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Australian experiences of farm forestry

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Summary

Farm forestry is increasingly promoted in many countries as a land-use option which is likely to provide benefits in terms of improving the viability of agriculture, developing additional timber resources for industry, and enhancing regional development. This paper draws upon experiences of farm forestry in Australia to identify some lessons for its development that may be relevant to other countries. The paper provides an overview of farm forestry in the Australian context and reports on a recent review of leading case studies to provide some insights into means of future development. Three case studies are included to illustrate the diverse nature, and multiple benefits sought, of farm forestry. The important requirements of landholders pioneering farm forestry relate to: managing risks, participating in research and development, contributing to information exchange, addressing key farm issues, developing in-depth farm knowledge, establishing links with government and/or industry, and contributing to long-term community values.

Keywords: case studies, socio-economic and environmental benefits, government policy and programmes

Introduction

Forestry is being redefined to meet a broad range of economic, environmental and social expectations (Sargent 1992; Kanowski 1995; Ferguson 1996; Myers 1996; Campbell 1997). As this happens, farm forestry is emerging as an important form of forestry (Pearse 1994; Kanowski 1996). For the purpose of this paper, farm forestry is viewed broadly as the integration of trees and/or shrubs with agricultural systems for multiple benefits.

As in many countries, farm forestry is increasingly promoted in Australia as a land-use option which is likely to provide benefits in terms of improving the viability of agriculture, securing additional timber resources for industry, and enhancing regional development (Commonwealth of Australia 1992, 1995). In particular, for regions, it appears to offer substantial benefits (McDonald 1993; Farm Forestry Task Force 1995), principally in the form of reduced environmental costs, by arresting land degradation (Powell 1995), diversifying farm incomes (Bird & Jowett 1996), and contributing to industrial development (particularly if timber processing is completed) and its associated employment (Dwyer Leslie Propriety Ltd & Powell 1995; Todd & Loane 1995). However, despite its apparent potential to achieve gains in economic, environmental and social terms for individuals and the wider community (Robins *et al*. 1996), viable, self-sustaining farm forestry industries are only just emerging in Australia (Race & Curtis 1996*a*), and it is only since the 1980s that farmers have been encouraged to explore commercial timber production as part of an integral farm enterprise.

Farm forestry also has the potential to be an important timber source contributing to import replacement: Australia currently has a balance of trade deficit of A$2 thousand million in wood and paper products (Commonwealth of Australia 1995, p. 1) (1A$≈US$0.7, December 1997). Recent calculations by the Centre for International Economics *et al*. (1996, p. 1) indicated that 'The value of farm forestry to Australia could be A$3.1 thousand million a year once a sustainable harvest is reached'. This calculation excludes the value of processing, which could increase the value of farm forestry to as much as A$20 thousand million a year, employing 40 000 people (Centre for International Economics *et al*. 1996, p. 1).

An important part of this calculated value of farm forestry could be put towards improving the profitability of farming, as Australian farmers have encountered declining terms of trade over most of the past 40 years (Australian Bureau of Agricultural and Resource Economics 1994). Farms could also expect to benefit from the environmental gains of integrating trees with traditional agricultural practices (e.g. grazing livestock, cereal cropping). While forests and woodlands covered much of temperate Australia 200 years ago, about 100 million ha have since been cleared, primarily for agriculture (Moore & Bird 1997). This loss of the native tree cover is closely linked to much of the natural resource degradation which is prevalent in much of Australia, including dryland salinity, soil erosion, waterlogging, and loss of biodiversity (State of the Environment Advisory Council 1996).

Farm forestry could also increase timber supplies and thereby reduce pressure on native forests in Australia and South-east Asia. Farm forestry using native species could also make an important contribution to the protection of biodiversity by improving the quality of vegetation on farmland and supporting neighbouring high-value conservation areas (e.g. by serving as ecological buffer zones) (Abel *et al*. 1997).

Given these potential benefits, Federal and State governments have been developing policies and programmes to support farm forestry since the late 1980s (Donaldson & Gorrie 1996). There is already a number of case studies

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evident throughout Australia suggesting these benefits are being realized by some landholders (Reid & Stewart 1994; Washusen & Reid 1996). However, these are often isolated examples rather than being indicative of general practices. If farm forestry is to attain a sufficient scale to make a substantive contribution to regional objectives, then widespread adoption needs to occur. This paper provides an overview of farm forestry in Australia, describes three farm forestry case studies, and draws upon the work of a recent review of leading examples (Guijt & Race 1998) to identify the important requirements of landholders pioneering its development. Three case studies from Tasmania and Western Australia (i.e. Australian states) will illustrate how farmers are developing farm forestry for a range of socio-economic and environmental objectives.

Emerging government policy and programmes

While aspects of farm forestry have been practised for centuries in many communities around the world, the concept is relatively new for most farms in Australia. Indeed, much of the pastoral and cropping land in Australia was cleared of its native forest or woodland vegetation in the 1800s and 1900s so that agriculture could be established (State of the Environment Advisory Council 1996). This feat required immense commitment from generations of Australian farmers, and helped to characterize a common antipathy towards the native bush amongst agriculturalists. It was only in the 1980s that the Federal government removed the last financial incentive available for landholders to clear native vegetation (i.e. taxation subsidy for clearing costs incurred) from proposed agricultural land. During this period, the Federal government began to sponsor major revegetation programmes for conservation and land protection (e.g. control of soil erosion, rising saline groundwater) under the National Tree Programme (NTP) (McDonald 1993). The NTP operated during 1982–87, after which it was replaced by the One Billion Tree Programme, managed by Greening Australia Ltd (a non-profit non-governmental organization), which was also attempting to reverse tree decline. Although there was little interest exhibited by State or Federal governments in the development of farm forestry prior to the 1980s, there were several industrial schemes in operation during the late 1960s and 1970s (Prinsley 1991). Farm forestry under these schemes consisted of small plantations established on cleared agricultural land or recently-cleared native forest sites, to provide future timber supplies for technologically-advanced industrial processors.

Partly inspired by the existing industry schemes and government revegetation programmes, several State government programmes aimed at developing a commercial farm forestry resource were initiated during the 1980s (e.g. Plantation Sharefarming Scheme in Victoria, Private Forestry Encouragement Scheme in South Australia) (Prinsley 1991). While farm forestry received national attention in major government inquiries (e.g. National Plantations Advisory Committee 1991; Industry Commission 1993) and policy statements (e.g. Commonwealth of Australia 1992, 1995; Ministerial Council on Forestry, Fisheries and Aquaculture *et al.* 1997), there has been little attention given to the details of farm forestry prior to the early 1990s. During the 1990s, mechanisms have been established to support its research and development, such as the Federal initiative which established the Rural Industries Research and Development Corporation in 1990 and nominated farm forestry as a specific area for support (Rural Industries Research and Development Corporation 1995). To date, the largest single programme contributing to farm forestry development by the Federal government is the Farm Forestry Programme (FFP), which was initiated in 1993 (Race & Curtis 1996*b*). The FFP is largely focused on support of regional projects to:

- raise awareness of farm forestry benefits amongst potential stakeholders (e.g. landholders, industry and government);
- link key farm forestry stakeholders in the various regions suited to farm forestry to build positive collaboration; and
- increase skills and knowledge to enable stakeholders to adopt farm forestry.

The Federal government's commitment to support farm forestry industries was reaffirmed in the Wood and Paper Industry Strategy (Commonwealth of Australia 1995) and the Natural Heritage Trust (Anderson 1996), with the value of the FFP set at nearly A$40 million during 1993–2000; this was a considerable increase in programme size from the previous commitment of A$3 million for the initial three-year period. While the situation remains somewhat fluid, a detailed farm forestry policy that is consistent with other government initiatives is beginning to emerge (Donaldson & Gorrie 1996).

Besides the FFP, several other farm forestry initiatives have been developed in Australia. The Joint Venture Agroforestry Programme, initiated by the Australian government and industry in the early-1990s, included a major farm forestry research project to provide the basis of a national farm forestry strategy (AACM International Propriety Ltd *et al*. 1996). The Joint Agroforestry Programme (involving Rural Industries, Land and Water Resources, Forest and Wood Products Research and Development Corporations) and the Murray-Darling Basin Commission support investigation and development of a range of topics. These include; socio-economic factors affecting adoption, tree selection and management, harvesting, processing and marketing of forest products, interactions between trees and agriculture, environmental rehabilitation and sustainability, insect control, growth modelling, regional and national strategies, and policy analysis. Major research projects investigating many of the above areas are being conducted by the Commonwealth Scientific and Industrial Research Organization, State agencies, universities, industry, consultants and research cooperatives (e.g. Cooperative Research Centre for Sustainable Production Forestry, Trees for Profit, and Southern Tree Breeders Association).

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Most State governments have developed farm forestry programmes which link the resources of landholders (e.g. labour, land and equipment) with government wood production using contractual joint venture arrangements. For example, the Department of Conservation and Land Management (CALM), Western Australia (WA), has joint venture programmes to establish *Pinus pinaster* (maritime pine) and *P. radiata* (monterey pine) for production of particle board, saw-logs and veneer logs; *Eucalyptus globulus* (southern blue gum) for pulpwood; and *Eucalyptus* species for eucalypt oil to be used for the industrial-solvent market. By mid-1995, these CALM farm forestry programmes had established 27 500 ha of plantings with landholders (Inions 1995, p. 420). Also in WA, an industry joint venture scheme operated by an industrial processor offers landholders an annual net return of A$100–150/ha for growing *E. globulus* for pulpwood (Eckersley *et al*. 1993, p. 20). In 1994, State Forests of New South Wales began using a joint venture agreement with landholders to establish a range of eucalypts to support the hardwood saw-log industry. Financial returns from joint venture agreements are divided between partners proportional to the level of inputs. An estimated 5000–10 000 ha/year of farm forests are now being established under these schemes (Curtis & Race 1998). Tasmania has a considerable forest industry based on government, industry and private plantings. An estimated 27 000 ha of *P. radiata* and 34 000 ha of eucalypts have been established, with 75% having industry involvement through joint venture or marketing agreements (Dunchue & Sinclair 1995). In 1995, the Victorian Department of Conservation and Natural Resources (DCNR) began a joint venture farm forestry programme which will invest A$1.2 million/year for three years in the north east (dryland) and north central (irrigation) regions of the state of Victoria (Department of Conservation and Natural Resources 1996). The DCNR programme will focus on developing shared arrangements with landholders to establish up to 800 ha/year of eucalypts on agricultural land, principally for saw-logs.

Joint ventures developed around Australia have enabled growers and industry/government partnerships to establish an important timber resource of 82 900 ha, most of these established since 1985 (Curtis & Race 1998). At an approximate cost of A$1000/ha to establish farm forestry, joint ventures have contributed A$83 million to regional forest industries through tree establishment alone. These plantings represent approximately 8% of Australia's 1.043 million ha of plantations (Bureau of Resource Sciences 1997).

Some remaining uncertainties

Some observers are sceptical of the potential of farm forestry because of the:

- uncertainty of the timber quality of plantation hardwoods;
- unproven commercial prospects for growers and industry; and
- long period before financial returns can be expected by 'independent' growers.

For instance, Barr and Cary (1992, p. 97) concluded that the general enthusiasm for farm forestry '... is driven more by the desire of foresters to see trees planted on farms than the desire to see farmers exploit a proven commercial opportunity.' Concerns have also been expressed by regional vegetation advisors that farm forestry is largely driven by government and industry, rather than it being an opportunity embraced by landholders. Small (1994, pp. 168–70) provided a farmer's perspective when he reported claims that widespread tree planting will address the threatening rise of saline groundwater and soil acidity, yet the '... value of trees in solving these complex problems has been oversold ... While the important reafforestation programmes must continue, for the bulk of our farmlands, Australia needs the wealth we can generate now, not in forty or fifty years'. Margules Groome Pöyry Propriety Ltd (1995, p. 93) also made a cautious assessment of the commercial opportunities for small-scale growers and noted that '... they cannot "see" success and only see government and large processing corporations, as very tough competition. This means a very long-term investment is also high risk, with limited opportunities to optimise or even make a reasonable return on their investment.'

Many of the uncertainties about farm forestry that confront growers, also challenge industry. For example, processors want some degree of certainty with respect to supplies and markets, yet they must trade in competitive and fluctuating global markets. Even small-scale processors (e.g. small hardwood sawmills) trading in regional markets can be affected by global issues. While world consumption of industrial timber is expected to increase over the next two decades, this demand may not translate into timber sales given the political instability in many countries (Ferguson 1997). Minor changes in the economies of China and India, for example, have the capacity to greatly alter the demand for wood products in Australia (de Fégely *et al*. 1997). Furthermore, increased world demand may not necessarily mean higher prices for growers, particularly small-scale growers in Australia. It is likely that increased demand may simply stimulate an expansion in the supply of forest products from countries with low labour and operating costs, where environmental costs are discounted in favour of short-term economic development. Such developments are likely to reduce the market competitiveness of small-scale growers and processors in Australia with higher cost structures.

Also, de Fégely *et al*. (1997) noted that industry faces uncertainty because increased demand for timber may lead to technological developments which will allow:

- processing of low-grade timber for high-value products;
- substitution with non-wood products; and
- recycling (e.g. old plywood into particle-board).

In summary, Cummine (1996, p. 39) reported that 'When sourcing their wood, the timber industries need to have confidence that there will be a consistent flow of wood of the specified quality over a long time period in sufficient quan-

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tities at a competitive price. This confidence cannot be provided by individual farm foresters growing trees on widely dispersed small plots with no regionally cohesive marketing plan.'

It is difficult to give accurate forecasts of farm forestry profitability due to the long-term nature of the industry, regional variation in specific opportunities, and the few case studies to draw upon. For instance, the economic opportunities for farm forestry can vary considerably within and amongst regions, due to differences in species performance, quality and quantity of resource supply, continuity of supply, competitiveness of markets, the scale of industrial processing, export potential, marketing options, and value of alternate land-use options. Clearly, if the viability of farm forestry within a region is uncertain, both landholders and industry will remain cautious and limit their investment. Understanding the broader socio-economic issues of farm forestry is likely to ensure its development has a wider appeal amongst rural landholders.

Impacts on people

Cernea (1991, p. 303) makes a strong case for 'Asserting the centrality of people in forestry ... (compared to) the stereotype that tree growth is the business of professional foresters alone'. In the case of farm forestry, it is clear that the nature of integrating forestry with agriculture will require people to alter their farming practices. In Australia, the current generation of farmers is undergoing a considerable cultural change in their perception of trees, from a general viewpoint that saw trees as a liability to seeing trees as a productive asset. Effecting behavioural change is often a complex, time consuming process, particularly if government and industry rely upon voluntary adoption of new technologies, as in Australia. If innovations are expensive, unproven, complicated or contrary to accepted farming ways, adoption of new technologies can be lower than anticipated (Vanclay & Lawrence 1995). There are numerous examples where desired changes have not occurred even though apparently feasible management options have been developed and promoted. For instance, considerable research and development of perennial pasture establishment has resulted in only a modest adoption rate by Australian farmers (Cary *et al*. 1993; Millar & Curtis 1995). Closer examination frequently reveals socio-economic reasons for low adoption rates, such as inappropriate targeting of extension messages (Rogers *et al*. 1988; Röling 1988; Cernea 1991).

In such circumstances, efforts to effect voluntary behavioural change will need to address the underlying reasons for non-adoption (Vanclay 1992). While farmers are typically familiar with some timber management for on-farm use, it is unlikely there are large farming communities in Australia with a strong cultural history of commercial timber production. Hence, developing farm forestry industries may require training and skills development (e.g. to enable landholders to undertake in-depth appraisals of farm forestry options), as well as assistance in addressing financial support, development of marketing arrangements, and the provision of infrastructure (Industry Commission 1993). Additionally, as the more effective rural development programmes are incorporating a strong respect for knowledge generated by local farming communities (Chambers 1983; Campbell 1994; Shepherd 1997), this is likely to be pertinent for future farm forestry programmes. Socio-economic research can assist in identifying and exploring factors which are likely to affect the adoption of new technologies.

Methods

This study is based on a recent review of 18 leading farm forestry case studies across Australia (Guijt & Race 1998) which appeared to illustrate innovative ideas that were considered possible for many landholders to adopt. The ideas included small initiatives with native species and large efforts with exotic species, timber production and other forest products (e.g. nuts, seeds and oil), individual family operations and collaborative efforts with neighbours, industry, or government. Three case studies were selected from examples nominated by 25 individuals with experience of farm forestry, including farmers, government agency staff, industry representatives or officers of non-governmental organizations. They nominated 45 examples, of which 18 were chosen by Guijt and Race (1998) for in-depth review as those most likely to provide a diverse range of ideas and lessons for farm forestry development in general.

While drawing upon the initial work of Guijt and Race (1998), the three case studies were further analysed to reveal some important lessons for farm forestry development in Australia at least, and perhaps internationally. The cases were selected so as to identify the critical features for farm forestry adoption across a range of socio-economic (i.e. farm families and informal community cooperatives), geographical (i.e. eastern & western Australia) and environmental (i.e. varying farm productivity) criteria. The information collected in the case studies was largely qualitative in nature, using an accepted approach for semi-structured interviewing of a selected population sample (Strauss & Corbin 1990; de Vaus 1991). In support of this approach, Minichiello *et al*. (1990, p. 5) argued 'Qualitative research attempts to capture people's meanings, definitions and descriptions ...' of their activities. For each case study, at least one of the authors undertook detailed semi-structured interviews, lasting 2–4 hours, and field inspections with the farm forestry practitioners. Interview notes were subsequently transcribed, and, to minimize inaccurate interpretation, landholders reviewed the transcripts developed from the interviews. The amended transcripts then provided the base information for analysis. The process of analysis involved identifying themes and corresponding issues, and determining implications for farm forestry development.

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Results

Case study 1: Branxholme, Victoria

When the husband and wife farming couple involved in this case moved to their 730 ha property in 1956, it was cleared of all remnant native vegetation. The property has an average rainfall of 700 mm/year and silty loam soils with occasional wetlands as part of the undulating basalt plains of the district. The farm had been run traditionally for wool and lamb production, with livestock left exposed to harsh weather. The farmers, with the help of their four children, began revegetating the farm with native and exotic trees and shrubs. During the last 40 years on their property, they have created livestock shelter, wildlife habitat, beautified the area, and more recently, produced timber for sale. A notable feature of the property is the extensive wetlands, with many native trees and shrubs that provide excellent wildlife habitat, particularly for birds. An additional 120 bird species have been recorded on the farm since the first record by the farmers in 1956, highlighting an improvement in habitat.

Since the early 1980s, the farmers have developed a strong interest in commercial farm forestry. Spurred by the declining terms of trade for many agricultural commodities, they have established areas of commercial softwood and hardwood production to reduce their long-term dependency on fluctuating agricultural markets. They began their 44 ha of farm forestry plantings in the early 1980s, with the exotic trees *P. radiata*, *Cupressus macrocarpa* (cypress) and a range of native eucalypts and acacias. More recently, they have planted an exotic *Quercus* spp. (oak) woodlot. Their eldest son has taken on much of the day-to-day management of the farm and now shares a strong interest in farm forestry.

Drawing on advice from practising farm foresters and researchers in Australia and New Zealand, the farmers believe their best commercial opportunities are if the timber trees are managed for high quality saw-logs. They thin tree stands at around 4–6 years to leave a final stocking of about 400 trees/ha. The final crop trees are pruned to remove all side branches up to a height of 6 m. The farmers do most of the forest management work themselves, as only about 2–5 ha require work in any one year and all the farm forestry areas are readily accessible. In recently-planted areas, grass growth is slashed until the trees outgrow grasses and weeds, and sheep can be introduced for controlled grazing, which is typically after 2–3 years.

Commercial harvesting has yet to begin, but firewood and fencing materials for use on the property have already been produced through thinning. Based on the latest agricultural and forestry price-trends, the farm is likely to be more financially viable with integration of agriculture and forestry than if it were only agricultural. Pine and eucalypt saw-logs are expected to be harvested within 20 and 35 years after planting, respectively, with plans to sell into domestic and export markets. There are several local sawmills and there is potential to export from a sea port which is about 75 km away. The value of exporting will depend in part on aggregating a large volume of timber within the region for more efficient handling and transport, highlighting the importance of a regional approach to farm forestry.

The farmers are convinced that their revegetation activities have not caused a drop in their farm's production of wool and lambs. They have revegetated 18% of the farm to date, a cover which is well above the regional farm average, and are considering increasing this to 40%, with most of the additional plantings including both commercial timber trees and native trees and shrubs for conservation. The farmers' style of farm forestry emphasizes balance between the farming enterprise and the environment. Their ideas on farm management have evolved over the years, influenced by visits from many landscape architects, conservationists, agricultural researchers, forest professionals, farmers and students.

Case study 2: Bridgetown, Western Australia

The farming couple involved in this case study, now with two young children, began experimenting with a variety of tree species on their 235 ha property in 1979. The initial investment in farm forestry was driven not so much by a detailed economic analysis but rather by a long-standing interest in trees, and intuition that well-managed trees could address environmental needs (e.g. by reducing waterlogging and salinity) and provide a future income source. They have established more than 50 000 trees (60 ha) for shelter, wildlife, amenity and timber-production benefits. The farm forestry is integrated in the property, taking account of terrain, water courses, aspect, remnant vegetation and farm management. While there are small areas of native bush, most of the trees that have been planted are eucalypts with clear commercial timber potential (*E. saligna* [Sydney blue gum] and *E. globulus* [southern blue gum]), with selected trees pruned to improve wood quality for saw-logs and enhance pasture production.

The first sale of timber in 1995 was an important boost to the farm income. This sale of 1600 t of eucalypt thinnings to a local processor for hardwood pulp allowed the purchase of a new tractor. The farmers have also sold a small quantity of pine thinnings (200 t) for softwood pulp. In 1997, the farmers sold another load of eucalypt thinnings (1200 t); they have seen their gross farm income double since they began selling timber.

The farmers believe the current industry investment in the eucalypt pulpwood industry is a good indication of strong long-term market prospects. While there is still no hardwood saw-log market for their species within the region, they are watching technological developments with keen interest to see if this becomes a viable market locally. They may even consider small-scale sawmilling themselves if there are no viable market alternatives to optimize the value of producing high quality saw-logs. They intend to maintain timber production as a regular income source, with the family planting about 5 ha every few years.

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The farmers have managed their farm forestry to produce a range of timber products, including:

- softwood (*Pinus* sp.) thinnings for chiplogs (200 t already sold);
- softwood saw-logs milled on-farm with a portable sawmill;
- hardwood (*Eucalyptus* sp.) thinnings for posts treated with preservatives;
- hardwood thinnings for chip-logs (2800 t already sold);
- hardwood saw-logs (80 t, as experimental 10-year old *Eucalyptus* sp.).

They also plan to sell speciality timber (e.g. *Acacia melanoxylon* [blackwood]) saw-logs for furniture and panelling.

The farmers have noticed that formerly salty creeks which were later surrounded by planted trees have now become freshwater creeks. Additionally, they have been surprised at how effective the trees have been at reducing the groundwater level and so reducing the threat of salinity, which is one of Western Australia's most critical environmental issues. Western Australia has an estimated 1.8 million ha of farmland that is salt-affected (70% of Australia's land affected by dryland salinity), with a prediction that this area could double within the next 15–25 years (AgWA *et al*. 1996). The cost of land lost to salinity has been estimated at A$1445 million, with a continuing loss of A$64 million per year unless it is fully addressed (AgWA *et al*. 1996). The Department of Agriculture has recently established a series of bores to assess the impact of the trees in controlling rising groundwater, with recent estimates indicating that the water table has dropped 3 m under the planted areas (D. Jenkins, personal communication March 1997). This compares favourably with neighbouring cleared areas showing no change in groundwater depth.

As the farmers concerned plant only small areas each year, their silviculture and grazing enterprises both remain important. Tree pruning and thinning have the same priority as sheep shearing. To ensure they will benefit from the trees, reducing the risk of wild fires is essential and this has influenced their grazing practices. For example, careful grazing during the summer months reduces the fire risk. From their experiences with wild fires in the district, their well-managed trees have reduced the speed of winds spreading fire and allowed fires to be brought under control.

Case study 3: Kalannie, Western Australia

Much of Western Australia's prime wheat growing country is facing the loss of productive land to rising ground-water salinity, as noted above. Farmers need to find a practical and economical approach to integrating trees into their current farming practices, yet they have no nearby commercial tree-product industry. In response, the State government developed one of the most innovative revegetation programmes in Australia. In 1994, CALM began the Oil Mallee Programme with farmers in six districts throughout WA's low rainfall (< 450 mm/year) wheat-belt region. An ex-farming couple was appointed to coordinate the Oil Mallee Programme in the Kalannie district.

In 1994, they bought their own five-hectare property on the outskirts of Kalannie and began growing trees full-time. At the same time, they applied to CALM to coordinate the Oil Mallee Programme for the district and grow the required trees. The couple employ six local people part-time in the nursery to grow about 200 000 general farm trees and 390 000 native oil mallee trees with four to eight species (*Eucalyptus* spp.). They also provide information to support prospective and continuing oil mallee growers in the district, which has low-growing open eucalypt woodland (< 10 m height) as the dominant original vegetation.

The concept of building a new farm forestry industry in the low-rainfall region has been embraced enthusiastically by landholders in the district. Building on earlier work of the Land Conservation District Council, farmers in the district have developed creative and practical ways of integrating large-scale revegetation into existing cropping and sheep enterprises. For example, the oil mallee hedgerows are planted without fencing to allow easy access for the cereal cropping equipment and grazing by sheep on the crop stubble after 18 months. This experience has been invaluable for new growers. Oil mallees are planted in hedgerows (two rows, two metres apart) and are allowed to grow to a height of about 1.5 m. The harvester moves along the hedgerow cutting the tree off at the base and so harvesting all the foliage. A feature of the oil mallee tree is its easy regeneration from ground level. The harvested trees regenerate in the shape of a bush before the next harvest in 6–18 months.

Although previous revegetation efforts in the region have been valuable, they were unable to reverse the pressing issue of salinity quickly enough. The interest of farmers and CALM in large-scale revegetation with oil mallees is primarily driven by the need to find an approach to incorporating deep-rooted vegetation into farming systems to utilize excess groundwater and prevent salinity. The secondary need of the region is to develop a viable tree-crop industry.

In the six districts, a total of 6000 ha of oil mallee plantings was established. Within the Kalannie district, over 70 farmers (about 30% of the farming population) have planted 2.2 million seedlings (1600 ha) since 1994. In 1997, the farming couple in Kalannie were expecting 41 growers, including 11 new growers, to plant 390 000 oil mallee trees on another 300 ha. The other 29 growers have planted the minimum 10 000 trees (decided by the Programme as the minimum quantity to support commercial operations) or more and have decided to focus on making the processing more viable rather than expanding the area. The Oil Mallee Programme takes just over half of the couple's working time. One partner does on-site planning with growers and delivers the seedlings, while the other partner coordinates the nursery and project administration.

Much of the commercial viability of the Programme re-

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mains speculative, with appropriate harvesting and distilling techniques still being developed by the Oil Mallee Association and CALM. While such uncertainty requires caution, most farmers are optimistic that commercial opportunities will be found. It is hoped by those involved that oil mallee foliage will yield oil for industrial solvents and that the timber by-product from the oil-extraction process can be used to fuel electricity generation in remote areas. Although it is too early to detect any change in salinity at the catchment level, several farmers have reported cases where the oil mallee trees have appeared to dry up small saline areas (< 1 ha) (A. & M. Waters, personal communication March 1997). One farmer has been able to recommence cropping on ground previously lost to salinity, three years after planting the oil mallee hedgerows (A. & M. Waters, personal communication March 1997). Others have reported that the areas affected by salinity have stopped increasing in size where oil mallee plantings have been established nearby (A. & M. Waters, personal communication March 1997).

Farmers growing oil mallees on a large scale (>10 ha) view the project as a low-risk investment for protecting the land from increasing salinity, particularly when compared to the other option of capital-intensive earthworks. If oil mallee plantings can continue to arrest the increasing salinity, as early indications suggest (A. & M. Waters, personal communication March 1997), then the project will help maintain the viability of cropping in the district. If harvesting and processing can also be developed sufficiently, then a viable new tree-crop industry is likely. The project has increased employment in the Kalannie district, with more people now employed at the couple's nursery and another farm-tree nursery, and the period of contract farm-work at tree-planting time has been lengthened.

Discussion

Lessons from leading case studies

The outcomes of farm forestry reported in the above case studies have been as diverse as the physical environments in which they occur. An analysis of these and the other 15 case studies reviewed by Guijt and Race (1998), helped identify a number of characteristics and activities that appear to be important for the apparent success of these farm forestry pioneers. Although the following characteristics are expressed individually below, in reality these are often closely related and entwined to form the basis of landholder decision-making.

Willingness and capacity to take and manage risks
Given the unfamiliarity of farm forestry as a new 'crop', uncertain economic viability, and the long-term nature of timber production, risks of varying proportions have to be taken. The farmers interviewed expressed a willingness and capacity to take risks (e.g. a cultural, structural and economic ability for risk-taking), and even to flaunt conventional wisdom in some cases. Sufficient time, finances, labour, and/or natural resources to invest in developing a new farm enterprise, affect a capacity to take the risks involved. Some farmers reduced the risk of farm forestry by managing the trees for agricultural and environmental benefits that became available in the short term (e.g. shade & shelter benefits), rather than having just a long-term aim of the potential economic returns of timber production.

Active in their own research and development
As farm forestry is a relatively new farm enterprise in Australia, there are many questions about how best to develop it due to regional differences and diverse farm family dynamics. All the landholders in the case studies relied to some extent, and often entirely, on their own curiosity and experimentation to find essential information. They stressed the importance of continual learning, experimentation and adaptation. Through trial and error they have learnt to identify appropriate species and plant/animal combinations for their soils and climates, establish trials, adapt tree management and processing techniques, and undertake monitoring and evaluation.

Regular information exchange with other landholders
Besides conducting their own research, landholders sought regular meetings with fellow practitioners. Many of the pioneers of farm forestry appeared keen to discuss common experiences, share new ideas and resolve issues. They have sought membership of enterprise-focused discussion groups or linked with other rural entrepreneurs. They often hosted visitors and were active in attending training courses.

Conviction that farm forestry will address a key farm issue
Despite the uncertainty of farm forestry, these landholders have established trees and/or shrubs to perform a range of functions that will improve overall farm viability for economic, environmental or social reasons. However, most of the landholders interviewed did not view farm forestry as a dominant source of farm income.

Development of a sound understanding of the farm
While all farmers tend to know their properties in considerable detail, the landholders interviewed explained that they had to increase this knowledge as farm forestry developed. Landholders sought much information about the exact biophysical and socio-economic features of their farms before making a substantial investment in farm forestry. For many, developing systematic farm management plans (in some cases facilitated by State agency 'property management planning' courses) proved to be an important process for gaining a better understanding of the likely impacts of farm forestry.

Development of strong links with government and/or industry
Landholders developed links with government and/or industry to gain critical advice, financial support and to negotiate market contracts. Several landholders stressed the import-

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ance of having a secure market for the major forest product involved.

Contribution to non-commercial, long-term community values
Most landholders expressed a commitment to designing farm forestry so that it might/would provide benefits to the broad community, such as through improved rural landscapes and water quality, or increased biodiversity. None of the landholders were motivated for personal commercial returns alone, although this was clearly an important element. They viewed farm forestry as critical to the achievement of economic, environmental and social objectives (e.g. the rejuvenation of rural communities).

Besides the above themes that were common to all of the interviewed landholders, some interviewees also emphasized other factors contributing to their 'successful' farm forestry operations such as:

- a capacity for on-farm processing of forest products;
- learning from the experience of parents and other family members;
- having a keen interest in working with trees; and
- developing a wide social network to share decision-making.

Perhaps the most striking characteristic of the landholders interviewed was the balance they have found between risk-taking and caution. Although sometimes accused of foolish behaviour by others in their local communities, the landholders believed they took 'informed risks' when developing their farm forestry.

With understanding of the combined important factors for 'success', farm forestry can guide government and industry efforts in developing farm forestry. Government and industry should consider how best they can contribute resources (e.g. financial, personnel) to ensure a large number of people in targeted farming communities understand and can meet the above, apparently important, requirements. Simply addressing just one or two aspects, such as providing financial incentives alone, is likely to be insufficient to motivate widespread adoption of farm forestry.

While many government and industry programmes are premised upon economic benefits being the main motivation for farmers to develop farm forestry, our study suggests that their motivation is more complex. However, there is considerable debate as to the relative priority of economic and social factors within farmers' decision-making. Alexander (1995, p. 25) explained that 'Most landholders have to respond above all to the economic imperative . . . There is little capacity for landholders, given terms of trade, debt, drought, etc. to take the longer view, invest in public benefit or take any risks.' Nevertheless, Bryant (1992) indicated that many farm families make decisions that do not appear economically rational, because they have an ideological commitment to maintaining the farm as a way of life, regardless of commercial opportunities. Vanclay (1992, p. 115) also argued that '. . . farmers tend not to act in an economically 'rational' way; they respond, instead, to farming culture and the notions of good farm management that exist within their community.' Indeed, several other authors have suggested decision-making by farmers is based on more than just economic factors, but rather is based upon a complex mix of socio-economic and cultural factors (Gasson *et al*. 1988; Kirby *et al*. 1993; Errington & Gasson 1994).

Conclusion

Despite its apparent potential to achieve gains in economic, environmental and social terms for individuals and the wider community, viable self-sustaining farm forestry industries are only just emerging in Australia. While the three case studies presented provide some insight into what may be possible for other landholders, they do not prove that farm forestry will provide the expected benefits, even if widely adopted by regional communities. Concurrent action by those responsible for farm forestry is required at the regional and national scales to develop:

- opportunities for small-scale growers to aggregate supplies to improve economies of scale, for example through grower cooperatives or brokers;
- economical access to competitive markets; and
- mechanisms for cost-sharing to account for private and public benefits.

Farm forestry's contribution to regional communities will need to be carefully assessed over time to ensure the anticipated benefits occur. Research is required to ascertain whether the anticipated benefits have flowed to the targeted communities and individuals, and if so, to what extent.

Across Australia, much effort is being invested in developing new opportunities for farm forestry. This appears to reflect the widespread enthusiasm to see it become a viable industry for regional communities. However, farm forestry is still in its infancy in Australia, and the agricultural and forestry industries are undergoing substantial change. Consequently, it is understandable that governments' policies are evolving while uncertainty remains as to the nature and extent to which benefits will flow to the target communities. Programmes to support farm forestry need to recognize the substantial commercial and environmental differences that occur amongst regions. Particular attention should also be given to engaging the diverse range of farm forestry stakeholders. After all, it is likely that the satisfaction derived from farm forestry by a range of growers and processors will determine the extent to which viable regional industries will develop.

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