village and Barron Falls gorge near Kuranda. These sites were chosen for two main reasons. First, they were more popular in the area than other destinations. Second, these sites had areas such as restaurants, picnic sites or viewing platforms where people would relax and therefore when approached most of them would be willing to take part in the survey.

To make sure each of the four versions with distinct sets of bid amounts was equally represented, the copies of each of the four versions were handed out alternately, regardless of socio-economic characteristics. This arrangement was designed to obtain unbiased WTP estimates.

In total, two teams of interviewers, who dressed in uniform shirts with Rainforest CRC or The University of Queensland logos printed on them, approached about 550 visitors during the survey period and collected 506 completed copies of questionnaire, of which 285 respondents were classified as tourists and the remainder as local residents. The response rate was sufficiently high to ignore the possiblility of non-response bias. It is notable that 18 respondents among the local residents were members of Trees for the Evelyn and Atherton Tablelands Inc. (TREAT), a local volunteer organisation that has carried out revegetation activities on the tablelands for more than 20 years.

FINDINGS OF THE PERCEPTION ANALYSIS

Respondents were required to list three features they considered the most attractive on the Tablelands. The first six features were picked up more often than others, although there were various other features mentioned. A summary of the results is presented in Table 2. It was found that both tourists and local residents saw the rainforest landscape as the most attractive feature of the tablelands.

Table 2: Most attractive features of the Atherton Tablelands.

Feature	Rainforest	Waterfalls	Lakes	Rolling hills	Wildlife	Crops
Tourists	157	74	94	113	59	33
Local residents	61	19	46	50	4	5
Total	218	91	140	163	63	38

Respondents were requested to rate how the establishment of hoop pine plantations on the Atherton Tablelands would affect their enjoyment of the current landscape. A 5-point Likert scale was adopted, with 1 representing a strongly negative effect and 5 being a highly positive effect. The results are presented in Table 3.

Table 3: The effect on aesthetic enjoyment of the Atherton Tablelands due to plantation establishment.

Rate	1	2	3	4	5	No response	Total
Tourists	40	35	82	75	47	6	285
Local residents	24	15	67	45	63	7	221
Total	**64**	**50**	**149**	**120**	**110**	**13**	**506**

The largest numbers of respondents assessed the effect of plantation establishment on their aesthetic enjoyment with ratings of 3 to 5. The rate of 3 is taken to indicate neutrality regarding the effect of tree plantation on the visitors' aesthetic enjoyment. A t-test was carried out to determine whether the establishment of plantations on the tablelands would not affect the visitors' enjoyment of the landscape. It was found that the sample mean rating does not differ from 3 at the 5% significance level, suggesting that the visitors' enjoyment would not be affected positively or negatively.

FINDINGS OF THE PAIRWISE COMPARISONS OF VEGETATION OPTIONS

To analyse the pairwise comparisons, the responses in each comparison was scaled over the range of 1 to 5, where 5 denotes the right-hand-side option is strongly preferred, 1 denotes the left-hand-side option is strongly preferred, and 3 means no strong preference between the two options compared. A summary of the pairwise comparison analysis is presented in Table 4. It was found that mixed rainforest plantation are the most preferred landscape scenario, given that this was always preferred when compared with any of the other three landscapes. Interestingly, the sample of tourists indicated they equally prefer the 'grazing land with plantation' option and the 'hoop-pine plantation' option. However, the local residents were found to prefer the 'hoop pine plantation' option to the 'grazing land with plantation' option, at the 5% significance level.

Table 4: A summary of pairwise comparisons of landscape scenarios.

Result of the pairwise comparisons	Sample mean	
	Tourists	Local residents
Degraded pasture land < Hope pine plantation	3.70	3.70
Hope pine plantation < Mixed rainforest plantation	4.24	4.35
Mixed rainforest plantation > Grazing land with plantation	2.35	2.43
Grazing land with plantation > Degraded pasture land	2.08	1.88
Grazing land with plantation > Hope pine plantation	2.99	2.58
Mixed rainforest plantation > Degraded pasture land	1.71	1.64

ESTIMATION OF MEAN WILLINGNESS-TO-PAY

Each respondent was asked if he or she were willing to pay a dollar amount and then a higher amount or a lower amount, depending on whether the response to the first bid with 'yes' or 'no'. Table 5 presents a summary of responses to the double-bound WTP questions. It was found that 181 (63.5%) of the tourists were willing to pay to support the establishment of hoop pine plantation on the southern Atherton Tablelands whereas 102 local residents (43%) were willing to pay for the same project.

Table 5: Summary of the responses to the willingness-to-pay questions to support the hoop pine project.

Visitor Type	Bid Amount			Frequency of the responses to the double-bound questions				Total
	1st	Lower	Higher	Yes-Yes	Yes-No	No-Yes	No-No	
Tourist	5	3	7	30	12	9	20	71
	10	5	15	19	17	15	22	73
	20	10	30	12	9	30	21	72
	40	30	50	10	7	11	41	69
Sub-total				71	45	65	104	285
Local resident	5	3	7	11	4	7	33	55
	10	5	15	24	4	4	23	55
	20	10	30	10	3	12	32	57
	40	30	50	14	1	8	31	54
Sub-total				59	12	31	119	221

The probability function associated with the single-bound dichotomous CVM is expressed as follows (Bennett and Carter 1993, Roe *et al*., 1996, Stevens *et al*. 2000):

$$P_i^Y = 1 \,/\, [1 + \exp[-(b_0 + b_1 Bid)]$$

where (b_0+b_1 *Bid*) represents the indirect utility function for an environmental improvement. For the double-bounded format, the following response probabilities are to be obtained for the logit model (Hanemann *et al*.1991):

$$(1)\ P_i^{YY} = \Pr(B_i^{Higher} \le \max WTP_i) = 1 \,/\, [1 + \exp[-(b_0 + b_1 B_i^{Higher})]$$

$$(2)\ \begin{aligned} P_i^{YN} &= \Pr(B_i \le \max WTP_i \le B_i^{Higher}) \\ &= \{1 \,/\, [1 + \exp(b_0 + b_1 B_i^{Higher})]\} - \{[1 \,/\, [1 + \exp(b_0 + b_1 B_i)]\} \end{aligned}$$

$$(3)\ \begin{aligned} P_i^{NY} &= \Pr(B_i^{Lower} \le \max WTP_i \le B_i) \\ &= \{1 \,/\, [1 + \exp(b_0 + b_1 B_i)]\} - \{1 \,/\, [1 + \exp(b_0 + b_1 B_i^{Lower})]\} \end{aligned}$$

$$(4)\ P_i^{NN} = \Pr(B_i^{Lower} > \max WTP_i) = 1 \,/\, [1 + \exp(b_0 + b_1 B_i^{Lower})]$$

In the logit model, the dependent variable is the probability that the individual is willing to pay for an environmental improvement, and 'Bid' is the only independent variable. However, nothing is theoretically wrong with adding socio-economic variables as independent variables if they are expected to influence the choice probability. The double-bounded log-likelihood function embracing the four components above can be estimated, using specialised computer software such as LIMDEP. The model coefficients were obtained as presented in Table 6.

Table 6: Coefficient estimates of the double-bound model.

Variable	Model	
	Tourists	**Local residents**
Constant	1.222 (7.124)	0.268 (1.625)
Bid	-0.088 (14.210)	-0.049 (8.564)
Mean WTP (A$)	13.82	5.53
Log-likelihood function	-407.819	-262.577
Observations	285	221

Note: The figures in the brackets are t-statistics.

The coefficient on 'Bid' is was negative and significantly different from zero. With logit models, the mean WTP is given by minus 1 times the intercept divided by the slope coefficient of the indirect utility function (Hanemann 1991), i.e. $-(b_0/b_1)$. If other independent variables are included in the mean WTP, the numerator is the sum of the estimated intercept (b_0) plus the product of the coefficients of the other independent variables times their respective means. The estimated mean WTP for hoop pine plantations on the Atherton Tablelands without any socio-economic variables was found to be $13.82 and $5.53 for tourists and the local residents respectively.

Reasons Why Some Respondents Were Unwilling to Contribute to the Plantation Project

The frequencies of various reasons why the respondents responded 'no' to both initial and lower bids presented to them are reported in Table 7. Both tourists and local residents pointed to the compulsory form of payment as one of major reasons why they did not like to contribute the hoop pine project, stating that government should pay or they had paid a lot of taxes. A low budget or lack of money was given as the major reason for some tourists not being willing to pay to support the hoop-pine plantation project. This means that the tourist respondents could have probably offered to pay if they had been presented with a lower bid amount. On the other hand, the largest number (26) of the local residents who rejected even the lower bid argued that they did not want to see hoop pine trees on the Atherton Tablelands, for various reasons. It should be noted that 6 out of this particular group of respondents were among the 18 TREAT members who participated in the survey.

Table 7: Frequency distribution of the reasons for negative responses to the lower bid amounts.

Reason for bid rejection	Frequency	
	Tourists	**Local residents**
'The Government should pay. I pay tax.'	19	16
'I don't like hoop pine.'	10	26
No money / low budget	27	18
'I come from overseas.'	10	1
Commercial / private benefits	14	9
Other	20	29
No response	4	20
Total	**104**	**119**

CONCLUDING COMMENTS

When survey respondents were asked which option they preferred between the hoop pine plantations and the grazing land with plantations, they revealed a slight preference to see the landscape with hoop pine plantations or were indifferent between the two option in terms of the landscape amenity provided. This may imply that the respondents may prefer the 'hoop pine plantation' option to the 'grazing land without plantation' option. This interpretation was supported by the responses to the question of whether they thought more trees would affect their enjoyment of the current landscape of the tablelands area. Further, the majority of the survey respondents interviewed was willing to pay to support the establishment of hoop pine plantations on the Atherton Tablelands.

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THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Rainforest CRC

VISITOR SURVEY, SOUTHERN ATHERTON TABLELANDS

This survey is being conducted by Dr Jungho Suh (School of Economics), Dr Edson Leite (School of Natural and Rural Systems Management) and Mr Robert Lwanga (School of Natural and Rural Systems Management), researchers from The University of Queensland. We would like your help. We need information about your perception of and attitudes towards the *visual landscape* of the southern Atherton Tablelands, which you see when you are driving through any part of the route of Yungaburra–Malanda–Milaa Milaa. Could you please take a little while to answer some of our questions? Your answers will be treated as confidential and used only for scientific purposes.

PLEASE TELL ME ABOUT YOUR TRIP

Q1. Where do you live?

☐ Queensland ☐ elsewhere in Australia ☐ overseas

Q2. Was this trip to the southern Atherton Tablelands undertaken as part of

☐ a vacation ☐ a business trip ☐ a visit to relatives or friends

☐ other (please specify)_____ ?

Q3. Is this trip to the Atherton Tablelands part of a longer trip?

☐ yes ☐ no

If yes, what other main destinations have you visited or do you intend to visit?

☐ Great Barrier Reef ☐ Daintree ☐ Kuranda

☐ others (Please specify) a)_____, b)_____,

Q4. How many previous visits have you made to the southern Atherton Tablelands? ☐ none ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ more than 4.

WHAT DO YOU THINK OF THE SOUTHERN ATHERTON TABLELANDS?

Q5. Do you find the southern Atherton Tablelands rural landscape similar to that in any other part of the world you have visited? ☐ yes ☐ no.
If yes, what areas? _____.

Q6. How does the natural attractiveness of the southern Atherton Tablelands compare to other landscapes that you have seen?

(1 = least beautiful; 5 = most beautiful)

1	2	3	4	5

Q7. What do you consider the most **ATTRACTIVE** features of the Atherton Tablelands landscape?

a)_____.

b)_____.

c)_____.

Q8. What features or qualities of the southern Atherton Tablelands **DETRACT** most from the satisfaction you derive from your trip?

a)_____.

b)_____.

c)_____.

Q9. Please rate the importance of the following characteristics in determining a beautiful rural landscape.

(1 = not important and 5 =very important)

	1	2	3	4	5
Open space					
Mixed rainforest trees					
Exotic trees					
Grazing animals					
Cropland					
Wildlife (birds and other animals)					

Q10. It has been suggested that more land on the Tablelands is suitable for tree plantations. How would more trees affect your enjoyment of the landscape? **(1 = very negative, 2, 3, 4, 5 =very positive).**

1	2	3	4	5

Q11. If you agree with the idea of planting more trees for future timber harvesting, where should more trees be planted?

☐ on the steeper land only ☐ on all land

Q12. Please indicate which of each pair of the two landscape scenarios below you prefer, by ticking one of circles in each row. Photographs are provided.

Strongly prefer ←			Neutral		→ Strongly prefer	
Degraded pasture land	○	○	○	○	○	**Hoop pine plantation**
Hoop pine plantation	○	○	○	○	○	**Mixed rainforest plantation**
Mixed rainforest plantation	○	○	○	○	○	**Grazing land with plantation**
Grazing land with plantation	○	○	○	○	○	**Degraded pasture land**
Grazing land with plantation	○	○	○	○	○	**Hoop pine plantation**
Mixed rainforest plantation	○	○	○	○	○	**Degraded pasture land**

LANDSCAPE VALUATION

The Atherton Tablelands was first cleared for dairying and cropping about 100 years ago. Over time, some of the land has deteriorated, with pastures replaced by poorer grasses and weeds. This land is well suited to growing trees.

It is proposed that an area of about 500 ha of degraded land on the southern Atherton Tablelands be planted to Hoop Pine (*Araucaria cunninghamii*) trees. This is an Australian native conifer tree species, grown in plantations by the Queensland Department of Primary Industries, which has high quality timber.

The Hoop Pine plantations would result in a permanent change in landscape appearance (with annual small areas logged after about 40 years and immediately replanted), and produce timber and provide wildlife habitat, watershed protection and carbon sequestration benefits.

It is hypothesized that the visitation cost to the area were to be increased per person, **through a supplementary accommodation charge** to be placed in a **Landscape Improvement Fund**.

Q13. Would you agree to an increase of **$5** in the accommodation charge per room per visit to the Atherton Tablelands and be willing to pay this amount when you visit north Queensland to support this project?

☐ yes

What if the cost to you turned out to be higher? Would you agree to an increase of **$7** in the accommodation charge per room per visit and be willing to pay this amount to support this project?

☐ yes ☐ no

☐ no

What if the cost to you turned out to be lower? Would you agree to an increase of **$3** in the accommodation charge per room per visit and be willing to pay this amount to support this project?

☐ yes ☐ no

Q14. (**Only if you ticked no-no in Q13**), why are you not willing to pay **$3** to support this project? Please print your answer briefly.

_____

_____

_____

Q15. Gender: ☐ M ☐ F

Q16. Age class:

☐ 20 or less ☐ 21–30 ☐ 31–40 ☐ 41–50 ☐ 51– 64 ☐ 65 or more

Q17. Highest level of formal education:

☐ primary ☐ secondary ☐ tertiary or trade.

Q18. Annual income before tax

☐ Less than $25,000 ☐ $25,000 to $50,000 ☐ $50,000 to $100,000

☐ more than $100,000

13. THE CRC FOR WOOD INNOVATIONS: WHAT'S IN IT FOR NORTH QUEENSLAND FOREST INDUSTRIES?

G. Hopewell and N. Wilkinson

The north Queensland timber resource includes native forest stands of high-density hardwoods (e.g. Cape York timbers), freehold areas of natural rainforest, commercial plantations of native and exotic conifers, sandalwood and more recently, private hardwood plantations. The planting of cabinet timbers and management of the native hardwood forests on appropriate sites in north Queensland has the potential to re-invigorate a local timber industry, potentially providing many benefits to the region. However, for landholders to remain encouraged and motivated to participate in tree planting and forest management for timber and veneer production they need assurance that the wood produced by their efforts and investment will be marketable upon harvest.

The Cooperative Research Centre for Wood Innovations is currently into its third year of operation, managing a range of programs aimed at developing techniques and equipment that will provide solutions to the inherent problems of wood quality, processing and performance in-service. Areas of research include: microwave technologies for growth stress relief, drying, preservation, and bending; enhancement of properties such as density, hardness and stability; and improved performance of surface coatings and adhesives. In addition to the microwave program, new engineering and design concepts are being investigated in the high value-added wood products program, alongside data capture of environmental conditions experienced during transportation to key export markets worldwide. Growers, processors and manufacturers of wood products in north Queensland should be encouraged that results from the work being undertaken at CRC Wood Innovations' nodes around Australia will help establish wood as the sustainable material of choice.

PAST UTILISATION OF NORTH QUEENSLAND TIMBER SPECIES

The forests of Queensland's north region have provided a diverse range of attractive and useful sawn-timber and veneer species for over 100 years. Timber getters and sawmillers were amongst the earliest white pioneers to explore the forests of north Queensland, as they moved further afield from the hoop pine and red cedar scrubs near settled areas in the south. The diversity of woods must have been overwhelming, and Government-employed researchers working with industry eventually found timber species that were suitable for all aspects of utility: building, engineering, plywood, furniture and cabinetry, coachbuilding, boatbuilding and other special purposes such as tool handles.

Over 80% of Queensland's listed commercial species occur in the forests and woodlands of north Queensland. These timbers were tested and appraised for properties and uses, and allocated into approximately 100 utilisation categories (see Appendix A). Some species were sold specifically into niche markets based on collaborative R&D efforts, for example northern silky oak (*Cardwelllia sublimis*) for furniture and window joinery; Queensland maple (*Flindersia brayleyana*) and Queensland walnut (*Endiandra palmerstonii*) for veneers, furniture and musical instruments, and Crow's ash (*Flindersia australis*) for squash court and dance hall floors.

With over 600 commercial species, many of which produced relatively large logs and high quality wood and veneer, the forest resources of north Queensland were supporting a vibrant industry of considerable importance to the region. By the late 1980s however, access to the traditional resource in north Queensland became severely restricted with World Heritage Listing of much of the public rainforests in the wet tropics.

PRESENT TIMBER UTILISATION ISSUES

The forest industry is still important in the region, with plantation pine (both native and exotic species) growing, processing and manufacturing industries and, on a smaller scale, rainforest cabinetwood, sandalwood and Cape York hardwood operations in existence. Researchers, landholders and community groups have been actively trialing and establishing hardwood plantations of a broad range of traditional native cabinet species and exotic species with the purpose of re-vegetating pastoral landscapes and establishing a commercial timber resource.

This period of plantation experimentation and establishment has coincided with a general reduction in availability of public base funds for research work. However, some projects have been undertaken, providing indications of plantation productivity and wood quality. Whilst these activities have been conducted, significant changes continue to occur on the global wood fibre production and marketing front.

Some key changes are:

- Plantation hardwoods are gaining market acceptance as more resource comes on stream, e.g. NSW Australia, Brazil and Argentina, producing eucalypt fibre for high-value appearance products;
- Innovation phase-engineered systems for flooring, decking and structural members are being developed and gaining market share, alongside traditional systems;
- China is rapidly becoming the furniture factory of the world, with offshore companies setting up high quality production facilities in China. Flooring system manufacturers are starting to follow the same trend;
- There is increasing consumer awareness of sustainable resource issues and emerging interest in eco-labelling and chain-of-custody requirements for consumers' conscience;
- Flow-on effects are creating more interest in packaging and use of recyclable materials;
- Consumers are demanding 'smarter' utilisation of forest resources and less wastage; and
- Plantation rates of growth provide optimism for growers but there are corresponding wood quality issues with negative attributes (including growth stress and distortion, higher proportion of juvenile wood, lower density and corresponding poorer mechanical properties, lack of colour or figure) that can reduce marketability.

It is often the case that candidate timber species suitable for planting on available or affordable land don't necessarily produce logs of the same size, nor wood of the same quality, that the timber industry and consumers have become used to. Smaller log sizes and fast-growth wood quality issues have implications for processors and current research programs are aligned to finding solutions to these.

THE STATE-OF-THE-ART IN WOOD TECHNOLOGY

Research providers have structured their programs and provision of services in the light of the rapidly changing wood fibre industry and in the midst of the current technological revolution. For example, in Queensland, DPI&F Forestry Research has four dedicated units within the Innovative Forest Products Program that cover the breadth of industry requirements for R&D, namely process development, wood quality, product development and product performance. In addition to traditional professions including foresters, wood technologists and chemists, a broader group of professionals and post-graduate students incorporating timber engineers and industrial designers are now employed in the research and development effort. Staff in these units also form the Queensland node of the Cooperative Research Centre (CRC) for Wood Innovations, which has its headquarters in Melbourne.

The CRC, now in its third year of operation, has stated objectives of:

- Developing new technologies to solve processing problems, primarily by researching and developing wood modification through microwaving;
- Producing innovative, engineered wood products that are competitive in the international marketplace, including the development of microwave-modified, resin-impregnated wood to provide stable, strong, durable products for high value-added markets;
- Significantly extending the potential of 'low grade' plantation-grown material;
- Developing and applying novel surface engineering of polymers to enhance the performance of coatings and adhesives;
- Developing bending technologies suitable for mass production of components;
- Developing optimal long-term performance criteria for wood products under the environmental conditions they will encounter throughout their life, including during shipping;
- Investigating process optimisation and development of high-efficiency production lines;
- Providing national leadership in research, innovation, education and training that can be accessed by all sectors of the industry, increasing the level of technical expertise, innovation and enterprise management; and
- Identifying industry needs for research and innovation into the future.

CURRENT WOOD TECHNOLOGY RESEARCH PROGRAMS

Microwave Processing

There are five key projects within the microwave-processing program. A synopsis of each is provided below:

1. Growth stress relief in fast-grown plantation hardwoods

Growth stresses are naturally occurring forces in living trees, whereby the core of the stem is in compression and the perimeter is in tension. When a tree is harvested and processed into sawn boards the stresses are released and the boards can subsequently distort, limiting the utility of the product. Generally, faster-grown wood contains higher levels of growth stress and is therefore more prone to distortion in the sawn product. Previous research has focused on selection of low stress individual trees for tree breeding programs, development of sawing patterns and equipment to mitigate the effects of growth stress, ring-barking prior to harvest, use of nail plates and other restraints to minimize end-splitting, and determination of appropriate log storage intervals between harvest and processing. Current research builds

on these processes, but through the CRC also includes microwaving logs after harvesting to reduce stresses.

2. Microwave modification to assist seasoning

Seasoning is the term applied to reducing the moisture content of wood to a level appropriate for its intended end-use. When trees are harvested and sawn, the wood material contains a high content of water, ranging from 20% for desert Acacias to over 200%[1] for plantation exotic pines, *Pinus* spp. and low density hardwoods like paulownia (*Paulownia* spp.). A combination of the variables of temperature and relative humidity provides an environment to which timber will attempt to equalize (equilibrium moisture content, EMC). This equalization of moisture content results in corresponding shrinkage (or swelling if dry timber is placed in a humid environment). Flooring, joinery and furniture timbers must be seasoned prior to machining and installation or assembly.

There is usually a reduction in the recoverable volume per unit of sawn wood due to degrade which occurs during the seasoning process. Research has previously investigated more efficient kilns and improved drying schedules in order to improve the quality of dried wood and improve the economics of drying. Some work has been done in regard to the design of low technology systems, such as solar kilns, suitable for smaller enterprises. The CRC is developing microwave conditioning as a pre-kilning process in order to accelerate drying and lower the levels of degrade associated with conventional kiln schedules.

Through CRC partnerships and consultancies, investigations into the accelerated drying of the major Australian hardwood species, as well as paulownia and Sitka spruce, are being undertaken. The CRC has established international collaborators for this project, including researchers in Sweden and the USA. An international patent application has been lodged for the microwave conditioning of sawn, green boards.

3. Microwave modification to assist preservation treatments

Sapwood is the zone of ‘living tissue’ forming an outer ring of wood inside the bark of trees. The sapwood of all timber species is non-durable and may perish if used in specific applications, such as ground contact or exposed to the weather. Further, the sapwood of some hardwood species is susceptible to attack by the ‘powder-post beetle’.

Removal of sapwood during conversion is often considered too wasteful, especially for species harvested at an age when a high proportion of the cross-section is comprised of sapwood. Preservatives and methods for their impregnation into timber products for protection against decay organisms and insect pests have been used safely and successfully for over 50 years. However, some commercial timbers are refractory to sapwood impregnation and the heartwood of many timbers is difficult to penetrate with preservatives using currently available technologies. Microwave modification has the potential to improve permeability of refractory species and allow for effective substitute processes and formulations, including online technologies.

4. Microwave modified solid wood

Not all wood produced from fast-grown plantation systems is of a quality suitable for traditional uses. Characteristics such as low density and hardness, low strength, and instability can result from high productivity plantations. A combination of these phenomena with the industry’s desire to utilise better logging residues has resulted in the rapid growth of composite wood products as a substitute material for traditional solid wood. Composites are

[1] Timber moisture content is expressed as a percentage of the oven-dry mass of wood substance.

rapidly gaining market share in major economies including as the USA, where plastic-wood products are becoming a popular and economical choice in applications such as cladding and decking.

The CRC has developed proprietary technology to impregnate microwave-expanded wood (*Torgvin*) with resin, compress it, cure the resin and produce a wood-resin composite product (*Vintorg*). The advantages of Vintorg over typical solid wood are improved stability, strength, hardness and durability. This may allow earlier harvesting ages, conferring the economic benefits of shorter rotations.

5. Fundamental properties of microwave energy and its influence on wood modification

The purpose of this project is to define the dielectric properties of green timber and determine the optimal frequencies for efficient modification of wood. The results will provide an understanding of how microwaves interact with wood and will establish a world-class knowledge base for microwave technology.

High Value-added Products

The program of high value-added product research consists of four project areas as described below:

1. Surface engineering

The unique characteristics of native Australian hardwoods such as their high density and attractive colourings, also present difficulties and challenges to manufacturers. The natural chemistry of the wood can affect the adhesion of glues, coatings and resins, leading to poor performance and failure of the product in service. The CRC is developing surface engineering concepts and equipment to enhance the adhesion and long-term retention of bondability. There is a wide-ranging demand for improvements in this field and the CRC has established collaborations with scientists in Germany, USA and the UK.

2. Innovative technologies in the design and manufacture of high value furniture and other products from microwave-modified wood.

To coincide with the development of microwave-modified wood, a team of CRC designers and engineers are considering innovative uses of the material. In addition, optimization of production systems for furniture manufacture is being investigated. Testing of components, design of household items, impregnation of wood with stains, and improved systems for CNC and sanding technologies are underway.

3. Innovative techniques in bending wood components

The use of bentwood offers a wider-range aesthetic consideration to furniture designers and significantly improves the recovery of timber for manufacture of curved components. There is high demand for improved technologies in bending, and the CRC is developing microwave processes as well as investigating traditional steam-bending methods with the objective of providing industry with a system of mass-producing bentwood components. The research includes mathematical modelling and design projects.

4. Development of high quality wood products for long-term service in a range of environmental conditions.

Wood 'moves' with changing environmental conditions, such as those encountered during shipping and when sold into different climate zones to where the product was manufactured. Wood can also deflect when under load. Research is being undertaken to determine the optimal parameters for maintaining high performance and quality during transportation and long-term use in a range of conditions. Shipping container conditions for all routes to major export markets are being monitored. Creep testing and stability testing of wood and modified wood is being conducted. The data generated by this research will be utilized to produce user-friendly tools for designers and manufacturers of high value export products.

OTHER PROGRAMS OF THE CRC WOOD INNOVATIONS

Program 3 of the CRC is the Commercialisation arm, where experts in intellectual property and licensing consider opportunities for commercialisation of processes and products, such as microwave pre-drying, resin impregnation for preservative treatment, bending technologies and new designs.

Program 4 is responsible for the Education, Training and Communication portfolio, which organises regular meetings, workshops, web and published material and assists with presentations for exhibitions and conferences.

CONCLUSION

The traditional timber resource, processing methods, products and markets have changed significantly over a relatively short timeframe. Processors are more frequently encountering smaller, faster-grown logs having different characteristics to traditional forest resource material. Governments and a wide cross-section of the industry have recognized the need to develop innovative processes and products to develop niche materials, processes and products. One result of this realization is the formation and continuing support for the CRC Wood Innovations, which promises to provide a variety of solutions and new technologies to assist the North Queensland forest industry.

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APPENDIX A

Timber Utilisation Categories for Queensland Timbers

(from DPI Forestry Research files)

Animal husbandry
Aircraft timbers
Aquaplanes
Artificial limbs
Bearings
Bentwood
Blinds
Boat building
Bobbins and shuttles
Boot and shoe trade
Bottle stoppers
Bridge construction
Broom handles
Brushware
Building
Carpenter's tools
Carving
Cases
Clothes pegs
Coach building
Coffins
Cooperage
Chemicals
Corestock
Cranes
Docks
Electrical purposes
Fancy articles
Fencing
Fisheries
Flooring
Fuel
Furniture
Hosiery boards
Insulation
Joinery
Ladders
Landscaping
Lock and canals
Marine hazards
Match making and match boxes
Meat chopping blocks
Military purposes
Mining
Motion picture industry
Musical
Noise barriers
Pallets
Parliament house fittings
Pattern making
Peel heads
Pencil woods
Picture frames
Playground equipment
Plasterer's floats
Plywood and veneers
Poles
Printing trade
Rulers, scales
Scaffold planks
Saddle trees
Sign boards
Skewers
Sleepers
Small dimension stock
Sports goods
Stamp strips
Shingles
Shingles and shakes
Survey pegs
Templates
Textile industry
Timber laminations
Timber paddles
Tobacco pipes
Tool handles
Tooth picks
Toys
Turnery
Walking sticks
Water cooling towers
Wharf timbers
Wheel barrows
Wood paving
Wood piles

14. DOMESTIC AND EXPORT MARKETING OF AURACARIA TIMBER

M. Cox

This article examines the need for a marketing approach to support the expansion of trade in Australian forest products. Opportunities available for trade in hoop pine (*Araucaria cunninghamii*), a Queensland species of timber, are examined. Markets within China and Japan are found to have substantial potential end product uses for this plantation timber.

INTRODUCTION

There is a need for greater involvement in the export trade in Australian timber due to increasing plantation output, greater potential returns in value-added product from overseas sales and in the case of Queensland because of a production surplus in the state for some varieties of timber. The Queensland forest industry faces surplus timber supplies from plantations and a sustainable supply of plantation timber by 2008 or beforehand. Export market development is needed, along with active trade promotion, to deal with these surpluses because the domestic market is one of mature demand. Domestic opportunities exist but face competition from New Zealand and other Australian timber supplies. In Queensland, the native conifer species hoop pine or araucaria – which has superior physical properties to the more widely grown exotic conifers – presents a challenging case for exporting. This paper first reviews acaucaria production of in Queensland, and the properties which make this a potentially valuable timber. Potential regional markets are then examined, with particular emphasis on China and Japan. Finally, the various types of value-added products and their market opportunities are reviewed.

HOOP PINE HISTORY, CHARACTERISTICS AND USES

One Queensland species of timber that demonstrates the necessity for export is *Araucaria cunninghamii*. This is more commonly known as hoop pine, and sometimes in the industry as araucaria or arakaria, and is a Queensland native species of that has been grown widely by the Queensland Department of Primary industries on Crown land plantations since the 1920s. Currently there are about 45,000 ha of plantation araucaria which makes up 26% of the plantation estate in Queensland (see Figure 1). This provided around 330,000 m^3 per annum in 1995 rising to 447,000 m^3 in 2004-05. It is an important resource for the state timber industry. The properties of araucaria include high strength to weight, a light colour with clear grain, easy workability, staining and sanding features and a non-tainting property which is useful for food handling. The timber gains its strength and fine texture from its longer and thinner fibres compared to other softwoods and the uniformity of its microstructure.

Araucaria has a wide variety of timber uses that reflect its properties. These include sawn and structural timber, veneer, mouldings, high quality furniture, musical instruments, aircraft propellers, plywood, flooring, edge glued panels and even food applications.

Araucaria has been sold in Queensland for the past 100 years as structural timber, for furniture use, for packing and other uses, due to the proximity of naturally grown and plantation timber to the domestic market and cost advantages, its ready availability and its ability to supply a number of end-uses. There has been little competition in the domestic market from interstate and overseas species since location and stumpage price for the timber supported local processors who supplied the Queensland market. The rise in

interstate and overseas competition in the past decade has meant major changes in the market.

Radiata pine from New Zealand has become a major competitor in the sawn timber and mouldings markets in Queensland due to its increased quality from improved silvicultural practices. Practices which have traditionally been followed with araucaria because of the high value it could obtain as an end-product in the domestic market, such as pruning to 5 m to reduce knots and kiln drying of timber for controlled strength rating, are now applied to radiate pine. This has depressed the price of A grade timber in the structural markets that araucaria normally supplied in Queensland. In addition to this trans-Tasman competition, other Australian states have growing supplies of radiata competing in the same Queensland markets. The state government provided the araucaria industry with stumpage price support equal to 25% over two years to help reposition the industry in the face of these structural changes in competition. They have also provided the impetus to examine overseas markets for hoop pine products.

Araucaria is a high quality timber that is more expensive to grow than radiata pine and its overall value in the market has been influenced by the top end of its product range in A or White grade lumber. Competition has eroded the traditional hoop pine markets and attempts to compete with radiata in lower-value end-uses such as mouldings have meant a reduction in prices which cannot be sustained against more efficient low-cost producers of a short-rotation species and lower quality product . Araucaria processors need to look elsewhere for markets where the specific properties of araucaria can be valued and higher prices paid for those properties.

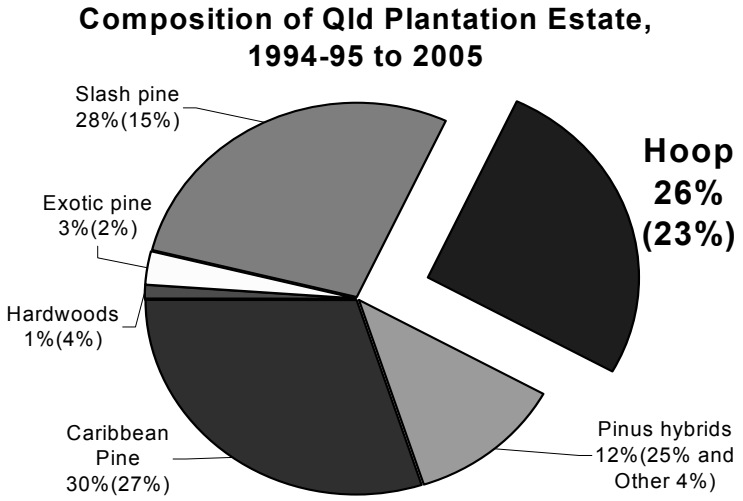

Figure 1: Composition of Queensland plantation estate
Note: Figures in parentheses are percentage shares in 2005.

It could be argued that New Zealand markets have already shown the way forward for Queensland araucaria processors who have a similar need to export. At the 1998 NAFI conference, David Stanley identified some key strategic moves of radiata processors in New Zealand in their efforts to add value to their product. In his address he identified Carter Holt Harvey (CHH), a major timber processor in New Zealand, which is 'focused on production of higher value end uses. The manufacture of mouldings, solid and finger jointed components, furniture and door jambs for export and… production of joinery and dimensioned timber to specific market requirements.'

Queensland producers are moving to create value-added outputs that can take advantage of araucaria properties and provide a viable export product. They have invested in finger-jointed timber product and edge-glued panel product and are open to new uses of the timber such as solid and composite flooring uses. They are entering into industry cooperative arrangements, have created an industry organisation called Araucaria Australia Group (AAG, now ceased operation) and are continuing to seek markets outside Australia to enter and compete in with new products. This has included industry tours of prospective markets in China and Japan.

POTENTIAL REGIONAL MARKETS FOR ARAUCARIA TIMBER

Two markets in the east Asian region that have the greatest potential for trade in timber products from Queensland processors are China and Japan. The high prices for timber product received in Japan and the rapid increase in imports by China are clear enough reasons to examine these markets. The proximity of both markets and consequent short delivery times (three week turnaround from orders to delivery are possible with 10 to 18 day sailing times), provide further incentive to investigate them. Low freight rates which build upon established trading relationships add to their potential (these depend upon volume of freight and benefit from group-negotiated prices). In addition, there are much larger differentiated markets in both these countries that can absorb value-added product in excess of Australian domestic demand. Finally, external markets can act as both a buffer for slack periods of domestic demand and as an indicator of upper limits of price potential in the domestic market.

Table 1: Impediments to small-scale timber exporter.

Impediment	Export issues	Possible solutions
Supply uncertainty	Multiple planting rationales, small and scattered woodlots, weather variability for small-scale plantings, management variability.	Industrial or cooperative lease and joint venture arrangements with export markets targeted.
Non-price issues	Variable quality, lack of recognised grade system for mixed species, no brand recognition	Development of uniform standards and accreditation; log standards established by AFFA
Lack of export experience	Compliance costs for solitary exporter are high.	Education through cooperatives, trade tours, case study examples, eBusiness solutions.
Lack of species recognition	Mixed species plantings for microclimate reasons; buyer uncertainty over material handling and processing.	Regional timber cooperatives creating awareness such as the US Western Woods Association, eBusiness solutions.
High transport costs	Distance to processors, to ports, road system small	Industry alliances, agents and cooperative contracts to control costs.
Need for government support	Entry into new markets, trade support with agents, insurance, banking and finance.	Recognition of the small-scale sector as worthy of trade support.
Long intrastate distances	Proximity to processors and ports, and obtaining appropriate land for accessible plantings.	Higher value to volume products.

The size of araucaria timber processors and growers is relatively small by world softwood standards and they face the impediments noted in Table 1 to any export attempts with a species that is unique to one state in a small country like Australia. Typically, timber cooperatives and agents have been proposed as solutions to small grower problems in export marketing attempts (see Table 2). Another way of assisting export marketing attempts for auracaria that was successfully implemented by AAG was to position its price according to similar products and this was achieved by matching its price to Agathis tree species, which have similar timber properties, and which are recognised and sold in the Japanese market.

ARAUCARIA EXPORT OPPORTUNITIES IN THE CHINESE TIMBER MARKET

The Chinese timber market supply has been influenced by the Natural Forest Protection program which has driven an increase in involvement in international trade. China's apparent domestic consumption of lumber in 1997 was 93 M m^3, with 55 M m^3 domestically produced and 15 M m^3 exported. The projections at that time were that the logging bans in selected areas would create a domestic undersupply of 15 M m^3 per annum which is about a quarter of China's annual demand. Estimates of timber needs were 110 M m^3 in 2000 with a domestic supply of 65 M m^3. This shortfall provides opportunities for trade in this market.

Timber demand by Chinese consumers is reflected in the projections provided by the Ninth National five-year plan of the Chinese government. This plan provided that the size of an average urban dwelling should be 9 m^2 per capita by 2000. This required construction of 1.25 billion square metres to house a predicted population of 1.3 billion people after 2000. The Chinese Ministry of Construction emphasised seven priorities for the housing market of which four are relevant to timber producers such as Queensland araucaria exporters. These are kitchen and bathroom facilities, lightweight and flexible room and wall partitions, high quality doors and windows, and insulating and indoor decorating materials.

The potential for trade of these product types was explored in a trade tour of southern and northern China and of Japan in July 1999 by the AAG group. The markets of southern China have expanded rapidly and demonstrate many joint ventures with Taiwanese companies in the south. In the north, Japanese and Malaysian companies using low-priced Chinese labour add value to timber with joint venture or franchised enterprises. The size and significance of the general market is realised when the Lechong wholesale furniture market of Guangdong is described. It is arguably the largest wholesale furniture market in the world, and certainly the largest in China. It stretches for 10 km on both sides of a six lane road and individual shops reach back two city blocks. It services much of the Chinese furniture market.

ARAUCARIA EXPORT OPPORTUNITIES IN THE JAPANESE TIMBER MARKET

Timber markets in Japan are more developed in market structure and more open to value-added product than those in China. Higher incomes and more exacting customers require a more sophisticated product and market approach. Japan has 67% forest cover but has tightly controlled harvesting of its timber resource. The market imports timber resources in log or lumber form and adds value to it domestically, as well as importing logs, lumber and finished product it has an interest in through joint ventures and in some cases outright control in other markets.

The relative size of the Japanese market can be understood when dollar comparisons are made. In Osaka, capital of the Kansai region, the furniture industry alone was worth approximately $A100 billion in 1998 while the total value of the Australian industry was worth $A1.2 billion. Japanese labour costs are considerably higher than in other international

timber markets. This leads to large expenditures on capital equipment to contain costs and meet appropriate price requirements for different supply needs in the Japanese market.

The Japanese timber market is also highly structured and relies on agents and a network of distribution channels that are sometimes seen as too rigid for modern business practices. Full entry into this mature market structure would take more time than the relatively younger and more open international market of China. The diversity and value of the Japanese market for timber makes it a prime market for export development, but one that requires sustained commitment for any new entrant to achieve a long-term presence. This means an involvement with the *keiretsu* network of company distribution and obligations. The fact that there now is a sustainable supply of araucaria could allow time for this to develop. The potential for export viability is explored in Table 2 and discussed in the next section.

Table 2: Possible small-scale output products and export viability.

Alternative small-scale outputs	Representative product options	Export viability
Pulp fibre	Pulp, MDF, OSB.	Mainly industrial processors have the volume of supply and value chain links for these lower-value wood products to be successfully exported. For farm forestry these products are limited to domestic markets due to their low value-added nature.
Small roundlog (First thinning)	Pulpwood, domestic market stakes.	
Medium roundlog (Second thinning)	Pulpwood, poles, fencing, firewood.	
Low grade sawlog (Not kiln dried)	Pulpwood, firewood, poles and posts.	
High-grade sawlog (for kiln drying)	Veneer output, flooring, lumber.	Small-scale export potential with the use of timber cooperatives and agents.
Engineered products	Finger-jointed short clears, laminated beams and panels.	
Non-timber products	Honey, native oils, woodturning craft items, bush medicines, perfumes, flowers.	

END-PRODUCT VALUE-ADDED MARKETS FOR ARAUCARIA TIMBER

Common end products markets that can be identified and are potential markets for export trade in Japan and China with auracaria timber products can be listed as follows:

- Furniture;
- Joinery and mouldings;
- Toy and gift products;
- Flooring; and
- Veneer, plywood and panelling.

In the Chinese and Japanese markets, furniture products typically use hardwoods and favour hardness and grain. Timbers such as oak, beech and maple are commonly used as solid woods in upmarket furniture, and composites in lower-value markets with the use of veneers, blackboard, ply and MDF to create furniture output. Araucaria's strength is a feature when matched with its lightness but its relative softness as a timber in the market for high quality

furniture makes it difficult to market effectively. The traditional styles of the Chinese market and hotel fit-out uses require reasonably heavy and hardfaced timbers in the upper end of the market. Furniture makers need sorted, precision-cut timber lengths for frame and carcase construction and this is a likely outlet with high returns. Prices of $A800/m^3 are achievable. Araucaria may be more suitable for Scandanavian-style furniture in a Japanese market than in the Chinese market. Low quality furniture markets are not a viable entry point, because plastic and even paper veneers are commonly used to finish products with the appearance of a higher value product. The composite low quality and low priced timbers used also indicate less potential at this end of the market.

Joinery and mouldings are a market where the size limitations of B grade lumber can be exploited. Short clears with no knots ranging between 70 cm and 120 cm but up to 2 m can be used in the door and window frame markets. This uses the natural internodal distances of the raw timber to provide a timber product in the form of a commodity. This would position the supply in a higher-priced end of the market. It would be in the form of a commodity (for example No. 1 clears of 25 mm x 50 mm x 1 m length) rather than a general supply of a range of raw product. The door market in Japan is a valuable and likely market for a lightweight strong timber and illustrates the demand for set component lengths that is well suited to araucaria timber. It has traditionally been used in the Queensland market for the same purpose. This appears to have potential for trade. The mouldings market ranges from cornices and skirting boards to picture frame manufacturers. In many cases in China the timbers used are of lower value and treated to achieve a higher appearance value by painting or plastic coatings, especially in the picture frame market. The lower value and ready supply of timber such as radiata pine precludes hoop pine from significant potential.

Toy and gift products are common in factories in southern China. In the case of toys, high quality solid wood and plywood are often used in the production process due to safety considerations. Weight can also be seen as a safety factor. A visit by the AAG to a southern China factory, ‘Jetson International’ which was producing ‘Thomas the Tank Engine’ toys under American license, revealed that beech was specified by the US client. For gift products, low-value woods are often treated with high-value finishing techniques, such as lacquering, to achieve an appearance of value. A potential exists for use of araucaria in these markets, but they would be low-value markets using general products because the use of composite materials is common, with finishing techniques designed to disguise timber features rather than benefit from them.

Flooring has a major market in China and Japan and one that is experiencing a high and growing demand in both countries. The range of flooring products extends from composite timbers to from solid timber hardwoods of high value which are pre-finished and show good grain characteristics mostly dark in colour. Solid timber has been the traditional flooring in Queensland but new panel products are entering the market using high quality face veneers that are tongue and grooved and end-matched. Composite flooring products of this sort are more common in Japan and quite sophisticated. Solid billets of laminated lumber are sliced to create a tiled timber look that is then glued to an MDF, timber or plywood base to provide flooring and stair-tread products. The lighter colour and softness of araucaria is a potential market barrier but the short lengths used are an advantage for the seller in this market. Improved surface hardening techniques for araucaria would make it more acceptable to users in this market.

Veneer, plywood and panel products provide a good market opportunity for araucaria processors. The common use of veneers in both China and Japan to create a solid-face timber product or engineered timber bases that are veneered is a feature of these markets. The use of rotary and sliced veneers can be observed commonly in Chinese factories, but sliced veneers seem the more accepted in Japan. Araucaria has a characterless grain that can be seen as beneficial or problematic in the market. In Japan, much of the veneer is

quarter sawn and sliced to obtain the greatest figure from the timber and this is one possible solution for the use araucaria timber. The most encouraging market for araucaria lies in edge glued panel (EGP). This is a random length and width product that takes advantage of both value-adding in the domestic market and the short lengths available in middle grade araucaria timber. With high quality finishing it stands out as the end product with greatest potential. Prices of above $A1000/m^3 are common for spruce, a comparable timber in these markets, and illustrate the potential for this use of araucaria.

CONCLUSIONS

Araucaria is a Queensland timber that has potential sound export prospects. The Chinese and Japanese markets provide a range of opportunities for value-added timber products to be exported and moves by the industry processors have indicated their willingness to enter into international trade and to add value to their domestic product. The end-product markets for greatest potential returns are not clearly defined given that value-adding costs and export supply are dependent upon volume and specific product demand. What is most likely is that various precision-docked lengths of timber for the market, edge-glued panel with its random length and width potential and flooring markets could be targeted in both Chinese and Japanese markets as the end products with greatest chance of export success.

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15. INTEGRATING SOCIAL ANALYSIS AND PARTICIPATORY PLANNING PROCESSES FOR ASSESSMENT AND DESIGN OF FOREST OPTIONS

H. Ross

A broad review is provided of the objectives and methods of social analysis, as they apply to forestry impacts in a region such as north Queensland. This has been designed to introduce the diverse group of workshop delegates to this field. The paper sketches how social analysis can play an important role in planning for sustainable forestry, both existing or in the creation of new plantations or farm forestry, in assessing the impacts of forest and plantation options and informing forestry negotiations. The paper then refers to issues in participatory regional processes witnessed throughout Australia. Regional stakeholder-based processes are becoming highly important for forest decision making, for instance through the Regional Forest Agreement making process of the 1990s, and the Natural Heritage Trust bodies and other regional processes created since 2000.

INTRODUCTION

This paper explains the meaning of 'social analysis', and the relevance of this body of theory and methods to the planning of forest industry development. In this brief overview, it is only possible to offer a general approach to this wide and interdisciplinary field, suited to a readership with diverse backgrounds and interests and varying knowledge of social analysis.

The paper seeks to explain what social analysis can bring to the types of issues which need to be considered in terms of developing future forestry, and the landscapes and communities that relate to futures in forestry. The paper will:

1. Sketch how social analysis can play an important role in:
   - planning for sustainable forestry, both existing or in the creation of new plantations or farm forestry;
   - assessing the impacts of forest and plantation options; and
   - informing forestry negotiations.

2. Discuss issues in participatory regional processes. Regional stakeholder-based processes are becoming highly important to forest decision-making, as they are in catchments and other sectors. This section draws on experience of the author in relation to integrated catchment management; and

3. Explain the relationship between social assessment and public participation, and how these can be integrated. An attempt is made to integrate the analytical issues and the participatory issues.

It is necessary to *integrate* social analysis with economic and ecological analysis, so that these considerations can be brought together towards generating or assessing options and opportunities for plantation development. The paper by Maczkowiack provides an example in this volume.

'Social analysis' is a broad lay term, referring to any form of analysis of social processes. Practitioners more often use the terms 'social impact assessment' or 'social assessment', which in turn can be understood in two ways. Some think of these terms as having exactly the same meaning (some academics and consultants thought 'social impact assessment' dwelt too much on negative impacts at the expense of the positive, so coined 'social assessment' to offer a different term). Others use 'social assessment' in a broader way, to include other forms of social analysis that might not be social *impact* assessment. In this paper I use the term 'social analysis' synonymously with the broadest sense of 'social assessment'.

THE NATURE OF SOCIAL ANALYSIS

Profiling – Describing the Present

Social analysis, or social assessment, is set of procedures, not a single approach by any means. It comes from several different disciplines and draws on many different techniques for understanding the social dimensions of a situation or of a change process. One can use social analysis to present snapshots, situation analyses or 'profiles', usually focused on the present situation. One may also focus on a change process, taking historical trajectories and future projections, for instance using demographic trends and projections for planning processes. *Profiling* is one important technique, the foundational step in planning and highly useful towards other ends, in the creative use of profiling towards exploring for future possibilities. In social impact assessment, a common form of social analysis, one aims to present a 'baseline situation', against which changes can be monitored into the future. The baseline is also used for forecasting through examination of scenarios – how does a set of possible future scenarios arising from an intervention such as a new forestry regime differ from the baseline?

Prediction and Retrospect

Social analysis can be used in predictive ways, to try to forecast changes arising from a proposed project, policy or plan. The analyst can know the present situation, and describe it in a profile of the community or region. It is important to understand the nature of the intervention that is being analyzed, for instance the introduction of plantation forestry, or cessation of old growth forest logging, in a region. Putting those together, what happens? Clearly, the outcome will not be the same in every community and region, because the 'host' locations have different social and economic as well as biophysical characteristics. Two communities can react quite differently to much the same intervention. There are theories and conceptual models to explain what features of communities make this difference (Ross and McGee in press), but prediction is necessarily difficult and imprecise given the complexity of communities, an imperfect understanding of causal relationships, and the contributions of public participation and the handling of the intervention to the outcome.

Social analysis can also be used retrospectively to examine what social impacts actually occurred from a past intervention. Monitoring and evaluation are highly important for all of learning, and for adaptive management, but are relatively rarely practised in social assessment. It is necessary to understand what has happened in the past, in order to improve predictions for analogous situations. Considering how a community has reacted to past situations, even those of a different kind, can assist in predicting their future responses. Similarly, examining analogous situations, where other communities have faced similar interventions, can be especially useful where such information is available.

Scales and Contributing Disciplines

Social analysis can focus on various social and geographical scales. One of the challenges is integrating between those scales – how does one link conceptually between impacts on regions (often taken from aggregated data), and impacts on communities and individuals? Aggregated economic benefits for a region do not necessarily mean that every community, and every individual, will receive positive benefits. Moving to participatory processes which can be associated with social assessment, how can one link a regional level of decision-making with landholders' decision making? To take a forest example, a regional organization may decide to pursue a forestry option for economic or environmental reasons, but this does not guarantee that individual landholders will decide to become involved.

In social analysis, it is necessary to think simultaneously about individuals, groups, sectors, communities, and broad societies and their cultures. This entails drawing on a range of different disciplines. *Psychology* focuses on the individual or even the parts of the individual (their attitudes, values or beliefs), and also behaviour in small groups. Sociology scales up from a micro-scale shared with Psychology, of small groups, to macro-dimensions of society. At the macro scale it produces theory and analyses on major change processes such as conflict, power relations and broad-scale social structures. *Anthropology* covers somewhat similar scales to *Sociology*, but focuses on culture, and different societal attributes such as religion and kinship. Anthropology tends to be more holistic and integrative than Sociology or Psychology, aiming to understand the whole society within its environment. Another related contributing discipline is *Demography*, which is highly important in considering population structures and change, and the influences these have on the viability of social services. Political dimensions are important in social analysis, but practitioners tend to draw on Sociology more than on Political Science for this understanding. History is important for a time scale – understanding the present and future through the past.

Uses of Social Analysis

Forms of social analysis are fundamental to planning, social impact assessment, and community development. A profiling step is a recommended, and shared, starting point in each of these fields. As described above in relation to social impact assessment, a profile or description of the baseline situation enables consideration of alternate futures. The same holds in planning. In community development, the profile is developed in either of two ways. A facilitator arriving in the community needs to understand it in order to work with it, and so may develop his or her own profile of the community as a first step in their assessment. Because community development involves a learning journey for the community, many facilitators encourage the community to develop its own profile, as a community learning tool. What are the good and bad attributes of the present situation, and what do they want to work together to improve? Baseline information is thus of common interest across these fields, as is the related ability to assess alternative scenarios.

Social Assessment and Public Participation

A common point of confusion in social impact assessment is where SIA and public participation (now often referred to as 'community engagement') are distinguished, if at all. Some people wonder if one needs social impact assessment, if one has a public participation process.

The view taken by the author, with collaborator Kristi Branch, is that in social analysis, one focuses on *analysis*, trying to understand social change from a dispassionate point of view. (The terms 'objective' and 'subjective' are avoided here, because many social scientists recognize that everything people do is 'subjective' to some degree). In analysis one takes the dispassionate view of a third party looking in, trying to be as equitable as possible, seeking to

understand as fully as possible what is going on. Public participation has different roles, to elicit from the public their views of a proposed intervention and their local knowledge, and to allow the public a 'say' in the way the process unfolds. Public participation is a highly important process, as well as an important source of information for the social analysis, but on its own it does not produce the analysis required.

This said, and depending on the purpose of one's study, one has choices as to how far to stand back and focus strongly on the analytical, and how far to become engaged in unfolding the process, for instance through advocacy for a particular outcome, or through a community development process that assists communities to take charge of shaping their outcomes. Many social assessment practitioners legitimately choose not to stand back and report on what is likely to happen, but to become involved with people and help them to understand what is happening themselves, and to be part of making their own futures. These are the more strongly participatory approaches. They are not strict alternatives. One can combine them creatively, for instance by taking a dispassionate analysis as a first step then sharing the learnings with the community and supporting a change-management process.

Examples of Social Analysis in Australian Forestry

One of many innovations in the national Regional Forest Agreement process in the 1990s was by creative research teams based around the then Commonwealth Department of Primary Industries and Energy – now Agriculture, Forestry and Fisheries Australia (AFFA) – which created a social assessment unit. Unit head Sheri Coates, with consultant Mark Fenton (Coakes and Fenton 2001), developed a technique called 'Town Resource Cluster Analysis' that Fenton has since gone on to apply in fisheries (Fenton and Marshall 2001). In essence, this is a sophisticated use of profiling that goes well beyond that used in social impact assessment. It quantifies and maps financial and consumption links between forest areas and particular communities, showing distributional effects of changes in forest practices.

This approach may be illustrated by considering a hypothetical location. The RFA process was considering the future for existing forests – should they remain in production, should they be conserved, or both in some combination? Imagine a forest where there is some commercial activity. Each forest industry, whether logging or even bee-keeping, is based in one or more small or larger settlements. The employees may not all live in the same town; they may live in several places. For each forest activity it is possible to examine where it is based, and where both the industry and its employees and their families make their usual purchases. This includes equipment and supplies for the industry, and the employees doing their household shopping. So which small retail businesses are tied in economically, in a kind of supply chain? Also, *where* are the people consuming? Where are the children sent to school? In essence, where are the funds earnt from the forest activity actually spent? Where are the populations employed in the forest industry drawing their necessities?

This type of analysis shows that not all social and economic activity is happening where the forest is. There is a flow of goods and services, with economic and social effects, forming a chain reaction between smaller and larger towns. If employees move out of a declining industry, what happens to the number of classes in that township's school, as a simplistic example? Town resource cluster analysis shows that when one changes the forest activities in one place, the impacts are actually felt to varying degrees in some surprisingly different places. The analysis traces the nature of the linkages, and the extent of impact in different places. It progresses from what is happening in the forest, to the small town, to the regional centre.

Another type of social analysis (which will not be expanded here because it is broadly familiar internationally and probably much more practised overseas than in Australia), is

community development approaches with forest-using communities. Common foci are understanding links between a community or culture and forests, such as common property systems, and empowering communities to manage these lands more effectively or to negotiate with their national governments to retain use and management rights.

METHODS OF SOCIAL ANALYSIS

Many basic approaches to social analysis are described in textbooks, such as Burdge (1998) and Taylor *et. al.* (1995). The perspective adopted here, shared by a number of others, is that a capability needs to be developed to integrate the social with the economic and ecological dimensions. A failing of some social impact assessment theory is the neglect of the biophysical environment, and the nature of people-environment relationships. The most promising way to achieve this, is to understand *systems*. It is critical to understand what influences what. If people change their behaviour, what happens somewhere else in the system, as the town cluster analysis shows? To understand the system, it is necessary to understand that many people have multiple choices, as Maczkowiack (these proceedings) illustrates.

The SIA scoping study of the likely impacts of introducing environmental flows in the River Murray (Hassall and Assoc., Ross and Maher 2003) introduced a tool for mapping systemic effects from individual choices, which was called 'influence diagrams' (see Figure 1). Figure 1 traces a sequence of choices and aggregations of sets of people's choices, in two directions. At the top of the diagram is the consequences of more water remaining in a river when irrigation is reduced to increase 'environmental flows' (a term for allocating specific amounts of water to the river for environmental purposes). At the bottom of the diagram is the set of choices faced by landholders, which when aggregated across many landholders produce varying possible effects in rural areas and on other businesses and towns. If an irrigator has less water, what choices do they face immediately on the farm? They can stop farming, sell up and leave agriculture. They can buy the neighbour's farm and expand their enterprise, they can grow a crop that needs less water, or they can go into debt to buy more water. At this very point each irrigator has multiple choices. Which choice each makes depends on individual characteristics which may be visible in the region's social profile – the age and life stage of farmers, their financial capacity, their degrees of entrepreneurship. Conceptually, one can then aggregate their individual choices. Perhaps there will be a situation of half the farmers leaving farming (but going where, to the nearest small town or far away?), and the other half buying the land which is released, so that there are half as many farmers and families, but each owning twice as much land (and for a while at least, carrying additional debt). Note that both parts of the influence diagram (resulting from reduced irrigation water and from having more water in the river) produce employment effects, affecting small business viability and economic decline and recovery.

From this situation, one can examine the supply chain implications for towns, and for businesses. Does having fewer families remaining in farming reduce the viability of the bank, the school, and the local stores? Or do the larger farms need – and reach the ability to afford after clearing their purchasing debts – more employees to achieve the work? Will there be time lags, with a period of heavy debts resulting in low employment, followed by delayed recruitment after debts are cleared? While trends can be guessed at, the many possible variants in restructuring of regions are difficult to predict because at any one of the staging points in the influence diagram, so many people have so many multiple choices. The combined outcome really could move in several possible directions. Understanding the system therefore really relies on understanding that people have multiple choices: strong profiling is necessary to understand the nature of individuals and how they make these choices. Obviously, it is not necessary to predict every individual's choices. In planning or social impact assessment, it is necessary to know about the cumulative impacts or cumulative effects – will there be major landscape, social and economic change, and if so in

what form? Social impact assessment may be viewed as akin to risk assessment. It is not possible to predict exactly what will happen, but the main risks can be identified and addressed.

PARTICIPATORY APPROACHES

Following this rapid synopsis of the analytical aspects of social assessment, it is now possible to offer a few comments about participatory processes to show these can be combined with social analysis. One of the interesting developments internationally is the ways in which participatory approaches have been adopted to sit alongside representative democracy. The public is no longer happy to trust elected representatives to make all decisions on all issues. Under representative democracy a very few people are expected to represent a multitude of interests, where these interests can be in conflict. Participatory processes enable the public to engage more directly with particular issues, often in greater depth. Some processes exist for consultation, to advise members of government (directly or indirectly through their departments) within the representative democracy process. Other participatory processes entail delegated decision-making or quite strong advisory powers. These provide a way of dealing with complexities of interests around particular issues, in considerable depth.

Participatory approaches complement and contribute to social assessment by allowing the public a direct voice in a decision-making process, and by contributing information and viewpoints that assist the social assessment. These approaches are often stakeholder-based to ensure all important stakeholders that are relevant to an issue are identified and considered. This includes Indigenous peoples who are not often seen as traditional participants in some sectors.

One of the challenges in participatory approaches is choosing appropriate approaches, which can include working between scales. Ross *et. al*. (2002) offer a typology of types of public participation in Australia. One type is composite stakeholder-based bodies, usually used at a regional scale. Here a management structure is deliberately composed of agency, industry, and community-based stakeholders to co-ordinate or influence management over a defined area which is not under the direct control of any one of the parties (e.g. a catchment under mixed land ownership). But how do such bodies engage with the local level of constituencies who are actually influencing change on the ground, such as landcare groups and individual landholders of all different descriptions? This creates a nesting challenge between these scales and types of participation. How should the regional group be composed and operate, and how can processes be created to link their decision making with all relevant local activities? Regional bodies created under the Natural Heritage Trust 2 and National Action Plan for Salinity and Water Quality are currently addressing such challenges.

A national study of integrated catchment management for the Murray Darling Basin Commission (Bellamy *et al*. 2002) has argued that there is no single ‘best practice’ – arrangements need to suit their *contexts*. The participatory arrangements require suitable governance *structures*, coupled with strong and well-accepted *processes*. Further, in order to make informed decisions, the bodies need access to *knowledge* in the form of sound, trusted, reliable information. Without a focus on informed decision-making, and agreement as to the forms of information to be used, the bodies can spend a disproportionate amount of energy in interest-based bargaining which may or may not result in useful decisions. Integrated resource management thus entails *analytical* aspects provided through knowledge, and the *participatory* aspect of working through effective structures and processes.

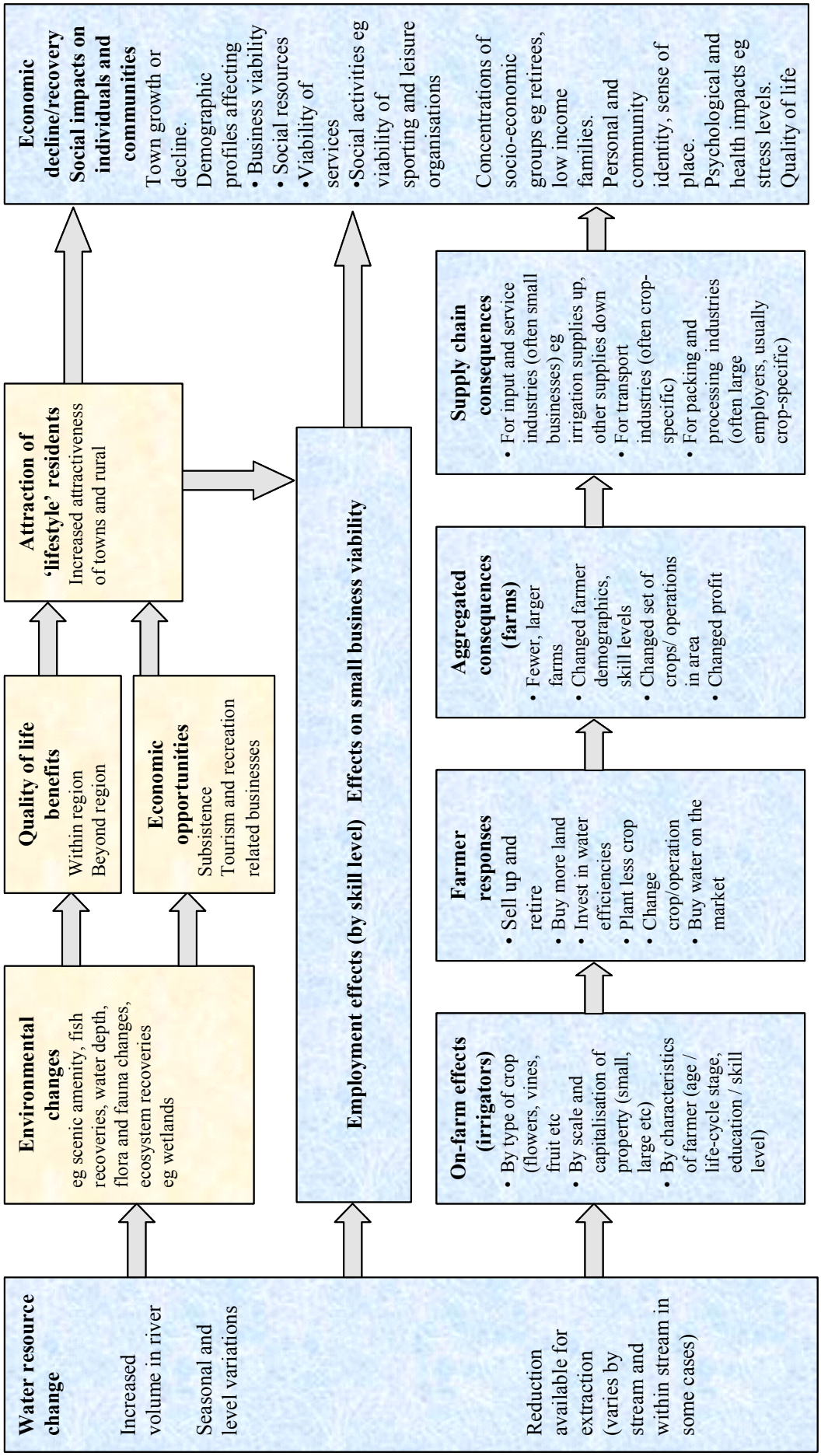

Figure 1: Influence diagram used for social and economic impacts of environmental flows.

*Source: Hassall and Associates, Helen Ross and Mary Maher and Associates (2003)

The linking of participatory with analytical processes in social assessment enables parties to share the *judgement calls*. This expression is used deliberately because most decisions, do, in fact, have strong value bases. Different people hold different perspectives on any issue, and there are social justice issues in enabling all to have a say, and in that decisions often have different distributional effects (winners and losers). Equity therefore becomes important, in both processes and outcomes. Balancing power relations, and assisting groups with widely differing levels of power to work together, is particularly challenging. The knowledge aspects are intertwined, in that broad participation entails bringing in different sets of knowledge and experience and perspectives, all of which are informative. Scientists only have one slice of the knowledge; other forms of knowledge, including traditional knowledge, observational knowledge and experience also play important roles. Ideally, a collaborative decision-making process is like a negotiation process, working towards creating better options for mutual gain (Fisher and Ury 1981).

With regard to forestry, there is a need for generating an equitably shared capability so that State and regional forest and plantation planning approaches share the process of decision-making for forestry options. It is important to be able to tell how a set of options affects the environment (natural and modified) to create landscape change, then how these options and landscape changes lead to economic impacts and opportunities, and social impacts including distributional impacts. The social analyst wants to know things like 'How will local society alter?' and 'how do the locals view that change – i.e. positively or negatively? Often communities are divided, some for and some against an option. It is necessary to consider such issues as changes in the population size and demographic composition, and their effects. Would population loss jeopardise services or the number of volunteers to keep voluntary organizations viable? Social dynamics are highly important to people. Will the area remain a pleasant place to live, or will social dynamics and local culture be affected by needing to absorb a large number of newcomers or by losing key people including professional families? Social interactions contribute to the sense of quality of lifestyle. Some very interesting work has pointed out the ramifications when an Aboriginal population shifts from being a majority to a minority in an area (Howitt 1993). For instance children can become marginalized in school, the focus of teaching moves towards the non-Aboriginal children, and their education and self-esteem suffers (R. Howitt pers.comm).

It is necessary to know about the effects on businesses and services because access to resources is another important part of local quality of life. People need livelihoods through employment or the ability to run a viable business, and critical mass in the local population is important for this.

CONCLUDING COMMENTS

This paper has offered a sweeping view of a range of considerations in social analysis, providing both an introduction to key concepts important to the forestry field, and some insights that are not well published. Readers seeking more specific guidance as to how to carry out social assessment are referred particularly to Taylor *et al*. (1995). Social assessment for forestry is somewhat more complex than for the types of project for which social assessment was first developed: single projects such as mines or factories, occurring in single places particularly small communities. The long growth periods before plantations are ready for harvest make time factors important too. Impact may be different in planting, growth, and eventual harvest (with continual rotation) phases. It has more in common with the assessment of policies and plans, a field known as Strategic Impact Assessment. It involves understanding complex chains of influence, somewhat similar to those considered by economists in preparing input-output tables. It calls for analysis of social (including cultural), economic and environmental changes, and preferably for analytical to be combined with participatory approaches.

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16. DEVELOPING A BUSINESS CASE FOR FORESTRY EXPANSION: CONCEPT AND METHOD

S.R. Harrison and J.L. Herbohn

This paper sets out a perspective and an underlying logic for development of a business case for regional forestry industry expansion. The objective is taken as establishing additional plantations to serve the specific requirements of the region, including the need for additional economic activity and the environmental sensitivity in relation to natural vegetation, wildlife habitat and landscape appearance. A number of steps in developing and validating the case and in its implementation are suggested. Comments are also made on specific issues to be addressed in application of the method to forestry expansion on the Atherton Tablelands in North Queensland. The steps in developing and validating the business case are seen to be complex and requiring a multidisciplinary team.

INTRODUCTION

A business case for forestry expansion in North Queensland is required to set out the arguments why investors (in the public or private sector) should invest in forestry in this region. In order to make the case, it is also necessary to recommend a particular plan or strategy for new plantation establishment with an accompanying financial analysis, sustainability analysis, and implementation plan. The required concept is by nature more than a financial case designed to attract investors, because of the particular requirements for achieving *sustainable* regional development, in terms of economic, social, cultural and environmental outcomes.

A *business case* is viewed here as a proposal, supported by financial and other arguments, for a new or expanded business enterprise. This has similarities with a business plan, a commonly used device in financial management which provides a blueprint for the future production and marketing operations of a new or established firm. The business plan may be used to seek funds from say a bank to establish a new firm. In this application, the business plan is typically developed by a previously formed business group or company wanting to set up the new enterprise, or by their consultants. In contrast, a business case may not arise from an existing entrepreneurial group, has to be accepted by a wider range of stakeholders, and may involve attracting finance from various sources, to be used by various firms. The specific nature of the business case will depend on how it is to be used, i.e. who it is to be presented to, and what form of advocacy it plays.

In that a business case is designed to attract investment, it has similarities with an investment *prospectus*. Forestry investment prospectuses have been widely used to attract investment into forestry joint ventures in New Zealand. According to Capill (2000, p. 131), in New Zealand 'Private off-farm finance has been critical to farm forestry success, particularly for joint ventures and, to a lesser extent, partnership arrangements … Some farmers may contribute land and management inputs in small partnerships with providers of venture capital – often urban-based professionals'. Capill (2000) noted one such 'partnership prospectus' issued by Roger Dickie (NZ) Ltd, an entrepreneur who has launched more than 100 such forestry projects.

Thus a business case is a broader concept than a *business plan*, although some form of plan for implementation and control would logically be part of a business case. An analogy is that a city would not just require a design for a new building such as an opera house, but also details on how to build it.

The elements of a business plan provide some insights into what is required in a business case. According to Cunningham *et al*. (2004, p. 61), a business plan consists of the following components:

- A description of the company;
- A marketing plan;
- A description of the operations of the company; and
- A financial plan.

The financial plan in a business plan includes estimates of capital requirements (including start-up costs in the case of a new firm) and sources of capital, and projections of financial performance. The cost-volume-profit (CVP) analysis of this component noted by Cunningham *et al*. (2004) does not fit the very long-term forestry investment situation, where capital budgeting is the relevant analysis tool. The application of capital budgeting to forestry investment with reference to North Queensland is discussed by Dayanandra *et al*. (2002).

Cunningham *et al*. (2004) further noted that a business plan has three main purposes, namely to help an entrepreneur to visualize and organize the company and its operations, to act as a benchmark against which the entrepreneur can later measure actual performance of the company, and to help obtain finance that new and growing companies often need.

The above elements are common to a business case which focussed on regional as well as individual company impacts. Where taxpayer funds are to be used, the business case also requires a broader justification (broad socioeconomic performance rather than solely financial performance criteria). When the business case is conditioned by requirements for regional sustainability, considerable attention to social and environmental impacts as well as satisfactory financial outcomes is called for.

The use of rural land in Australia is subject to various government legislative acts, regulations and policies, and to the often strongly expressed views of community groups. Wide variations can exist in value systems within the community, against which proposals are judged. In this context, a business case needs to be designed with close attention to the institutional environment in which a project is to operate.

A business case involves inputs from people with a range of professional skills. It is unlikely that any individual will have the breadth of expertise to address adequately all issues, such that the plan can stand up to vigorous scrutiny.

Forestry is an investment with particular characteristics: a long payback period; uncertainty particularly in relation to timber prices many years hence; an investment opportunity available to a variety of agents (government, industrial, farm); a relatively complex product supply chain; sharp division between softwood and hardwood timber sectors; and having strong positive spillover or externality effects, and a major landscape impact.

PURPOSES OF A FORESTRY BUSINESS CASE

It is pertinent to ask why a business case is necessary, and why sound investments do not automatically attract funding and organizational support. In economic terms, this may be addressed with reference to the discrepancy between private and social discount rates and between private and social payoffs, as well as concepts of market and regulatory failure. Notably, most plantation establishment in Australia historically has been carried out by state forest agencies within state governments, on the grounds that the nature of the investment is not attractive to the private sector, particularly due to the long payback period. In that forestry plantations generate ecosystem services and other positive spillovers or externalities, there is a public good component of forestry which is not captured in the market returns of private tree growers. In addition, governments often send negative signals for forestry investment, through closure of logging areas (such as occurred with the World Heritage listing of the Queensland Wet Tropics), new restrictions over vegetation management and timber harvesting codes on private land, unpredictable changes in forestry taxation arrangements, and in some cases refusal to permit logging on plantations established for timber production.

Plantation development for timber production can be a financially viable enterprise in its own right, although there have been many obvious cases where the return, if any, has not justified the financial outlay, e.g. the Caribbean Pine plantations established on Atherton Tablelands' farms in about the 1960s and 1970s. Hence investors can be expected to be cautious about forestry proposals, and carefully planned projects with thorough documentation are required to attract support.

It is to be expected that government initiatives will be required to promote forestry projects, through direct investment, creating a more attractive environment for private investment, or providing other forms of support or encouragement. If taxpayer dollars are involved, then a broad social cost-benefit perspective is needed to ensure that this is an appropriate form of public investment.

A business case for forestry potentially has a variety of applications, for example:

- To provide a basis to lobby government for funding or other assistance. This may take the form of one level of government attempting to obtain investment in their electoral territory, seeking support from a higher level of government.
- To present a case to private investors for the merits of investment in plantations.
- As a planning and monitoring tool, along similar lines to that of the business plan as presented by Cunningham *et al.* (2004).
- As input to land-use policy, e.g. deciding the locations and land types for which production forestry is to be encouraged or discouraged.

The nature and contents of the business case could vary between each of these applications.

COMPONENTS AND STEPS OF A FORESTRY EXPANSION BUSINESS CASE

A number of components or elements can be identified for the development of a forestry business case. These could be grouped as listed below.

Gaining an Understanding of the Particular Investment Situation

This involves an assessment of the current resources available for forestry (land, human resources and expertise, tree species and germplasm, finance), current plantation and timber processing operations, and markets for timber produced in the region. These steps could be divided into *knowledge consolidation* (summarizing what is currently known about likely performance of the proposed investment) and *situation analysis* (identifying particular issues relevant to the investment decision).

Identifying Information Gaps for Development of the Business Case, and Filling These Gaps

Where there are conspicuous gaps in the information available, steps need to be taken early in the process of developing the business case, to collect further information or carry out appropriate analyses, e.g. concerning what plantation options are available, what land is available which is of suitable quality for the intended tree species and is appropriated located with respect to processing infrastructure, and what financial performance can be expected from particular species.

Identification of Regional and Local Planning Legislation, Regulations and Policies

Forestry expansion decisions are made in a particular regulatory and policy environment, which imposes restrictions on the nature of forestry expansion, hence a comprehensive understanding of the institutional environment is required.

Market Analysis

This involves an assessment of the current domestic and export market for logs, sawn timber, components of timber products, and perhaps joinery and plywood products. This assessment may be in terms of volumes of timber of the preferred tree species which can be sold, by timber type (dimensions, quality) and market destination, and predictions about future market conditions and prices as well as any new opportunities for value-adding.

Identifying and Comparing Forestry Options and Strategies

A wide variety of forestry options are possible, in terms of species, ownership, scale of planting, and funding arrangements. It is probably that one or a small number of tree species will be identified, possibly to be grown both in commercial (government or industrial) and farm plantings. In that identification of one or more specific forestry expansion plan – in terms of species, location, scale of planting, ownership type, funding mechanism and silvicultural system – logically precedes the any impact analysis, critical decisions have to be made at this stage as to preferred options.

Generating Estimates of Financial Performance

Once one or a small number of forestry options have been chosen, these need to be subjected to a comprehensive evaluation of financial viability and feasibility. This stage typically also includes conducting a sensitivity and breakeven analysis of the option or

options. The analysis may require development of a financial model or using an existing forestry financial model. A number of standard discounted cash flow (DCF) performance criteria would normally be estimated, expressing the level of payoff (particularly net present value NPV and land expectation value LEV) and rate of return (financial internal rate of return FIRR).

Where public sector funding is to be sought, there is also a case for deriving estimates of wider economic performance, through an extended or social cost-benefit analysis. This requires applying various methods of valuing production benefits (e.g. valuing logs at import parity price rather than local market price) and the consideration of a wider range of costs and benefits, including the non-market environmental and social values. Consideration may also be given to the flow-on impacts in terms of additional tree planting as a result of both the demonstration effect of the project and complementarities in use of infrastructure and access to markets of other private tree growers.

Identifying Forestry Funding Sources and Mechanisms

If the forestry expansion is to be of sufficiently large scale to make an impact on the industry, substantial investment capital may be needed. Obtaining this capital can present a challenge; finance may need to be accessed from a number of sources, e.g. governments, venture capital providers, landholders own funds. Various arrangements can be instituted for accessing and utilizing these funds, e.g. direct investment by government or timber companies including purchase of land, joint ventures, partnerships or land renting.

Assessment of the Regional Economic Social and Environmental Impacts of Forestry Expansion

Forestry expansion potentially has major social benefits (e.g. in terms generating income and jobs and supporting the viability of regional banks, schools and medical services), some potential disbenefits (e.g. increased heavy traffic on roads), and environmental externalities (e.g. watershed protection, wildlife habitat, biodiversity conservation). There may be major changes in landscape appearance. A business plan developed within a sustainable development framework needs to identify these impacts, and contain measures to maximize beneficial impacts on the regional community.

Identifying Risks Associated with Forestry Expansion and Measures to Control Them

To some extent, a forestry expansion program is itself a risk minimization strategy, in terms of assuring resource security for the regional timber industry and the employment and other benefits it provides. However, forestry expansion can carry a number of risks in terms of physical and financial performance, and social and environmental outcomes. There are a number of factors or conditions which could lead to the forecast financial performance not being achieved, concerned with physical plantation yield, timber marketing and log prices, and legal and institutional factors. The program could generate adverse externalities, such as increased heavy traffic on roads, obstructions to attractive landscape views, inflexibility in future land use for new crops or residential development, crowding out of small-scale timber producers, or genetic introgression to local tree populations. ‘Sovereign risk’ may arise where new government regulations impose costs on plantations grown in the program, e.g. new restrictions on timber harvesting. Such risks need to be anticipated and measures instituted to avoid them as much as possible. Also, it is desirable to include a pessimistic scenario and breakeven analysis within the financial analysis.

The analysis of financial risk from forestry may be viewed within the total risk profile of the forest owner. Flexibility in harvest age provides a hedge against depressed income from other sources. Some plantation financing arrangements include a mechanism for risk

sharing, e.g. plantation joint ventures. Some tree species have a relatively long near-optimal harvesting period allowing considerable flexibility in the timing of harvest to meet critical periods of cash requirements.

Developing Implementation and Monitoring Strategies for the Business Plan

It is critical that guidelines are prepared as to how the proposal business plan can be implemented in an efficient way, and performance can be checked against anticipated outcomes to ensure that the venture remains 'on track' in terms of timeline and budget.

Developing an Overall Business Model

At the heart of the business case is an overall business model or plan, components of which may include a physical production plan, investment scheduling, implementation guidelines, and identification of funding requirements and sources.

Validation of the Business Case

Once a business case is formulated, it is highly desirable to subject this case to critical assessment, by experts in business planning and forestry, outside the team which developed the case. The plan may be evaluated in terms of practical feasibility of implementation, compatibility with the regulatory environment, reliability of financial estimates, validity of the predicted social and environmental impacts, and availability of estimated funding requirements. An independent check is required about the assumptions concerning investment options, the technical coefficients and financial estimates.

Statement of Reliability and Responsibility

It is desirable for the business case report to make clear the assumptions of the analysis, and indicate the degree of confidence which the proponents have in their analysis. It needs to be made clear that implementers and investors take responsibility for their actions. Even though the case is developed using sound technical data, well validated, presented in the clear and precise language, with assumptions made explicit, and endorsements are included from validators, a disclaimer is necessary to protect the authors and proponents of the plan from business losses due to financial outcomes which are beyond their control.

TAILORING A BUSINESS CASE TO A PARTICULAR FORESTRY EXPANSION PROGRAM

The method of developing a business case and series of steps outline above have to be tailored to the specific forestry situation and needs in North Queensland. For example, suppose a case is being made for expansion of hoop pine plantations on the southern Atherton Tablelands. Some of the specific features to take into consideration for this application could include:

- The suitability of available land for the proposed plantation species, and prevailing land-use legislation and regulations;
- The high priority placed by the North Queensland community on the growing of native tree species and maintaining an attractive landscape and attracting tourism – this could imply including buffer areas of mixed-local-species planting, and harvesting in relatively small coupes to minimise impact on wildlife and landscape appearance;
- The availability of log markets, which can be a concern for farm-grown timber;
- The current processing infrastructure (on the Atherton Tablelands this is mainly geared

to softwoods) and timber markets (domestic and export), and opportunities for further timber processing (e.g. peeling or slicing) and new markets (e.g. a chipwood or processor market for thinnings);

- Potential contribution of the forestry proposal to ensuring resource security for the current processing industry, and possibly new processing activities;
- Plantation or compartment size and economies of size in log harvest and transport;
- The prospects that high-quality silviculture will be practiced, so as to produce high-quality logs;
- The critical need for employment creation to maintain viability of the infrastructure and services of rural communities on the southern Atherton Tablelands; and
- Stability of the chosen tree species to extreme weather (cyclones), and availability of relatively sheltered planting sites.

CONCLUDING COMMENTS

A business case is a well documented argument to support investment in a particular business venture, in this case with respect to forestry expansion. A broad concept of 'business case' is adopted here, including a forestry expansion plan, financial analysis, socio-economic impact assessment, environmental impact assessment, funding mechanism and implementation plan.

Development of a business case for forestry expansion is not really science so much as gaining an understanding of the practical issues in the particular situation. No simple prescription can be made, but a number of readily identified steps appear necessary. Forestry history in the area, or experiences from other location, may provide only limited guidance. High-quality silviculture and reliable access to timber markets appear to be critical ingredients to forestry success, and may require specific arrangements for smalls-scale forestry.

No forestry expansion plan is likely to be welcomed by all stakeholder groups. The proposed plantation development plan, business case and implementation plan may need to withstand criticism from specific interest groups, and hence need to be carefully documented and justified. The business plan needs to present a clear and well argued assessment for anyone who is considering investment in plantations. It also needs to take a strong advocacy role if the vision of a viable forest industry in the future is to be gain community support and government funding.

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