2. The Current Status of Farm Forestry in Australia

J.L. Herbohn, S.R. Harrison, N. Emtage and P. Norman

The purpose of this chapter is to place the current project to develop a farm forestry financial model and a multi-objective decision support system in context of the farm forestry scene in Australia and to highlight relevant aspects of past research. As part of this, a brief overview of the history of forest use in Australia and the developing plantation estate is provided. The nature and extent of farm forestry in Australia is discussed, including an assessment of recent developments in the two key regions in the current study. The key elements of past research, which are relevant to the current project, are then identified.

2.1 The Australian Forestry Sector

Historically, forestry activities in Australia have been based on the exploitation of the extensive eucalypt forests that existed at the time of European settlement or has regenerated following the exclusion of regular fire events. The forest resource has been depleted since European settlement, and large tracts of forest land have been withdrawn from timber production following a bitter public policy debate between the forestry industry and conservation groups. At present about 17.5 M ha are currently in conservation reserves (Table 2.1). It is likely that over the next 10 years further large areas of native forest will be placed within conservation reserves.

Table 2.1. Area of native forest and plantation estate in Australia

Forest type	Area (1000 ha)
Native forest[1]	
Conservation reserves	17,580
Multiple-use forests	13,351
Leasehold land	66,103
Other crown land	15,597
Private forests	42,018
Total native forest area	155,835
Plantations[2]	
Softwood	972
Hardwood	503
Other (mixed species and unknown)	10
Total plantation area	1,485

[1] As at December 1997.
[2] As at September 2000.
Source: National Forest Inventory (1998), Wood *et al*. (2001).

Control over the exploitation of the native timber resource has traditionally rested with the various State governments. However, the Commonwealth government has exerted increasing influence through a combination of economic incentives and the application of external powers provided by the Constitution. In addition to timber production, Crown-controlled native forests have been used as a means of achieving a number of social objectives such as regional development and the provision of low-cost housing materials. The pricing and allocation of logs has been a controversial issue

(O'Regan and Bhati 1991). The ready supply of logs at artificially low prices from public native forests has contributed to a lack of interest in private plantation forestry and a corresponding high level of public ownership of the plantation resource.

2.2 The Australian Plantation Estate

Domestic timber requirements are increasingly being drawn from the plantations. Softwood plantations currently comprise over 972,000 ha, or over 65% of the current plantation estate of 1,485,000 ha (see Table 2.1). A high proportion of the softwood estate is controlled by public organisations, while most hardwood estate is under private control. A breakdown in the ownership and types of plantations is provided in Figure 2.1.

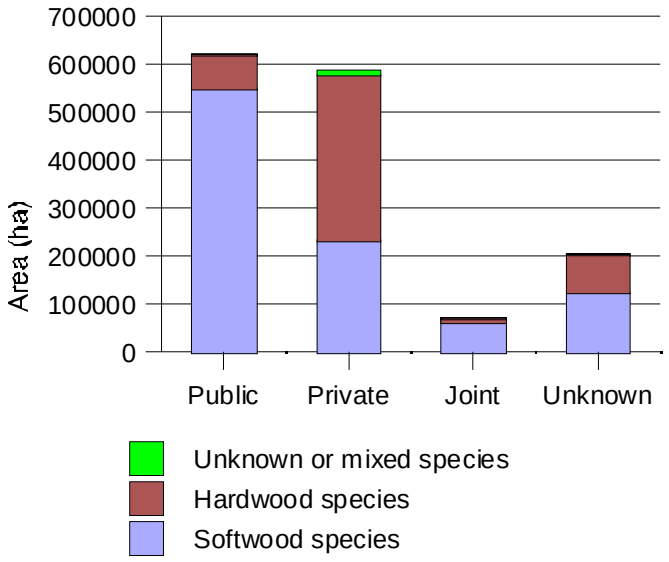


Figure 2.1. Total area under hardwood (HW) and softwood (SW) as at September 2000 by tree ownership

Note: 'Joint' refers to plantations with both public and private sector equity.
Source: Wood *et al*. (2001).

There have been concerted efforts in recent years to expand the plantation estate. Under the 2020 Vision (a joint policy statement agreement between the federal and state governments) it is planned to triple the existing plantation estate to 3.3 M ha (Plantations 2020 1997). As part of the National Forest Policy Statement (Commonwealth of Australia 1992, p. 29) there is an agreement that 'all States share the policy, consistent with ecologically sustainable development, of not clearing public land for plantation establishment…'. This thus dictates that most of the expansion in the plantation estate will have to be on freehold cleared land. The 2020 Vision and the National Forest Policy Statement have important implications for an increased role for the private sector, including farm foresters. This represents a major shift away from the current State domination of the forestry sector.

The efforts to expand the plantation estate are reflected in the recent rate of plantation establishment. In 2000, it was estimated that almost 125,000 ha of new plantations would be established, of which about 116,000 ha were to be hardwoods (NPI 2000 and Figure 2.2). This represents an increase in the plantation estate of around 10% in one year. The vast majority of new plantations were established on private land (Figure 2.3), which is a major shift away from the previous focus of establishing softwoods on public land by State forestry organisations.

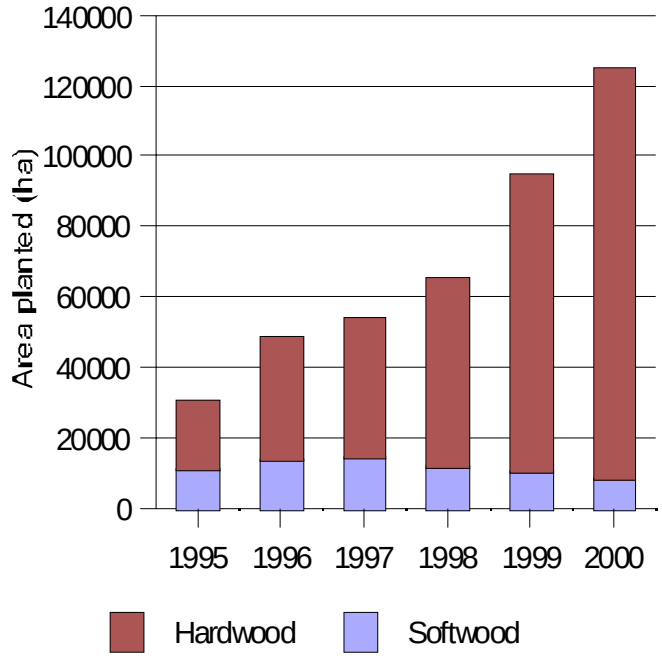
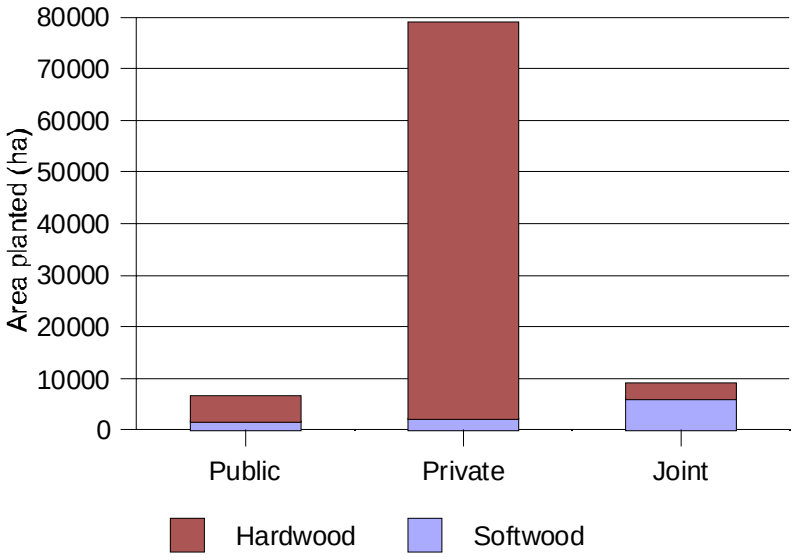


Figure 2.2. Annual areas of new plantations established in Australia since 1995

Source: NPI (2000), Wood *et al*. (2001).



Source: NPI (2000).

2.3 Types of Private Forestry in Australia

Three common types of private forestry can be identified in Australia based on the motivations for participation, which range from predominantly environmental plantings to a strong production focus.

Large-scale industrial plantings established primarily for timber production constitute by far the largest areas of plantation establishment. Private large-scale plantations are typically owned by large forestry companies, or alternatively established under joint venture arrangements, either with forestry companies or government. There is also an increasing number of forestry investment companies establishing large-scale plantations. Based on data in Wood *et al.* (2001), about 95% of the area of plantations in Australia could be classified as 'large-scale industrial'.

Conservation plantings or initiatives are at the other end of the production–environment spectrum. These plantings tend to take place in environmentally sensitive areas such as along watercourses. They are commonly established to ameliorate environmental damage such as streambank erosion and rising watertables leading to salinity caused by past poor land management practices. A sizeable proportion of the conservation plantings in the past 10 years in Australia has occurred under the umbrella of 'Landcare'. Landcare is an Australian community-wide program with strong government support at all levels and currently involves over 4000 autonomous groups (Marriott *et al*. 2000). Most groups comprise farmers and other landowners restoring land and increasing sustainability, and to a lesser extent groups based in towns and cities. Marriott *et al.* (2000) observed that increasingly landcare members are focussing on whole catchments and regional themes, rather than confining attention to their own properties, and many groups have amalgamated into loosely bound but highly task-orientated and opportunistic regional networks. There are also a large number of other groups active at a regional level that promote or assist in tree planting for environmental purposes which are not directly associated with Landcare. Due mainly to the high establishment cost, limited financial support and a lack of direct economic returns (at least in the short term), conservation plantings tend to be small in area. While timber production is not excluded as a potential forest use, the environmental sensitivity of many of the areas established and high non-wood benefits generated from these areas suggest that it is unlikely they will produce substantial volumes of timber.

Small-scale forestry involving the establishment of woodlots as an integrated part of farm activities is growing in popularity, although accurate figures on the extent of planting are difficult to obtain. There are also about 42 M ha of native forest under private ownership in Australia (Table 2.1). Most is on leasehold land, with the forests under the control of the Crown. However, some of the more productive native forest is on private land. Logging of these areas is often ad hoc and uncontrolled. The importance of these areas for conservation and as a source of sustainable timber production has recently been recognised by governments, and programs have been developed to improve the management of these forests.

2.4 The Nature and Extent of Small-scale (Farm) Forestry in Australia

The nature of small-scale forestry differs from country to country (see for example Harrison *et al*. 2000) and it is difficult to define what is meant by small-scale forestry. Harrison and Herbohn (2000) have suggested that large-scale forestry is typically owned or managed by government or large companies, and has a focus on large, even-aged, single species blocks, with compartments of varying ages. A primary aim of large-scale forestry is to provide regular volumes of timber over time in a cost-effective manner with minimal labour input, to supply established long-term market contracts. In contrast, small-scale forestry typically consists of a single blocks (or a small number of stands), non-professional management and often a lack of silvicultural skills, with little planning for future marketing.

The term ‘farm forestry’ is commonly used in Australia, although it’s meaning is poorly defined. The common interpretation is simply ‘forestry undertaken on farms’, which involves small-scale farm woodlots, but may also include windbreaks and shelter belts, agroforestry (in the narrow sense of combining forestry with crops) and break-of-slope plantings. These activities are consistent with the interpretation of small-scale forestry outlined by Harrison and Herbohn (2000). Farm-based forestry may also involve large-scale planting of monocultures under joint venture arrangements, and the leasing of farmland to industrial forestry companies for industrial plantations. These latter activities are more consistent with the definition of large-scale forestry suggested by Harrison and Herbohn (2000).

Preliminary data from the National Farm Forestry Inventory (NFFI) (see Table 2.2) indicates that there are 76,250 ha of small-scale plantations in Australia, most of which are found in the states of Victoria, New South Wales, Western Australia and Tasmania. Queensland, despite highly favourable growing conditions and an abundance of suitable land, has a relatively small area of small-scale plantations. Table 2.2 does not contain data on the large number of individual landholders who have entered into farm forestry via joint venture agreements or leasing arrangements with commercial tree grower companies. It is probable that of the order of 20% of Australia’s total plantation resource has been established via joint venture arrangements (Stephens 2001). Early analysis of data collected through the NFFI suggests that the size and nature of plantations can vary greatly between regions (Stephens 2001).

It appears that there are two quite distinct farm forestry sectors developing in Australia. The first is based around the growing of *E. globulus* for pulp. Planting of *E. globulus* on farms mirrors recent trends in the large-scale industrial private sector, and the area is greatest in those States where this species is grown in industrial estates, i.e. Victoria, Tasmania and Western Australia. Rotation periods are typically around seven to eight years. Farmers involved in growing *E. globulus* seem typically to be primarily motivated by financial returns. The second distinct type of farm forestry involves the growing of native hardwoods, often in mixed-species configurations, for saw and veneer logs. This type of farm forestry dominates in NSW and is developing in Queensland. Rotation periods are typically 30 to 50 years. A range of motivations has been found for farmers entering into farm forestry (e.g. see Emtage *et al*. 2000). In addition to financial returns, considerations such as conservation, personal satisfaction and farm aesthetics are viewed as being important.

Table 2.2. Small grower plantations in Australia

State or region	Total area (ha)	Main species planted
VIC	24000	*Eucalyptus globulus, E. nitens, E. cladocalyx, Pinus radiata*
NSW	16000	*E. nitens, E. grandis, Corymbia maculata, P. radiata* and cabinet timbers
QLD	3000	Numerous eucalypt species and cabinet timbers, *P. caribaea*
WA	13000	*E. globulus, P. radiata, P. pinaster*, plus 6000 ha of oil mallee species
Green Triangle, Vic/SA	3300	*E. globulus* and *P. radiata*
Mt Lofty, SA	1900	*E. globulus, C. maculata* and *P. radiata*
Tasmania	15000	*E. globulus, E. nitens* and *P. radiata*
NT	50	*E. pellita,* Sandalwood and *Acacia sp.*
Total	76,250	

Source: Bureau of Rural Sciences (2001).

2.5 The Forestry Sector in Northern NSW and South-east Queensland

The two areas of interest in the current project closely approximate the Northern Tablelands region and to a lesser extent the South-east Queensland region, as defined in the National Plantation Inventory (NPI).

Forestry in the Northern Tablelands

Wood *et al.* (2001) described the Northern Tablelands as having a total plantation resource of about 16,543 ha, comprising 16,142 ha of softwood species (mostly *Pinus radiata*) and 392 ha of hardwood species. There is limited farm forestry planting in the region, with 15,722 ha (95%) of the plantation estate being industrial plantations and only 821 ha (5%) being farm forestry plantings. In the Northern Region of NSW, which incorporates the Northern Tablelands, forestry contributed 1.5% ($81.4M) of regional output and 2.0% (1,278) of the number of paid jobs in 1993-94. The equivalent shares for agriculture in the region were 19% and 18%, respectively. The economic impact of forestry is far greater on a local scale in some towns (e.g. Walcha, which has the largest hardwood mill in NSW). There are few hardwood plantations, and all hardwood timber is sourced from State Forest and private native forests. A conservative estimate of the sustainable harvest of hardwood on private land in the Region has been set at 250,000 m^3/year. CARE studies suggest that less than 10,000 m^3 of this resource is used for timber production. Consequently, the scope for the sustainable management and harvesting of native hardwood and cypress forests on the Tablelands is large.

The Northern Tablelands/New England Regional Plantation Committee has actively promoted farm forestry; however, there is a lack of markets and processing capacity for farm-produced timber. Landholders in the region do not currently have access to annuity schemes or joint venture arrangements with State Forests of NSW to grow hardwoods on their land, as are available to landholders in some other regions (Wood *et al.* 2001). A recent study by Greening Australia identified the following species as having sound potential: *Corymbi maculata* (Spotted Gum), *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box), *Casuarina cunninghamiana* (River Oak), *E. sideroxylon* (Mugga Ironwood) and *E. camaldulensis* (River Red Gum).

Forestry in South-east Queensland

State Forests have been a major source of native hardwood timbers in south-east Queensland. However, as noted by Capill (2002, p. 3), 'half the State native forest used for hardwood timber production is being transferred into the conservation reserve system, as part of the SEQ Forest Agreement, with the remainder to be transferred progressively during the next 25 years'. Hence, in the future there will be increased reliance on plantation forestry, supplemented by a small proportion of the timber native forests on private land.

There are substantial plantation resources in the South-east Queensland NPI region, with a total of 165,451 ha comprised 155,523 ha of softwood species and 9,046 ha of hardwood species (Wood *et al.* 2001). Most of these plantations are located in the coastal strip north of Brisbane. There are currently few plantations on the Darling Downs. In the South-east Queensland NPI region here are 989 ha of farm forestry plantations, comprising less than 1% of the total plantation estate. About 890 ha of farm plantations are hardwoods and over 80% of these are recorded as being mixed species plantings.

In the greater Darling Downs area, there is an estimated 120,000 ha of privately owned native forests, most of which has no previous history of harvesting. With an approximate production of millable timber of 0.3 m^3/ha/yr, an estimated on-farm price of $30/$m^3$, and a regional forest multiplier of 1.75, immediate sustained harvesting could boost the local economy by $1.98 M/yr. In addition, 20,000-30,000 ha has been set aside from agricultural use each year for the last few years, for conservation and other purposes but only 50-100 ha is used for commercial tree crops in block plantings. There is

also growing interest in establishing commercial trees in strip plantings around farm and paddock perimeters. If 5% (a recommended optimal increase by AACM International, 1996) of the 7.9 M ha was set aside for plantation, with a millable return of $5m^3$/yr and at $\$35/m^3$, this would contribute $122.5 M/yr to the regional economy. Perimeter plantings also offer potentially large benefits in northern NSW cropping zone and the central Highlands. Forest process models, such as 3PG (Landsberg and Waring 1997) and ProMod (Battaglia and Sands 1997) provide the means to quantify the commercial viability of yields from such plantings. These models are being refined for application in sub-tropical environments in a related JVAP project the outcomes of which have contributed to the incorporation of biological growth information within this project.

Wood *et al*. (2001) reported that farm forestry pursuits in the region are promoted via a large network of forest grower groups and that strategic guidance is provided by the South Queensland Forestry Development Association which is developing an action plan to promote plantation development and native forest management. Twenty five private forestry support groups currently exist in Queensland, about 10 of which are in the south-east (Anon 2002).

2.6 Farm Forestry Research

The importance of research in the development of a vibrant farm forestry sector in Australia cannot be overstated. Up until 10 years ago, a relatively scant amount of research had been undertaken. Most research relating to forestry had been focussed on improving the silviculture and performance of industrial conifer plantations, with some research on native forest management. With the decreasing importance of native forest logging, and the substantial increase in the rate of establishment of native hardwood plantations, there has been a corresponding shift in forestry research emphasis towards the genetics and silviculture of native hardwoods. There has also been an increase in farm forestry research, both from a silviculture and socio-economic perspective. This research, while still at a relatively early stage has provided important information that has greatly assisted the development of farm forestry plantings.

There are a number of Commonwealth funded agencies that either undertake farm forestry research or act as funding providers for other organisations to do so. Two notable examples are the Joint Venture Agroforestry Program (JVAP) that draws funds from three separate Commonwealth funding agencies and the Forestry division of AFFA. At least two Cooperative Research Centres (the Rainforest CRC and the CRC for Sustainable Production Forestry) are also undertaking research relevant to farm forestry. Various State agencies have undertaken important farm forestry research. For example, In Queensland, the Queensland Forest Research Institute (QFRI) and the Queensland Department of Natural Resources and Mines (NRM) have undertaken a number of farm forestry studies in such diverse areas as plant breeding, silvicultural systems, management of private native forests and some socio-economic research.

The breadth and extent of recent farm forestry research is indicated by publications which span such diverse studies areas as:

- the identification of suitable areas for farm forestry (e.g. Stephens *et al*. 1998);
- planting systems and trials (e.g. Abel *et al*. 1997, Lamb and Borschmann 1998, Lamb and Keenan 2001);
- integrating biodiversity and farm forestry (e.g. Dames and Moore NRM/FORTECH 1999, Herbohn *et al*. 2000);
- financial models and information systems (e.g. Herbohn *et al*. 1998b,c, Norman *et al*. 2001, Emtage *et al*. 2001b);
- landholder attitudes and extension (e.g. Harrison *et al*. 1994, Herbohn *et al*. 1998a, Black *et al*. 2000, Emtage *et al*. 2000, Emtage *et al*. 2001a);
- markets for farm forestry products (e.g. Smorfitt *et al*. 2002);

- processing timber on farms (e.g. Hanson and Stewart 1997, Smorfitt *et al*. 1999, McCormack *et al*. 2000);
- taxation (e.g. Smorfitt and Berry 1997, Smorfitt *et al*. 2001b); and
- various other social aspects of forestry (e.g. Race 2000).

Apart from these completed projects there are a large number of projects currently in process which will provide information to further assist the development of a vibrant farm forestry industry (e.g. RIRDC 2002). There have been a number of recent efforts to ensure dissemination of information relevant to farm foresters (e.g. the market report compiled by U.N. Bhati at ANU) and to more widely disseminate research results (e.g. publishing of conference proceedings by Race 2000, Herbohn *et al*. 2001), and the web-based forestry publications of RIRDC).

It is beyond the scope of this chapter to review all the recent literature on farm forestry. The following sections briefly outline some of the more important farm forestry research that is directly related to the current project.

2.7 Landholders' Attitudes to Farm Forestry

Surveys of landholders have produced useful insights into what are important elements to consider when developing financial models and decision support systems. Recent surveys of landholders are summarised in Table 2.3. The key findings of these studies are:

- financial returns from forestry are important but there is little information available, particularly for native hardwoods (excluding *E. globulus*);
- the main reasons for planting trees are 'environmental', although the number of trees planted for this purpose tends to be small and concentrated in non-productive areas of the farm;
- the main impediments to greater planting are associated with economic factors; and
- farmers are interested in the wider benefits of trees, possibly because of poor information on financial returns and the economic impediments.

More detailed discussions of the implications of past studies of landholder attitudes for farm forestry development are presented in subsequent chapters of this report.

2.8 Studies of Financial and Economic Impacts of Farm Forestry

Input-output and closed general equilibrium (CGE) models are used by economists to examine the impacts of forestry investment at the regional level. Impact is typically expressed as output, employment and income multipliers. A recent example of such an analysis is the assessment of the potential impacts of a farm forestry industry on the Goulburn regional economy undertaken by Todd *et al*. (1997). As well, employment and output multipliers for the five forestry regions in Queensland are reported by DPI Forestry (1998). Earlier estimates were obtained by the Fraser Island Commission of Inquiry (1991). Typically, each $1M increase in forestry expenditure results in about $1.8M output and income in the region, and about 40 additional jobs.

It is well documented that the regional economic flow-ons from forestry are substantial, provided processing and contractor operations are carried out within the region. In cost-benefit terms, the potential net benefits from the management of existing native forest with commercial volumes of extractable timber are positive because there are no establishment costs – only silvicultural costs – and harvesting can begin immediately rather than in 20-30 years time. Past 'high grading' (selective harvesting through removal of only the best and biggest trees) has left many of these native forests in

Table 2.3. Results of past surveys examining reasons for tree planting, incentives to planting and constraints to tree planting and management

Survey	Reasons for planting	Constraints to planting	Incentives to plant
Schaefer and Sinden (1969)	Only looked at one planting scheme (poplar plantations)	Rotation time 59% Economic doubts 23% Trad. farmland 10% Technical doubts 4% Too much work 4%	-Support for: Annual payment a)equal to present income 63% b)annuity of expected return 44% -Full tech. assist. 8% -Subsidy of % costs 4%
Reid (1987)	Reasons for practicing agroforestry; -liked trees and the idea -diversification of income -sound economic investment -economically efficient way to provide shelter to stock -to produce timber	Disadvantages of agroforestry ; -loss of grazing returns in early years -demand on labour -lack of good information -tree protection from stock and vermin -management skills required	Not examined
Prinsley (1991)	-windbreaks 16.6% -shelter 14.1% -shade 13.8% -soil conservation -salinity control and reclamation -biodiversity -commercial timber Overall 26% had planted, over 50% in Vic. and W.A., less than 10% in N.S.W. and Qld	-economic and financial doubts 60% -technical doubts 14% -competition with agriculture 14% -negative attitude 6% -low priority 5%	Prove the economic advantages and compatibility of integrating forestry with agriculture
Harrison, Sharma and Lamb (1994) Harrison *et al.* (1994)	Most planting for ecological and aesthetic rather than commercial reasons; to protect/restore land, for wildlife, personal interest in trees, farm beautification, watershed protection. 36% had planted	-long wait for returns -high capital needs -high labour demands -concern about harvest regulations -concern about profitability -lack of machinery for tree growing -risk of pests and diseases	Not examined
Stewart and Reid (1994)	Remnant forests good for: -shelter 46% -wildlife 21% -on-farm timber 20%	Problems with commercial wood production; - establishment 15% - management 12% - marketing 12%	Not examined

	Plantings for: -shelter 70% -land protection 55% -timber 35% -wildlife 17% -aesthetics 13%	- cost in time 12% - harvesting 11% - cost in money 10% - information 9% Note: variation across region	
Lyons and Lambrino (1994)	-diversify farm income -increase capital assets, long term speculation, control of land deg. -shelter for stock/pastures -wildlife habitat and landscape improvement	-lack of compatibility of joint venture schemes with agricultural pursuits, -perception of problems marketing/sales	Better understanding between farmers and industry, in terms of contracts offered and compatibility with agricultural activities.
Mues, Roper and Okerby (1994) Mues *et al.* (1994)	Examined conservation farming practices, -reported 44% of farmers planting in total, mostly for wind breaks/stock shelter, -reported 11% planting for soil conservation, -many plantings said to be multi-purpose	Not surveyed, discusses impacts of economics and financial pressures, behavioural influences/ personal attitudes, impacts of government policies, the role of information etc	Not examined specifically in relation to tree establishment and management
Emtage (1995)	Conservation highest rated reason for planting or managing trees, followed by shelter and timber. Greatest actual number of trees planted for timber, shelter then conservation	Lack of water rated as greatest impediment followed by uncertainty about harvest rights the financial effects of planting and then the size of the landholding and pest risks (time of extreme drought)	Commercial incentives including harvest guarantee rated significantly more useful than joint venture type incentives.
Specht and Emtage (1998)	As above. Landholders grouped according to their ratings of reasons for planting.	Economic constraints (including lack of time and time until harvest) rated highest, followed by production problems such as damage from cattle and lack of equipment	Harvest guarantee rated highest followed by tax incentives, information provision and annuity schemes.
Herbohn *et al*. (1998a)	'Conservation/environmental' protection highest rated reason for planting, then 'personal' reasons and then 'timber'. Landholders grouped according to their ratings of reasons for/restrictions to planting.	In order of descending importance: Economic/structural impediments; Satisfaction with current activities; Information limitations; Resource limitations; Physical risks; Site limitations	In order of descending importance: Economic incentives; Information incentives; Joint venture schemes

a degraded condition and requiring some investment in improved silviculture and some time before substantial timber production can take place.

The advantage in straight economic terms is that native forest management is not an alternative enterprise competing with other farm activities. For farms with sufficiently large areas of native forest resource, the issue is about converting largely unproductive resource into a productive one. Moreover, in terms of regional employment effects, work by CARE has shown that on a per hectare basis, a well-integrated forestry industry can employ up to 12 times as many people as the beef cattle industry, for the same area of land. On the Northern Tablelands, the basis of such an industry is more likely to be native forest where costs are relatively low compared with plantations of fast growing softwoods.

In addition to market benefits, there will be non-market benefits from the retention of native forest (and from the establishment of plantations) on private land in terms of shelter for stock, biodiversity and habitat value, erosion control and water and nutrient cycling. The current incentive for many landholders is to gradually clear native forest for more traditional agricultural activities. If the native forest resource can be shown to have a commercial value and sound guidelines for its management are applied, this trend may be reversed.

Financial models, typically in the form of a computer spreadsheet, are used to determine the profitability of farm forestry, say in terms of net present value per hectare (e.g. Lourain-Smith 1993, Herbohn *et al*. 1998b). Also, financial models may examine the profitability of forestry within the context of other farm enterprises (Capill 1996). There a number of financial models available to calculate costs and returns associated with farm forestry in Australia, and these are reviewed in Chapter 3. For example, the Australian Cabinet Timbers Financial Model (Herbohn *et al*. 1998b,c) is a spreadsheet-based model developed primarily to predict returns from mixed-species plantations of high-value rainforest cabinet timber (Harrison *et al*. 2001). This Australian Cabinet Timbers Financial Model (ACTFM) uses a series of Visual Basic macros and buttons bars to enhance usability of the model. The model is readily adaptable to areas outside of north Queensland and has been used recently in the Philippines (Venn *et al*. 2001).

2.9 Estimates of Stand Growth Rates

Only limited information is available about yields of most native timber species (e.g. as established by Russell *et al*. 1993, Herbohn *et al*. 1999). Some progress has been made in biological modelling of timber yields of mixed species plantings (Vanclay 1991, 1994). Further work is in progress at the Forest Research Institute at Atherton, using the North Queensland Rainforest Management (NQRM) model (Keenan 1998).

2.10 Efforts to Develop Farm Forestry Decision-Support Systems

Natural resource management decisions, such as those involving farm forestry, are distinguished from single objective problems by the need to consider several, and possible conflicting, criteria in the decision-support process. When trade-offs are required between economic, environmental, social and legislative aspects, it is more appropriate to use a Multi-Objective Decision-Support System (MODSS). Recently, several MODSSs have been developed or adapted within Australia for applications in natural resource management, for example, AEAM (Adaptive Environmental Assessment and Management, Grayson *et al*. 1994) and CMSS (Catchment Management Support System, Davis *et al*. 1991). These systems integrate modelling approaches with stakeholder information to examine the impact of policy and land-use at the catchment scale. From the literature, it appears that both the AEAM and the CMSS systems provide only a limited capacity to include social aspects of resource management. Research work in progress, which will advance decision-making, includes ‘Decision support for sustainable management of grazing lands’ (J. Bellamy, CSIRO–LWRRDC funding), ‘Community participation in improving land use and management’ (A. Campbell, University of Melbourne–LWRRDC funding) and ‘Decision support systems for

sustainable agricultural management and sustainability' (R. Itami, Victorian Department of Natural Resources and Environment). While considerable work has been undertaken to develop and verify indicators of sustainability, there are limited accounts of specific applications of MODSS to identify preferred options in the farm forestry industry. A means of integrating farm forestry economics with biophysical modelling and expert opinions is needed.

Decision-support systems that are generic, capable of considering soil, water, plants, air, animals and human requirements and supported by scientific rigour are needed to successfully support property and regional scale decision-making. The USDA-ARS and the NRM in Queensland jointly developed a MODSS which can integrate a diverse range of decision criteria and utilise measured data, simulation models and expert opinions in the decision-support process (Lane *et al*. 1991, Yakowitz *et al*. 1993, Lawrence *et al*. 1997). In addition, the decision model requires participants to nominate an importance order for the criteria which overcomes the difficult, and largely contentious, issue of assigning numerical weights to decision criteria. The process involves stakeholders at the outset, and becomes highly interactive when exploring 'what-if' scenarios. In 1993, a RIRDC Postgraduate Scholarship provided the opportunity for Paul Lawrence, a member of this project, to work with the USDA-ARS in Arizona. Since that time, NRM has undertaken several studies to assist landholders improve their decision-making using this tool.

2.11 Concluding Comments

The growing of trees is clearly an activity that farmers consider to be part of wider farm activities. The modelling work developed as part of the current project recognised this – directed at both the individual farm level (i.e. the Australian Farm Forestry Financial Model) and at the regional scale (i.e. the farm forestry MODSS). This provides support for the 'whole farm' financial modelling approach adopted in the development of the AFFFM which will allow farmers to investigate the impact of forestry on the overall farm financial operations. It is also clear that there is an urgent need for an integrated framework to assist planning of farm forestry development on a regional scale. Such a framework is provided by MODSS that has been developed in the current project.

References

Abel, N, Baxter, J., Cambell, A., Cleugh, H., Fargher, J., Lambeck, R., Prinsley, R., Prosser, M., Reid, R., Revell, G., Schmidt, C., Stirzacker, R. and Thorburn, P. (1997), Design principles for farm forestry: a guide to assist farmers to decide where to place trees and farm plantations on farms. RIRDC, Canberra.

Anon (2002), 'Private Forestry Support Groups in Qld', *Queensland Forest Network News*, Issue 7, May, p. 48.

Alexandra, J. and Hall, M. (1998), Creating a viable farm forestry industry in Australia: What will it take? RIRDC Publication No. 98/74, Canberra.

Battaglia, M. & Sands, P. (1997), Modelling the productivity of *Eucalyptus globulus* in response to climatic and site factors, *Australian Journal of Plant Physiology*, 24: 831 - 850.

Black, A.W., Forge, K. and Frost, F. (2000), Extension and advisory Strategies for Agroforestry. A report for the RIRDC/LWRRDC/FWPRDC Joint Venture Agroforestry Program, RIRDC Publication No. 00/184, Canberra.

Capill, L. (1996), 'Adoption of a New Zealand agroforestry evaluation model to a site in south east Queensland', in A. Grodecki, ed., *Managing and Growing Trees on Farms*, Greening Australia Queensland, Brisbane, Volume 2, pp. 399-407.

Capill, L. (2002), 'Trends in Private Forestry in Queensland', *Queensland Forest Network News*, Issue 7, May, p. 3, 6, 28.

Commonwealth of Australia (1992), *National Forest Policy Statement: a New Focus for Australia's Forests*, Canberra.

Dames and Moore NRM/FORTECH (1999), Integrating Farm Forestry and Biodiversity. RIRDC Publication No. 99/166, Canberra.

Davis, J.R., Nanninga, P.M., Biggins, J. and Laut, P. (1991), Prototype decision support system for analyzing impact of catchment policies, *J.Water Resources Planning and Management*, 117: 399-414.

DPI Forestry (1998), *An Overview of the Queensland Forest Industry*, Queensland Department of Primary Industries, Brisbane.

Emtage, N. (1995) *Landholders' Perceptions of Planting and Managing Trees*, B.App.Sci. Hons. Thesis, Southern Cross University, Lismore.

Emtage, N.F. and Specht, A. (1998), 'Landholders' perceptions of farm forestry in the northern rivers region of New South Wales', in R. Dyason, L. Dyason and R. Garsden eds., *Plantations and Regrowth Forestry: a Diversity of Opportunities*, Proceedings of the biennial conference of the Australian Forest Growers, Southern Cross University, Lismore, pp. 345-369.

Emtage, N.F., Harrison, S.R. and Herbohn, J.L. (2001a), 'Landholder attitudes to and participation in farm forestry activities in sub-tropical and tropical eastern Australia', in S.R. Harrison and J.L. Herbohn, eds., *Tropical Small-scale Forestry*, Edward Elgar, Cheltenham, pp. 195-210.

Emtage, N.R., Herbohn, J.L., Harrison, S.R. and Thompson, D. (2001b), The Australian Farm Forestry Financial Model (Visual Basic Version), School of Natural and Rural Systems Management, The University of Queensland, Brisbane.

Emtage, N.F., J.L. Herbohn and S.R. Harrison (2000), 'Using Segmentation Analysis to Understand Landholders Attitudes to Farm Forestry in Australia', proceedings of the *10th World Congress of Rural Sociology*, held in Rio de Janerio July-August 2000, International Rural Sociology Association.

Fraser Island Inquiry (Commission of Inquiry into the Conservation, Management and Use of Fraser Island and the Great Sandy Region) (1991), Appendices, Volume 1, Goprint, Brisbane.

Grayson, R.B., Doolan, J.M. and Blake, T. (1994), Application of AEAM (Adaptive Environmental Assessment and Management) to water quality in the Latrobe River Catchment, Environmental Management 41(3), 245-258.

Hansen, I. and Stewart, M. (1997), Processing trees on farms: A literature review for the Rural Industries Research and Development Corporation, RIRDC Report 97/20, Canberra.

Harrison, S.R., Sharma, P.C. and Lamb, D. (1994), Progress in farm forestry in the Obi Obi Valley. Paper presented to the Farm and Community Forestry Seminar, Dorroughby Field Studies Centre, NSW.

Harrison, S.R., Herbohn, J.L. and Herbohn, K.F. (2000), *Sustainable Small-scale Forestry: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham, 247 pp.

Harrison, S.R. and Herbohn, J.L. (2000), 'The role of small-scale forestry throughout the world', in S.R. Harrison, J.L. Herbohn and K.F. Herbohn, eds., *Sustainable Small-scale Forestry: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham, pp. 3-13.

Harrison, S.R., Herbohn, J.L. and Emtage, N.F. (2001), 'Estimating investment risk in small-scale plantations of rainforest cabinet timbers and eucalyts', in S.R. Harrison and J.L. Herbohn, eds., *Sustainable Farm Forestry in the Tropics: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham, pp. 47-60.

Herbohn, J.L., Harrison, S.R., Emtage, N. and Smorfitt, D.B. (1998a), Attitudes of landholders to farm forestry in North Queensland and the implications for policy development, *Integrating Environmental Values into Small Scale Forestry*, IUFRO Symposium, Vancouver, Canada, 16-20 August 1998.

Herbohn, J.L., Harrison, S.R. and Emtage, N. (1998b), Australian Cabinet Timber Financial Model, Computer software based on Microsoft Excel, James Cook University, Townsville.

Herbohn, J.L., Harrison, S.R., Emtage, N. and Smorfitt, D.B. (1998c), The Australian Cabinet Timber Financial Model: A model for mixed species cabinet timber plantations in North Queensland, *Proceedings from the Managing and Growing Trees Training Conference, October* 1998, Vol. 2 pp. 397-406.

Herbohn, J.L., Harrison, S.R. and Emtage, N. (1999), 'Potential performance of rainforest and eucalypt cabinet timber species in plantations in North Queensland', *Australian Forestry*, 62(1): 79-87.

Herbohn, J.L., Harrison, S.R., Lamb, D. and Keenan, R. (2000), Small-scale Forestry Systems for Timber and Non-timber Benefits including Biodiversity, in S.R. Harrison, J.L. Herbohn and K.F. Herbohn, eds., *Sustainable Small-scale Forestry*, Edward Elgar, Cheltenham, pp. 14-25.

Keenan, R. (1998), Forest Research Institute, Atherton, personal communication.

Lamb, D. and Borschmann, G. (1998), *Agroforestry with high value trees*, RIRDC Publication 98/142, Canberra.

Lamb, D. and Keenan, R.J. (2001). Silvicultural research and development of new plantation systems using rainforest tree species in north Queensland. in S.R. Harrison and J.L. Herbohn, *Tropical Small-scale Forestry*, Edward Elgar, Cheltenham, pp. 21-38.

Lane, L.J., Ascough, J.C. and Hakonson, T.E. (1991), Multiobjective decision theory – decision support systems with embedded simulation models, Irrig. and Drainage Proc., IR Div., American Society for Civil Engineering, Honolulu, July 22-26, pp. 445-451.

Landsberg, J. J. and Waring, R. H. (1997), 'A generalised model of forest productivity using simplified concepts of radiation-use efficiency, carbon balance and partitioning', *Forest Ecology and Management*, 95: 209-228.

Lawrence, P.A., Stone, J.J., Heilman, P. and Lane, L.J. (1997), 'Using measured data and expert opinion in a multiple objective decision support system for semiarid rangelands', *American Society for Agricultural Enginering*, 40(6): 1589-1597

Lourain-Smith, R. (1993), 'Modelling mixtures of species', in *Computers in Forestry: Use of Spreadsheets*, Wiley, New York, Ch. 7

Lyons, A. and Lambrino, M. (1994) *Survey on commercial tree growing information*, Department of Conservation and Natural Resources, Melbourne.

McCormack, B., Kerruish, B., Reid, J., Antilla, E. and Stewart, M. (2000), Harvesting trees on farms, RIRDC Report No. 00/46, Canberra.

Marriott, S., Nabben, T., Polkinghorne, L. and Youl, R. (2000), Landcare in Australia: Founded on local action, *International Landcare Conference*, Melbourne, Australia, February.

Mues, C., Roper, H., and Okerby, J. (1994) *Survey of Landcare and land management practices: 1992-93*, ABARE Research Report 94.6, Canberra.

National Forest Inventory (1998), Australia's State of Forests Report 1998, Bureau of Rural Sciences, Canberra.

NPI (2000), National Plantation Inventory, National Plantation Inventory Tabular Report – March 2000.Bureau of Rural Sciences, Canberra.

Norman, P., Cockfield, G., Emtage, N., Harrison, S.R., Herbohn, J.L., Lawrence, P., Thompson, D. and Williams, K. (2001), Trees and cows, cash and conservation: A whole farm and regional agroforestry decision making system, in *Developing Policies to Encourage Small-scale Forestry*, J.L. Hebohn, S.R. Harrison, K.F. Herbohn and D.B. Smorfitt, eds., Proceedings of the IUFRO Research Group 3.08 Symposium, Cairns, Australia. 9-13 January, 2000, pp. 201-211.

O'Regan, M. and Bhati, U.N. (1991), Pricing and allocation of logs in Australia, Discussion Paper 91.7, Australian Bureau of Agricultural and Resource Economics, Canberra.

Plantations 2020 Vision Implementation Committee (1997), *Plantations for Australia: The 2020 Vision*, Ministerial Council on Forestry, Fisheries and Agriculture, Standing Committee on Forestry, Plantations Australia, Australian Forest Growers and National Association of Forest Industries, Canberra.

Prinsley, R.T. (1991), *Australian Agroforestry – setting the scene for further research*, Rural Industries Research and Development Council, Canberra.

Race, D. ed. (2000), Socio-economic research to support successful farm forestry: Selected papers from the ANU Forestry Colloquium, RIRDC Report No. 01/13, Canberra.

Reid, R. (1987), 'Agroforestry: a study of agroforestry extension and a model of light interception in agroforestry', Masters thesis, Melbourne University School of Forestry, Melbourne.

RIRDC (2001), http://www.rirdc.gov.au/programs/aft.html#newprojs, accessed 8 July, 2002.

Russell, J.S., Cameron, D.M., Whan, I.F., Beech, D.F., Prestwidge, D.B., and Rance, S.J. (1993), 'Rainforest Trees as a New Crop for Australia', *Forest Ecology and Management*, 60: 41-58.

Sinden, J.A. and Schaefer, N.T. (1969), Farmer attitudes to farm forestry on the north coast of New South Wales, Department of University Extension, University of New England, Armidale.

Smorfitt, D. B. and Berry, M. L. (1997), 'A review of the capital gains tax treatment of the disposal of existing trees by landholders', *Australian Forestry*, 60 (4), 213-217.

Smorfitt, D.B., Herbohn, J.L. and Harrison, S.R. (1999), 'Factors in the acquisition and utilisation of portable sawmills in Queensland', *Australian Forestry*, 62(1): 45-50.

Smorfitt, D.B., Herbohn, J.L. and Harrison, S.R. (2001a), 'Australian Rainforest Timbers as a Valuable Resource: Community Perceptions and Purchase Habits of Rainforest Timber Products', *Economic Analysis and Policy*, 31(2): 161-173.

Smorfitt, D.B., Berry, M.L., Cummine, A.J. and Townsend, P.V. (2001b), 'Taxation in the forestry setting', in S.R. Harrison and J.L. Herbohn, eds., *Tropical Small-scale Forestry*, Edward Elgar, Cheltenham, pp. 179-194.

Smorfitt, D.B., Herbohn, J.L. and Harrison, S.R. (2002), 'Cabinet-Makers' Awareness and Usage of Rainforest Cabinet Timbers in Queensland', *Small-scale Forest Economics, Management and Policy* 1(1): 103-117.

Specht, A. and Emtage, N.F. (1998), Landholders' perceptions of farm forestry in the Northern Rivers region of New South Wales, Report to the Northern Rivers Regional Plantation Committee, Ballina, NSW.

Stephens, N., Sun, D. and Tickle, P. (1998), Plantation Potential Studies in Australia: an Assessment of Current Status, Bureau of Rural Sciences, Canberra.

Stephens, N. (2001), Project Manager, National Farm Forestry Inventory, personal communication.

Stewart, A. and Reid, R. (1994), The design and development of agroforestry and farm forestry options to match farmer needs in the Otway ranges, proceedings *Australian Forest Growers conference (1994) Faces of Farm Forestry*, Launceston, Tasmania.

Todd, C.R., Loane, I.T. and Ferguson, I.S. (1997), Potential impact of a farm forestry industry on the Goldburn regional economy, School of Forestry and Resource Conservation, Bulletin No.10 University of Melbourne.

Vanclay, J.K. (1991), *Modelling the Growth and Yield of Tropical Forests*, D.Sc.For. thesis, The University of Queensland, Brisbane.

Vanclay, J.K. (1994), *Modelling Forest Growth and Yield: Applications to Mixed Tropical Forests*, CAB International, Wallingford, UK.

Venn, T.J., Harrison, S.R. and Herbohn, J.L. (2001), 'Relative financial performance of Australian and traditional timber species in the Philippines', in S.R. Harrison and J.L Herbohn, eds., *Socio-economic Evaluation of the Potential for Australian Tree Species in the Philippines*, ACIAR Monograph 75, pp. 93-110.

Vise, S.M. and Creighton, C. (2001), 'Institutional impediments to farm forestry', in S.R. Harrison and J.L. Herbohn, eds., *Tropical Small-scale Forestry*, Edward Elgar, Cheltenham, pp. 241-256.

Wood, M.S., Stephens, N.C., Allison, B.K. and Howell, C.I. (2001), Plantations of Australia – A report from the National Plantation Inventory and the National Farm Forestry Inventory, National Forestry Inventory, Bureau of Rural Sciences, Canberra.

Yakowitz, D.S., Lane, L.J. and Szidarovszky, F. (1993), 'Multi-attribute decision making: dominance with respect to an importance order of the attributes', *Applied Math. and Comput.*, 54: 167-181.