

# Australian forest plantations: an overview of industry, environmental and community issues and benefits

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## Summary

Australia has over 1.5 million ha of plantation forests. Governments and industry share a goal of doubling this area by 2020, with most new plantations to be established on previously-cleared agricultural land. Plantations currently supply over half of the raw material required by the forest products industry and also provide a range of environmental and social services. The ownership and management structure of Australian forest plantations and plantation-based forest industries has changed considerably over the past decade, and plantation growing, processing and marketing sectors are becoming increasingly globalised.

This paper reviews the major forces driving development of forest plantations in Australia and the key policy and management issues to be considered if plantations are to meet varied expectations of the Australian community. Our assessment is based on papers and discussion at the 'Prospects for Australian Forest Plantations 2002' conference. The wide-ranging papers to the conference considered opportunities for Australia's forest plantations and plantation-based industries in changing global wood markets. They discussed alternative and emerging markets for wood and other plantation products and environmental services, the potential for plantations to provide environmental benefits such as salinity mitigation and biodiversity conservation, effects of plantations on water yield and quality, and the effects of plantation development on rural and regional communities. The role of plantations in providing a broader range of environmental and social benefits emerged as a major focus of discussion. Lessons learned from Australia's experience with plantation development are relevant in a wider global context where plantations will be expected to supply products for, and benefits to, society that historically have been supplied by native forest.

*Keywords:* forest plantations; forest products industries; rural environment; environmental impact; forest influences; biodiversity; forest management; community involvement; Australia

## Introduction

Plantations have been a feature of forestry in Australia for well over a century (Carron 1990). The area of plantations increased rapidly between 1950 and 1980 as a result of government investment in a domestic softwood resource. Since 1990, the plantation estate has increased by over 50% (500 000 ha), an expansion largely funded by private investment, bringing the total plantation estate to over 1.5 million ha. Governments and industry have the goal of doubling this area again by 2020 (Commonwealth of Australia 1997). Plantations currently provide over half of the wood supplied to industry, and significant increases in this wood supply — particularly of hardwood pulpwood — are projected over the next 20 y. Older softwood plantations now supply large-scale domestic processing facilities that make a significant contribution to regional economies across the country. Plantation softwood is now the dominant raw material in many commodity wood products that traditionally used native hardwoods. Previous government policies set out to replace imported softwood timber and, while import replacement has occurred to a significant extent, substitution of products from native hardwoods with those from plantation softwoods has been a major change in the timber-processing sector. In some cases, wood supply from the plantation estate has enabled governments to respond to community pressure and reduce the rate of timber harvest from native forests. A similar substitution process is likely for at least some of the 6 Mt of hardwood pulpwood now cut from native forests and largely exported.

At the same time that Australia's reliance on plantations for wood supply is increasing, there is an expectation that planted forests can be used to provide other environmental benefits such as water quality improvement, dryland salinity mitigation, carbon sequestration, and habitat for native plants and animals. Plantations are also considered by some to be a potential driver of regional development and of the rejuvenation of rural communities. However, the appropriate nature, design and operation of plantations to provide multiple benefits are not necessarily well understood, and the extent to which plantations might meet environmental expectations remains unclear. The rate of plantation expansion, and the shift in land use away from traditional agricultural production activities, are also causing

community concern in some parts of rural Australia, and a larger role for plantations is not universally supported.

This issue of the journal presents papers from the national conference, 'Prospects for Australian Forest Plantations 2002', held in August 2002 ([www.brs.gov.au/plantationconference](http://www.brs.gov.au/plantationconference)). Over 250 delegates attended, representing a wide range of interests. Speakers and participants used proceedings of a 1989 conference with the same theme (Dargavel and Semple 1990) as a reference point, and reviewed subsequent developments in order to consider the prospects and actions needed to meet the diverse expectations of both the forest plantation sector and the wider Australian community. This paper summarises the conference presentations and discussion, explores the main areas of deliberation, and considers prospects for Australian plantations in the context of global trends and issues in forest management.

### The Australian plantation estate

There are now over 1.5 million ha of plantation forests in Australia (Wood *et al.* 2001). This is a diverse estate located largely in higher-rainfall regions ( $>600 \text{ mm y}^{-1}$ ) close to the coast, from the wet tropics of north Queensland and the Northern Territory to the southern extremities of Western Australia and Tasmania. There are about 1 million ha of softwood (mainly *Pinus* sp. but with about 50 000 ha of the native *Araucaria cunninghamii*), and 500 000 ha of hardwood (mainly *Eucalyptus*, dominated by *E. globulus* and *E. nitens* managed on short rotations for pulp).

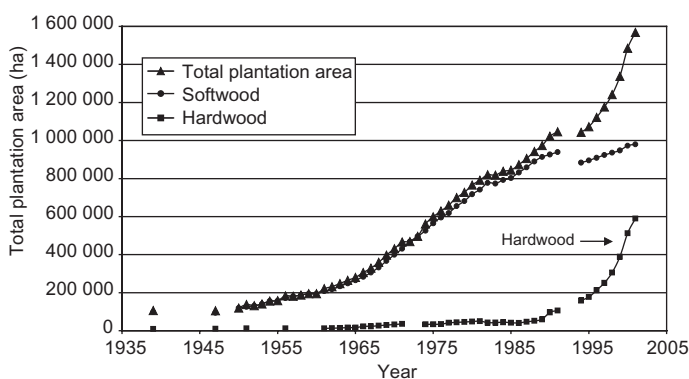
The history of forest plantations in Australia to the mid-1980s was reviewed by Carron (1990), and the development of the plantation estate since 1935 is shown in Figure 1. In Figure 2, the data have been converted to show the average annual increase in plantation area at intervals of five years.

Four phases of plantation development are apparent from Figure 2.

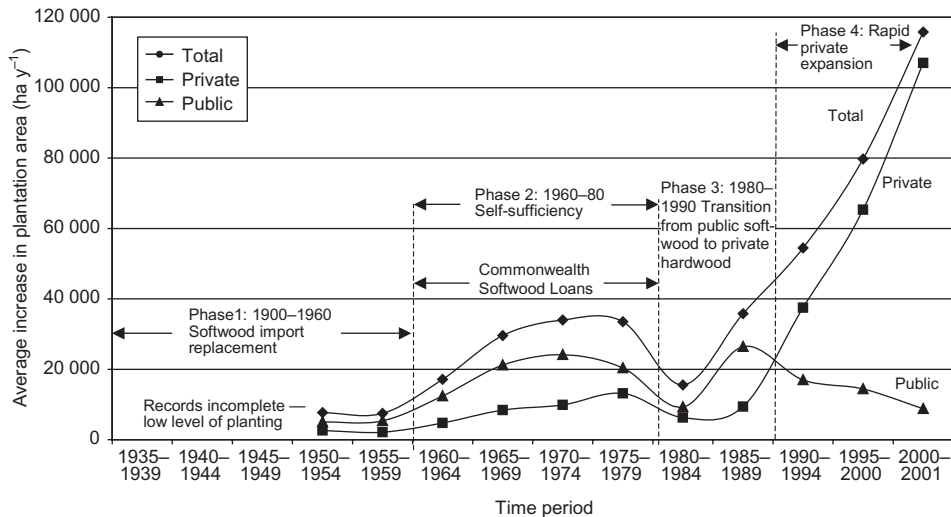
1. The first phase can be summarised as a period of 'softwood import replacement'. Through to the mid-1950s, plantation establishment focused on softwoods for replacement of both imports and valuable native species which were being over-harvested. In the late 1800s and early 1900s, there were attempts to manage high-value native forest species such as red cedar, Queensland maple and hoop pine. The potential of a range of species for cultivation in plantations was tested: the trials included high-value hardwoods and softwoods intended to replace imported softwood timbers that were preferred by woodworkers and builders. These efforts became more systematic with the development of State forest services from about 1900 to 1930, but only relatively small areas of plantation were established prior to World War II.
2. In the second phase, extending to the mid-1970s, the rationale for plantations broadened to one of 'self-sufficiency'. It was dominated by softwood plantings under the Softwood Forestry Agreements between the Commonwealth and State governments, which provided federal government funds to the States for plantation establishment. These were largely to meet wood self-sufficiency goals, although they were also used to address labour market issues in some regions. During this era, the public softwood plantation estate expanded from around 230 000 ha to nearly 550 000 ha; over 100 000 ha of

the increase was attributable to the loans program. These plantations became the basis for the wide range of domestic wood processing facilities that now make substantial contributions to regional economies in all Australian States and the Australian Capital Territory. However, acceptance of plantation development by the community was mixed. Native forests were cleared and replaced with softwood plantations in some regions, raising concerns of an increasingly vocal conservation movement about effects on wildlife, native plant species and water and soil values (Routley and Routley 1972). Where plantations were established on land used for agriculture, there were concerns in some communities about social and economic effects on rural communities and on the production of agricultural commodities.

3. A third phase in the 1980s can be described as a transition phase between public softwood and private hardwood plantation expansion that was to come later. There was increasing private investment in softwood plantations and limited expansion of the then small area of eucalypt (hardwood) plantations. Changes in industry and society, including budgetary pressures in governments, demands for a more commercial focus of government activities, high interest rates and community activism on native forest harvesting, all had a significant effect on forest management agencies. Commonwealth and State government programs provided various forms of incentives for plantation development, including loans, grants and support for research. The Western Australian Government began actively promoting the development of Tasmanian bluegum (*E. globulus*) plantations on farms, and various States tested plantations of a variety of hardwood species, principally eucalypts.
4. In the fourth phase, beginning in the 1990s, private investment became the dominant source of funds and a strong shift to hardwood species for new plantation establishment started. Almost all government-managed publicly-owned softwood plantations in Victoria (around 155 000 ha) were sold to the US investment group, John Hancock Ltd, in 1998; the Tasmanian Government established an arrangement whereby Forestry Tasmania and Renewable Resources LLC, a United States-based investment company, jointly own 42 000 ha of the State's public softwood estate, which is managed by Rayonier Tasmania (another US subsidiary) under a joint venture established in 1999; Japanese and Korean pulp and



**Figure 1.** Plantation forest area in Australia by species group since 1935. Estimates derived from various sources #.



**Figure 2.** Increase in Australian forest plantation area averaged over five year periods, by tree ownership, showing the four developmental phases #

# Notes for Figures 1 and 2:

1. Data have been derived from several different sources: the Commonwealth Forest and Timber Bureau (pre-1975), ABARE (1976–1991) and BRS National Plantation Inventory (since 1994). Methods used for collection of these data have changed over time. Hence there are some breaks in the data (e.g. in the early 1990s).
2. To make analysis of trends clearer, data were averaged over five-year periods in Figure 2 to minimise annual variability. Data points are mid-way through each five-year period.

3. Records before 1950 are incomplete and readily available only for 1939 and 1947. Therefore, planting rates and trends in this early period cannot be quantified other than to say the general planting rate was low and probably less than a few thousand hectares per year.
4. For this paper, areas reported for ownership other than ‘public’ have been treated as ‘private’. This includes all joint ventures, annuities and unknown ownership. Large areas of plantation land were transferred from public to private in the late 1990s, through privatisation/corporatisation of State (public) plantations.

paper companies invested in significant areas of short-rotation eucalypt plantations, especially in Western Australia and Victoria; and individual private capital funded large areas of similar plantations through managed investment schemes. These schemes provide tax advantages to some investors based on the capacity to defer payment of tax on current income to a later time.

The history of forest plantations in Australia has been characterised by a considerable research and development effort, summarised for this conference by Nambiar (2003). Investment in species selection, genetic improvement and silvicultural practice has yielded substantial gains in productivity and value recovery in almost all forest plantation crops, as demonstrated for example by *Pinus radiata* in South Australia. In 1960 around 70% of the radiata pine estate was in the low site quality classes (MAI of 14–18 m<sup>3</sup> ha<sup>-1</sup> y<sup>-1</sup>) but by the mid-1980s almost 80% was in the highest site quality classes (MAI of 26–33 m<sup>3</sup> ha<sup>-1</sup> y<sup>-1</sup>) (Nambiar 1999). These investments in research have increased the productivity and quality of the resource and extended the boundaries of land suitable for plantation forestry.

**Prospects for Australian plantations**

While this history of plantation development provides a sound industrial and scientific basis for further expansion of the plantation estate, there are significant economic, environmental and community issues which need to be addressed if forest plantations are to meet the wide range of industry and community expectations.

**Economic and market issues**

Economic analysis indicates that past investments in softwood plantations have been relatively profitable over the longer term. Based on an analysis of average establishment and management costs, growth rates and product prices, Roberts (2003) estimated that the pre-tax real rate of return on capital invested in plantations over 30 y has been about 6–10%. In his view, with re-establishment costs of A\$900 ha<sup>-1</sup> (about 6% of final crop revenue), a decision to replant for a subsequent rotation is well justified. The contribution of forest plantations to regional economies is significant. In regions like the ‘Green Triangle’ in south-eastern South Australia, industries based on plantation forests are estimated to provide 25% of the jobs and 29% of gross regional product. The opportunity to supply a strong domestic market for building materials is critical to stability and the ongoing success of the softwood-plantation-based industry. Softwood placed into the international market is subject to greater fluctuations in price and greater competition from international suppliers.

Modest increases in Australian softwood sawlog and pulp availability are expected over the next 10–20 y (Ferguson *et al.* 2003). These are likely to be largely absorbed by expansion of existing large-scale domestic processing plants, and possible new plants in some regions. Returns could be more volatile with increased competition from imported processed softwood timber from New Zealand or Chile. Substitution of softwood for hardwood in commodity markets such as house framing will continue, but producers will need to explore a wider range of

products such as plywood and laminated veneer lumber. Competition from alternative, higher energy and less sustainable materials is an increasing challenge. For example, wood used in construction is facing strong competition from alternative materials such as steel and plastics (Vinden 2003). Roberts (2003) noted that research and innovation will be critical to the ongoing success of the softwood sector and that investment in education and training will be important in maintaining future prospects for the softwood sector.

Australian hardwood plantation pulpwood availability will increase rapidly in the next decade, rising from the current level of 2.4 million m<sup>3</sup> y<sup>-1</sup> to 11–18 million m<sup>3</sup> y<sup>-1</sup> from 2015 (Ferguson *et al.* 2003). Hardwood sawlog availability will not increase substantially until after 2015. The large increase in availability of hardwood pulpwood from plantations represents an opportunity to expand local manufacture of pulp and paper, and the export of hardwood chips. Kelly and Bull (2003) see China as the main potential market for increased sales. Demand for native forest timbers with particular strength, durability or appearance properties will continue, in the short-term at least. Native forest operations reliant on sale of associated pulpwood to be profitable will have to compete with increasing supplies of hardwood pulpwood from plantations.

Alternative products that might be profitably produced from plantations include activated carbon, wood composites, eucalyptus oil, chemically modified wood and bioenergy (Prinsley 2002; Vinden 2003). Commercial development of these alternative products, and greater use of wood generally, will require substantial investment in research and development and continuing education especially of architects, engineers and builders (Vinden 2003).

## Environmental issues

### *Plantations and landscapes*

The British historian Simon Scharma has described landscapes as being where 'nature meets culture'. Eucalypts and other native trees are defining features in our national identity and have provided inspiration to generations of artists. While there continues to be considerable appreciation of our unique flora and of trees in the Australian landscape generally, the notion that 'any tree anywhere is a good thing' is increasingly questioned (Alexandra and Campbell 2003). Plantation forests powerfully reshape landscapes and plantation proponents need to carefully consider their impacts on the community, culture and ecology. In many regions, plantation establishment on agricultural lands is rapidly changing the appearance of some landscapes, and sometimes communities are reacting negatively to such change.

Alexandra and Campbell (2003) suggest that more complex and varied plantation designs can be used that more effectively integrate timber production with existing agricultural pursuits. These designs can modify the impacts of plantations on both agricultural production and landscape aesthetics, and facilitate the provision of other values such as wildlife habitat. Schirmer (2002) found that many in rural communities prefer plantation systems that are integrated with agricultural uses, rather than displacing them completely. While there have been some

significant innovations in plantation design (Biggs 2002), these systems are not yet widely developed in Australia. These systems will also involve additional planning and, sometimes, potentially higher cost in establishment and management. Using multiple species can add to complexity in management but significantly reduce direct income from plantation production. Integrated systems, however, do offer considerable potential for expansion in many Australian regions beyond the scope of traditional plantation systems (Williams *et al.* 2001).

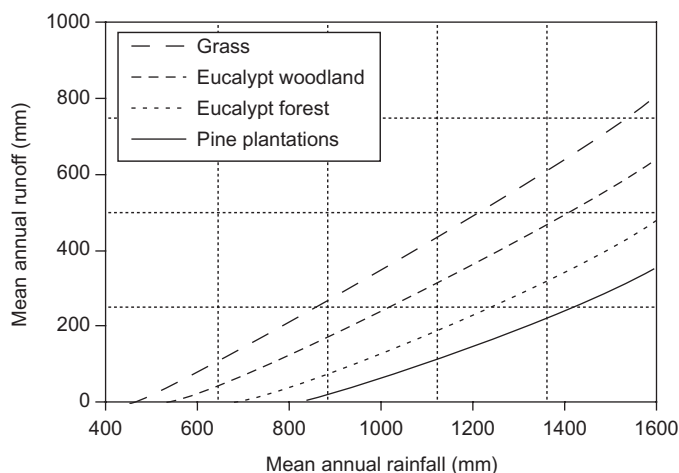
More importantly, a paradigm shift will be necessary within the plantation-growing community if it is to embrace the diversity of potential management options more acceptable to rural landowners and local communities. These approaches, however, are not likely to be optimal supply arrangements for large-scale, high volume plants that will dominate future timber processing. Integration of multi-objective plantings with future processing will require considerable planning, with all stakeholders considering each others' perspectives. Such accommodation is possible, as demonstrated in a number of European countries where small-scale growers currently supply wood to large-scale processors.

Several Australian plantation growers are pursuing independent third-party certification systems that indicate to the market the quality of their management. Many environmental, economic and community factors will need to be taken into account in such certification. The equivalence of different systems and their recognition by the international market needs to be considered by groups developing certification standards. Certification is a matter of increasing importance, especially for several active NGO groups, but it has yet to make an impact in the Australian marketplace compared to that made in other regions.

### *Plantations and water*

Allocation and use of water is becoming an increasingly vigorous and divisive public policy issue in Australia. Water use by plantations is a small but increasing part of this debate (Nambiar and Brown 2001). Large areas of agricultural Australia were previously covered with forest vegetation, often with a woodland structure (20–50% canopy cover). These forests used water at a higher rate than the grazing and cropping land-uses which replaced them after European settlement. Cropping and pasture land-uses are hydrologically more 'leaky' than forests, and movement of water through the soil mobilises salt stored in the landscape, usually increasing stream salinity, or raising water tables, resulting in dryland salinity. Stream and dryland salinity are regarded as Australia's greatest environmental problems (Stirzaker *et al.* 2002). Many consider plantation establishment or other forms of revegetation as an important salinity mitigation option (Biggs 2002; Henry 2002; Stirzaker *et al.* 2002).

Water moving through cropping and pasture systems is now an important, but over-allocated, irrigation resource for many downstream agricultural producers. The greater water use by tree crops than by pastures means that plantation development on a large proportion of a catchment will reduce river flow and recharge to groundwater (Fig. 3). This may have the unintended consequences of reducing water available to downstream users



**Figure 3.** Mean annual runoff curves for different land covers, after Vertessy and Bessard (1999)

and of increasing stream salinity concentrations. It has been argued in some jurisdictions that plantation growers should purchase rights to water in a manner similar to that necessary by other water users (Hopton *et al.* 2001; Vertessy 2001). Vertessy *et al.* (2003) consider that plantations should be incorporated into the water management system and their water use traded away from other land uses.

There has been significant progress in identifying where trees should be placed in the landscape and how they should be managed to produce the best environmental outcomes (Stirzaker *et al.* 2002). These authors suggest that the effect of plantations on water yield can be minimised by:

- concentrating plantation establishment in lower-rainfall areas ( $<800 \text{ mm y}^{-1}$ ) where reductions in water yields are smaller and salinity is a greater problem;
- spreading plantations across the landscape and keeping them to less than 20% of any catchment; and
- phasing plantings to generate a spread of age classes, and planting away from drainage lines.

Expanding plantations into drier parts of the continent brings its own management problems. Tree survival and growth rates in these areas are lower than in traditional plantation-growing regions, and most sites are a long way from existing plantation development infrastructure or processing plants. Financial returns from plantations are therefore likely to be relatively unattractive to investors unless land, transport and management costs are significantly lower (Lamb *et al.* 2002; Nambiar 2003). To develop plantations in these regions, low returns could be offset by payments for environmental benefits associated with plantation development. These could come from government or from industries seeking carbon credits or other rewards from being involved with projects with environmental outcomes. Funding mechanisms such as tax incentives, grants, market-based incentives and public–private partnership can be used to direct commercial investment to meet public good outcomes. The relative merit of these approaches is still the subject of debate. Further research and evaluation of pilot programs will assist in developing appropriate tools and mechanisms tailored to both

national and regional social and environmental objectives. Different species and silvicultural practices are required for low-rainfall areas compared to those used in traditional situations. Further research and development is also needed to support the expansion of plantations outside the high-rainfall zones and to achieve commercial outcomes from low-rainfall tree crops.

### **Plantations and biodiversity**

Until the 1990s, most new plantations were established on areas converted from native forests. Replacement of native forests with exotic conifers provoked considerable and increasing adverse community reaction from the early 1970s (Routley and Routley 1972). Policies now prohibit conversion of native forest to plantations in all mainland States and Territories, although the practice is continuing in Tasmania within the context of a comprehensive, adequate and representative forest reserve system, and a code governing forest practices. The practice, however, is still causing some community and professional concern. Most Australian plantations are effectively based on exotic species, as even those composed of eucalypts — predominantly *E. globulus* and *E. nitens* — are largely planted outside the natural range of these species. However, even relatively simple plantation monocultures have greater structural diversity than agricultural crops, and can provide habitat for a range of native animals (Lindenmayer *et al.* 2003).

With appropriate design, plantations on cleared agricultural land can increase landscape diversity and quality for wildlife (Keenan 1998; Keenan *et al.* 1999; Lindenmayer *et al.* 2003). Retention of remnant native individual trees or patches within a plantation is important as these can have considerable biodiversity value (Klomp and Grabham 2002). Maintaining a mosaic of plantation age classes is also of potential value in providing a range of habitat. Using a mixture of species within the plantation can increase structural and functional diversity, and potentially increase overall production. Restoring native species at the time of plantation establishment and retaining native vegetation in watercourses, ridges or steep areas, following codes of practice, will increase the conservation value of plantations. Leaving thinning and pruning waste to rot can provide habitat for invertebrates. These practices may involve some tradeoffs with wood production. For example, retained native trees that offer significant habitat value may compete with plantation trees or harbour browsing native animals that can cause severe damage to the plantation. Research is resulting in increased awareness of management options for increasing biodiversity benefits of Australian plantations, but many ameliorative measures are only at an early stage of implementation.

### **Plantations and communities**

As indicated above, plantation development has made a positive contribution to regional development and, where they have been a part of the landscape for some time, plantations are generally well-accepted by the community. Many farmers, for various personal or economic reasons, have also willingly embraced plantations as an alternative commercial enterprise, or as an exit strategy. Plantation expansion into new regions, however, has

caused some negative community reaction. Major issues include conversion of native forest to plantations; large-scale transformation of agricultural land to plantations and associated loss of traditional rural enterprises; use of chemicals and their possible effects on native animals and waterways, especially by aerial application; impacts on roads and increased truck traffic once large-scale harvesting commences; and impacts (real or perceived) on social structures and community networks (Lockie 2003; Schirmer and Tonts 2003). The perceived impact of plantations on community structure and services is often actually the result of decline and change in rural populations for other reasons, and must be seen in a wider context of economic forces and social trends. Nevertheless, plantations have become a significant political issue in many regional communities, demanding and receiving attention at all levels of government and within the forest sector.

Plantation industries and government need to work closely with communities to address their concerns. Formal planning appeal mechanisms may not always be an appropriate way to resolve disputes, and informal communication arrangements seem to be more successful (Schirmer and Tonts 2003). Strategies for community engagement include information dissemination, communication and consultation with local governments, communities and owners of neighbouring properties. State governments have formed consultative groups on particular issues to improve communication and dialogue between the industry and the community. In some regions, industry has taken the initiative; in Tasmania, for example, plantation growers have developed a Good Neighbour Charter that provides guarantees about practices and continued dialogue with the community.

## Commentary and conclusions

Plantations in Australia continue to develop in an atmosphere of rapid change. Expectations for plantations to deliver multiple benefits also continue to rise. Past performance suggests that softwood plantations grown in current locations will continue to be profitable investments for growers. While softwood processors will face increased international competition, as anticipated in the late 1980s (Dargavel 1990a), the domestic building market is likely to continue to provide a sound base for marketing products from Australian softwood plantations, although expanding New Zealand production is likely to significantly increase competition in some major domestic markets. Profitability and markets for hardwood plantations, grown for solid wood or pulpwood, are currently less certain.

The 'bold proposals' for an increase in the plantation estate of about 600 000 ha, envisaged at the 1989 national conference, were exceeded once government policy focused on key policy issues and removed impediments to private investment in plantation development. Corporatisation and commercialisation of State agencies has proceeded more rapidly than many considered was likely, as has the involvement of global forest businesses in the plantation growing and processing sectors. Australia's National Competition Policy is driving many changes and is likely to result in more competitive marketing arrangements for plantation growers. The rise of managed investment scheme companies in the 1990s, underpinned by favourable taxation rulings, provided

a vehicle for individual investment in plantations that was not anticipated in the late 1980s.

The relative role of plantations and native forests in providing wood to industry was the subject of discussion at the 2002 conference, as it was over a decade ago. Some participants at the 2002 meeting argued that it was in the plantation industry's interest to clearly differentiate in the marketplace its products from those produced from native forests. Others argued that there was more to be gained from the two sectors working together to market the benefits of wood against substitute products such as steel or aluminium. Some discussion reinforced Dargavel's (1990b) view that, if native species and mixed configurations are grown on longer rotations, it might be quite difficult in some regions to differentiate plantations from regrowth forest ecosystems. It was also argued that conservation objectives needed to be considered in a landscape context, with plantations and managed native forests providing a valuable buffer between conservation reserves and more intensive agricultural land uses.

Environmental issues were certainly at the forefront in the late 1980s, but these were largely driven by a domestic environmental agenda. Developments in global policy, for example through UN initiatives on forests and Conventions on Biodiversity and Climate Change, were not part of the debate at the 1989 conference, and expectations that plantations will deliver the multiple benefits implicit in these agreements continue to rise.

There are a variety of ways in which plantation development can proceed to meet commercial, environmental and community outcomes. However, there is likely to be ongoing tension between the desire of the commercial world for highly efficient, large-scale, globally competitive, plantation-based industries, and the expectations of many stakeholders that smaller-scale plantations will be integrated with traditional farming activities and meet land rehabilitation, water quality and/or conservation objectives.

Government agencies, industry and extension groups promote the establishment of woody vegetation through industrial-scale plantations, through smaller-scale commercial farm forestry integrated with agriculture, and through revegetation for conservation or landcare benefits. Because these three different approaches are usually promoted and implemented by different management agencies and research funding bodies, there are large divides and relatively little interaction between the groups allied to each. For plantations to be effectively integrated into rural landscapes and meet multiple objectives, these 'three worlds' of plantation development need to communicate better and work more closely together.

Water use by plantations was not a significant part of the debate in the late 1980s. This issue has been of concern in places with a climate similar to that of Australia, such as South Africa and parts of India (Malik and Sharma 1990), for some time. The current debate in Australia over allocation of water resources for irrigation for intensive agriculture will focus more attention on the way in which plantations established on currently cleared land affect water availability in catchments. As a result of recent research, more is now known about these effects and options for their mitigation. Revegetation with woody vegetation of large parts of

the landscape is widely acknowledged as a necessary response to the major environmental problem of increasing stream and dryland salinity. This initiative will require careful design and planning to avoid adverse effects on water yield while achieving salinity mitigation and water quality improvement.

Concerns about the impacts of plantation development on rural communities were also on the agenda in the late 1980s. These concerns have grown in the last decade as the plantation estate has expanded onto cleared agricultural land in a much more substantial way. There is evidence that most plantation proponents are now more aware of and responsive to community concerns about these impacts than formerly.

Given the rapidly changing environment, it may be unwise to speculate on the nature of the plantation estate, the timber industry, community attitudes or the issues facing plantation managers in 10–20 y time. Australia has made substantial progress in developing a plantation forest estate and associated commercial processing industries. Many technical issues have been resolved through relatively small but successful research efforts, and the development of innovative forest management and processing practices. The challenges have now moved on to other dimensions, including improving biodiversity and environmental outcomes and addressing community concerns and needs.

Policy needs to be dynamic and institutions need to be in regular dialogue with stakeholders to remain effective. Future policy and institutional arrangements should take account of this changing environment to ensure that plantations deliver economic, environmental and social benefits for all the Australian community. To echo the words of Dargavel (1990a,b, 2003), the need for public examination, informed debate and critical participation remains an important component of this process. Much still remains to be done to ensure that plantations deliver economic, environmental and social benefits for all the Australian community.

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