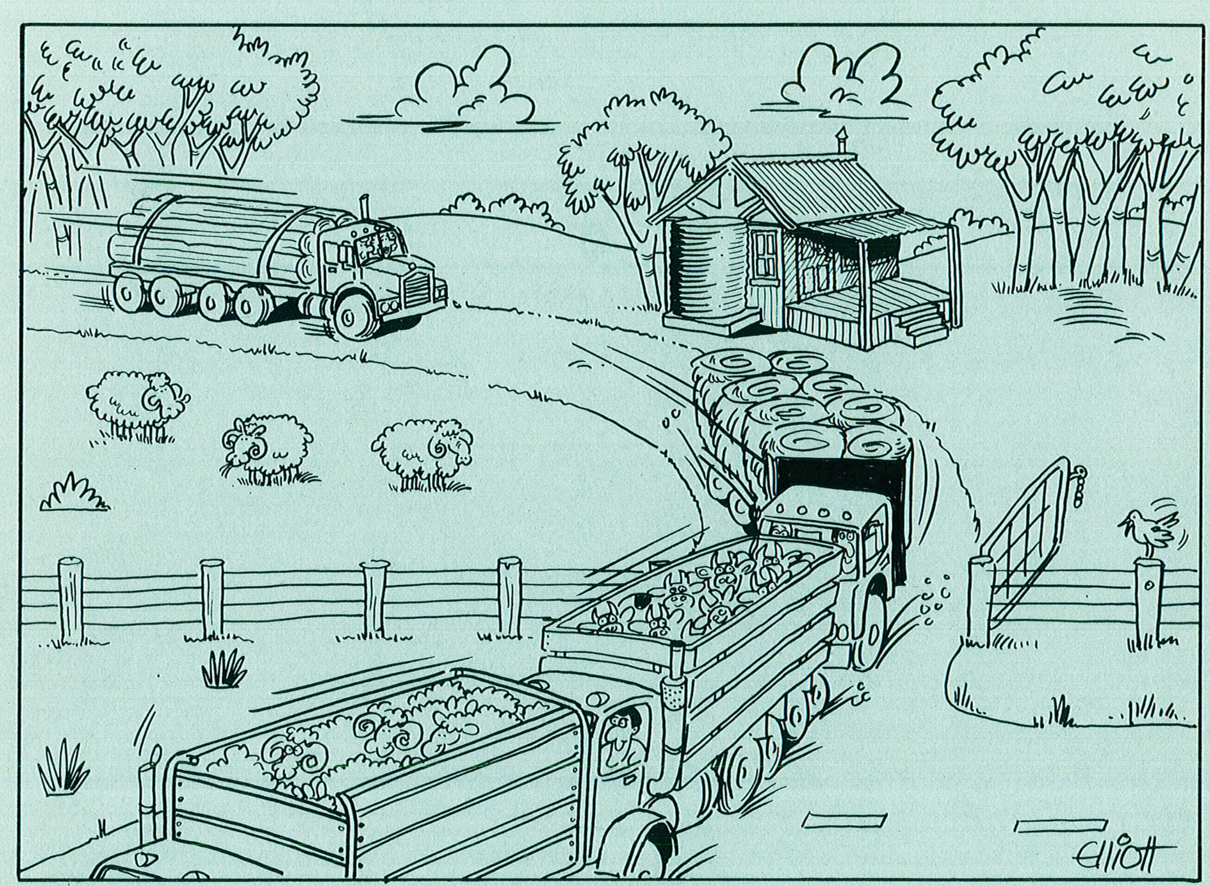
THE POTENTIAL FOR THE INTEGRATION OF TREE CROPS INTO AUSTRALIAN AGRICULTURAL SYSTEMS



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INTRODUCTION

The development and success of Australian agriculture is a spectacular example of the benefits of integrating practical experience and scientific innovation, collaboration and individual enterprise which has achieved resilience by balancing persistence and reality. Australian agriculture has maintained its world class competitiveness by developing new equipment, overcoming bizarre soil problems through the use of trace elements and the introduction of new crops and pasture such as clovers, medics and lupins, to name but a few.

Notwithstanding the difficulties that the rural sector faces, we propose (we concede from the comfort of the public service) that the qualities that have made Australian agriculture so successful can be employed to develop a new profitable perennial crop - woody plants and trees - which will assist farmers to overcome the landcare and economic problems they currently face. We are conscious that Australian agriculture has had a parade of panaceas before it. These include in the past, unfortunately, a minority of forestry promoters who were either charlatans or incompetents (some were both) who raised false hopes. Tree crops are not a panacea and there are still uncertainties and consequently risks. We believe, however, that there have been in the last decade significant developments (particularly in Western Australia) which provide a window of opportunity for the establishment of a new significant enterprise based on tree crops grown on farms.

TREE CROPS - WHY NOW?

There have been over the past four decades a few farmers and private forestry companies who have used agricultural land to grow tree crops. But in the past the main intrusion of forestry into agriculture has been by government agencies who purchased whole farms and established government-financed plantations. For example, the Western Australian Forests Department purchased over 7000 hectares of then "marginal" farmland in the Blackwood Valley during the 1960s and established *Pinus radiata* plantations. In the past agriculture and forestry have been regarded as mutually exclusive.

There are several reasons why commercial tree crops have not been an extensive part of Australian agriculture:

- Cultural and institutional factors have been an effective barrier. Understandably, farmers have had little interest in establishing trees when one of their or their father's principal occupations had been to clear native vegetation. It is less than two decades since farmers in Western Australia faced penalties if they did not clear the land that they had "conditionally purchased". The existence of extensive native forests which were in public ownership and which produced most of Australia's commercial timber needs meant that most foresters were employed in Government agencies and preoccupied with developing effective management for the forests they were responsible for. Despite the fact that forestry and agricultural scientists often had overlapping training, it is only in relatively recent times that there has been a freer interchange of ideas and personnel between agricultural and forestry agencies. This institutional compartmentalisation meant that the technology required to establish tree crops on farms was not developed and where information was available it was not transmitted effectively to farmers.

- The commercial returns for tree crops per hectare have, until relatively recent times, been significantly less than those achieved for agricultural products. Even in areas where tree productivity was particularly high, so that tree crops were competitive, the delays between planting and a return on the crop (often in excess of 15 years) made them unattractive to farmers.

- The full extent of the landcare problems associated with clearing of native vegetation have only been widely recognised in the last ten years.

- Markets for wood based products were perceived to be limited, in part because markets were excessively regionalised.

- Wood fibre has a relatively low weight/value ratio and this, together with the high capital investment required for wood fibre processing facilities, has meant that the distance between the farm and processing centre or port has been a major constraint.

In a relatively short period (less than a decade) almost all of the factors which have constrained the integration of tree crops into Australian agriculture have been significantly ameliorated.

IS THERE A MARKET AND WHAT WILL BE THE PRICE?

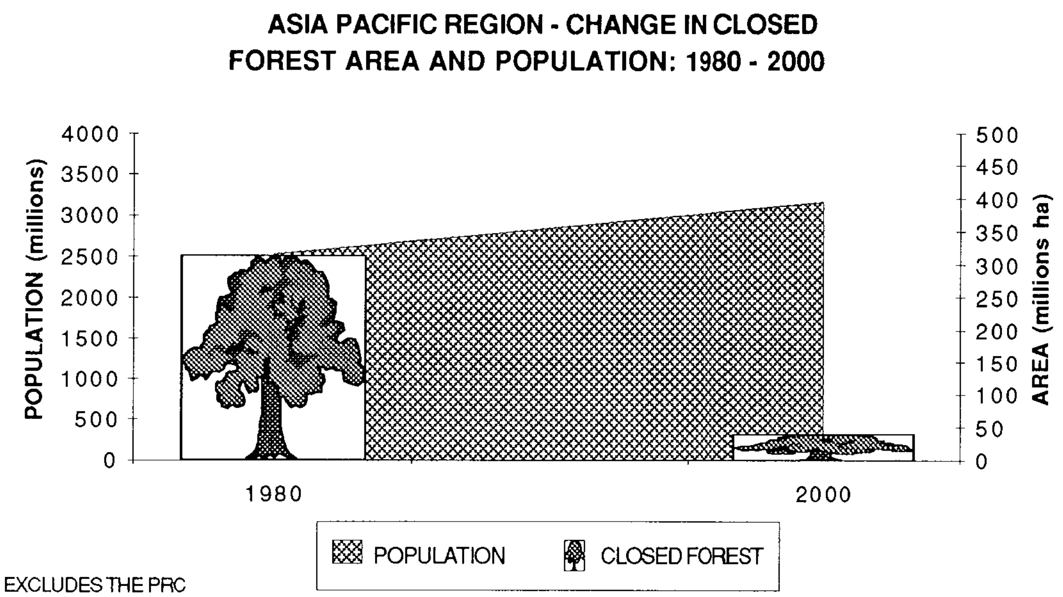
Wood products are traded in a wide variety of forms, from the humble woodchip to the value added dressed cabinet grade products. All trade in timber products is strongly influenced by international events and consequently, like agricultural products, they are subject to the vagaries of the international market. Predicting the demand for and price of wood products is of course more difficult because the minimum time between crop establishment and yield is eight years.

It is impossible to guarantee a market or a price for wood products but there are a number of factors which indicate that there is a significant and increasing market for wood products produced in Australia at prices that will provide a competitive return on the investment into tree crops.

Historically, the existence of large areas of native forests has been a major factor depressing the price of wood fibre products. The price paid for logs obtained from these forests has usually not reflected the cost of replacement. There are still three billion hectares of forest on earth, however the size of this estate does not necessarily reflect its capacity to continue to meet the increasing demand for wood fibre.

The level of wood removal of many of the world's forests has exceeded the long-term sustainable yield, and each year an area of forest equal to the size of Great Britain is destroyed. The principal reason for the destruction of forests is clearing for agriculture (Shea 1993). The world forest stocks, particularly in the Asian Pacific region, are being rapidly depleted (Figure 1). This is being reflected in major reductions in allowable cuts and even where the extensive native forest areas remain, the costs of extraction are increasing dramatically. There have also been significant withdrawals of highly productive forest in the west coast of the USA as a consequence of environmental pressure from the environmental lobby.

Figure 1



While the world's forest estate is decreasing the demand for wood products has continued to increase (Figure 2). The result has been a significant increase in the price of logs. For example in New Zealand, log prices for some export sawlog grades from *P. radiata* plantations have increased 400 percent in the short term (Figure 3).

Figure 2

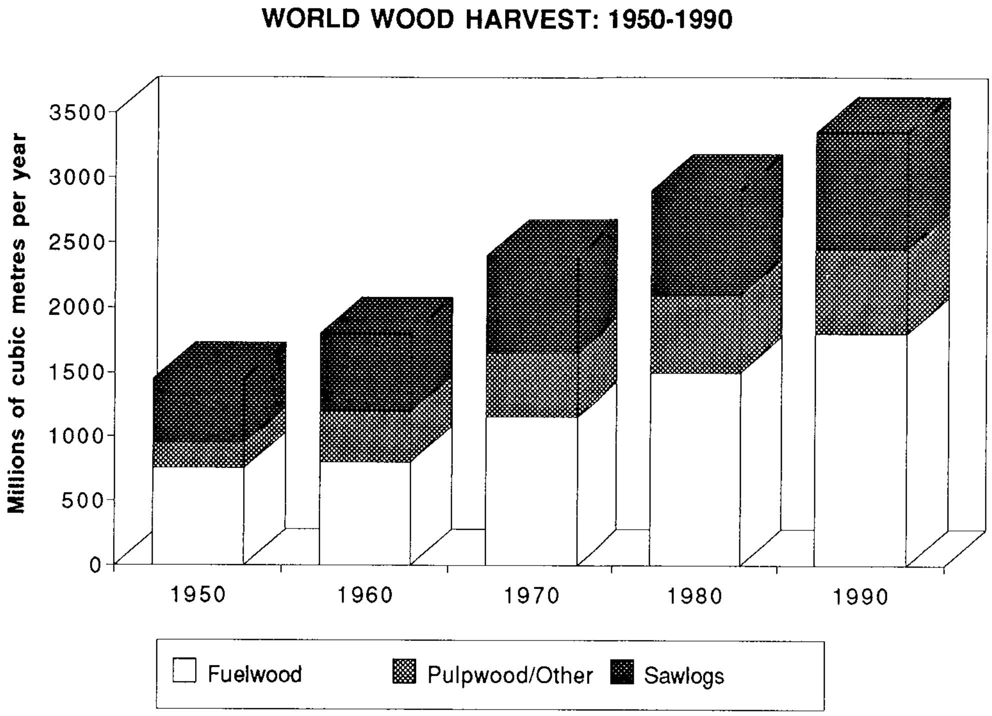
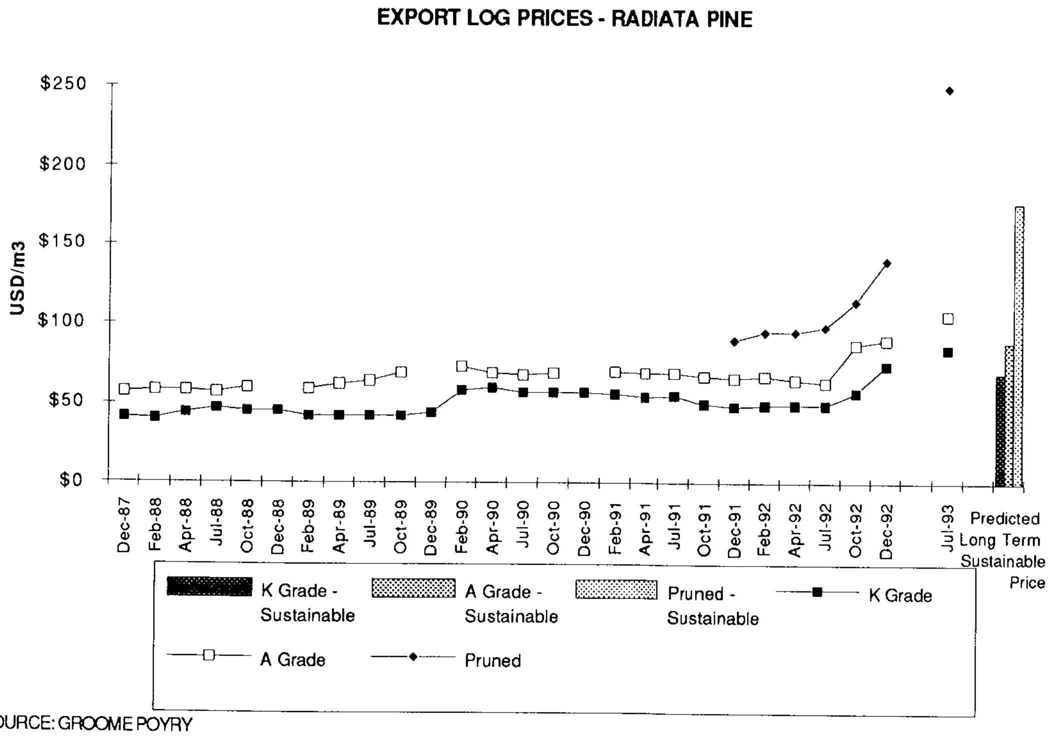


Figure 3



SOURCE: GROOME POYRY

Wood in its many forms is now accepted as a standardised internationally traded commodity. As such, efficiency in production and transportation is essential if one is to compete. Currently, Australia is a large net importer of newsprint, printing and writing paper, plywood, sawn timber and wood pulp. In 1989/1990 Australia imported $2309 million of forest products but exported only $548 million worth of forest products, mainly in the form of woodchips from native forests (Table 1). We should not continue to accept this situation when we have a diversity of species suitable for producing forest products and the most efficient farming sector in the world.

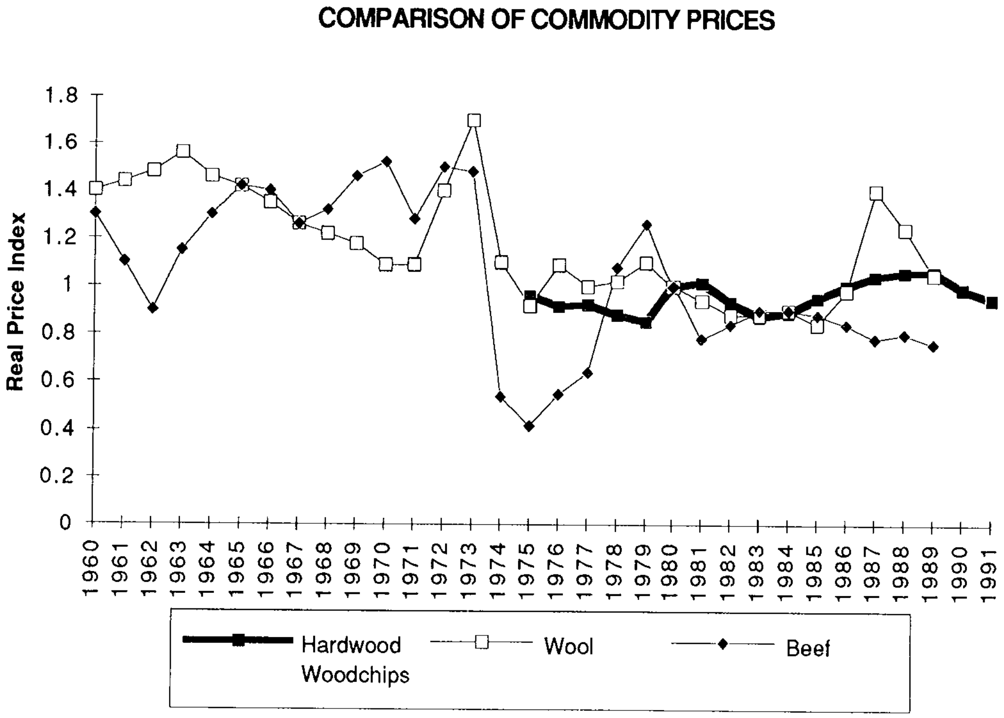
Table 1: Australian production and trade in forest products, 1989-90

Product	Production	Imports	Exports
Paper ('000 tonnes)			
Newsprint	384	288	0
Printing and writing	369	435	32
Tissue	163	0	1
Packaging and industrial	1087	148	123
Panel products ('000 m3)			
Particleboard	743	15	20
Plywood	125	58	2
Hardwood	112	3	1
Softboard	11	0	2
Other products			
Woodchips ('000 tonnes)	4774	0	4774
Railway sleepers ('000 m3)	142	1	4
Sawn wood ('000 m3)	3330	1727	21
Wood pulp ('000 m3)	1037	27	62

Sources: ABARE (1990a and 1990b)

Wood product prices over the past two decades have been stable in comparison to the progressive decline in the real price for the major Australian agriculture products (Figure 4). More recently there have been significant increases in the price of wood fibre in the international market (Figure 3) which suggest, together with the evidence that there has been a significant reduction in supply available from native forests, that there is a change in the fundamental characteristics of the international wood fibre market occurring. It is impossible to predict how long the rate of increase will be sustained but there is a general consensus that even if wood prices are reduced they are unlikely to return to previous low levels.

Figure 4



The decline in the supply of wood fibre from native forests is inevitable if for no other reason that in regions of the world they are being over exploited and cleared for agriculture. It will be possible to replace this source of wood fibre from tree crops, but the price of wood fibre will reflect the cost of establishment and management. In the future those regions of the world which have the capacity to produce wood efficiently will capture the market created by the decline in the wood produced from native forest.

LAND CARE AND TREE CROPS

While land and water degradation on agricultural land caused by the clearing of native vegetation was identified many decades ago, it is only in the last decade that the magnitude of the existing problem and its latent potential to increase has been realised. This in part is because of the lag between clearing and the expression of the problem. For example, groundwater accumulation in the higher rainfall zones (approximately 800 mm) of Western Australia may not reach the soil surface until twenty years after clearing (Figure 5). In lower rainfall areas the lag between clearing and damage to surface soils and water may exceed 40 years. In many areas of Western Australia the impacts of past clearing are yet to appear. The magnitude of the problem in Western Australia is summarised in the 1992 report of a State Parliamentary Select Committee (Table 2).

Figure 5

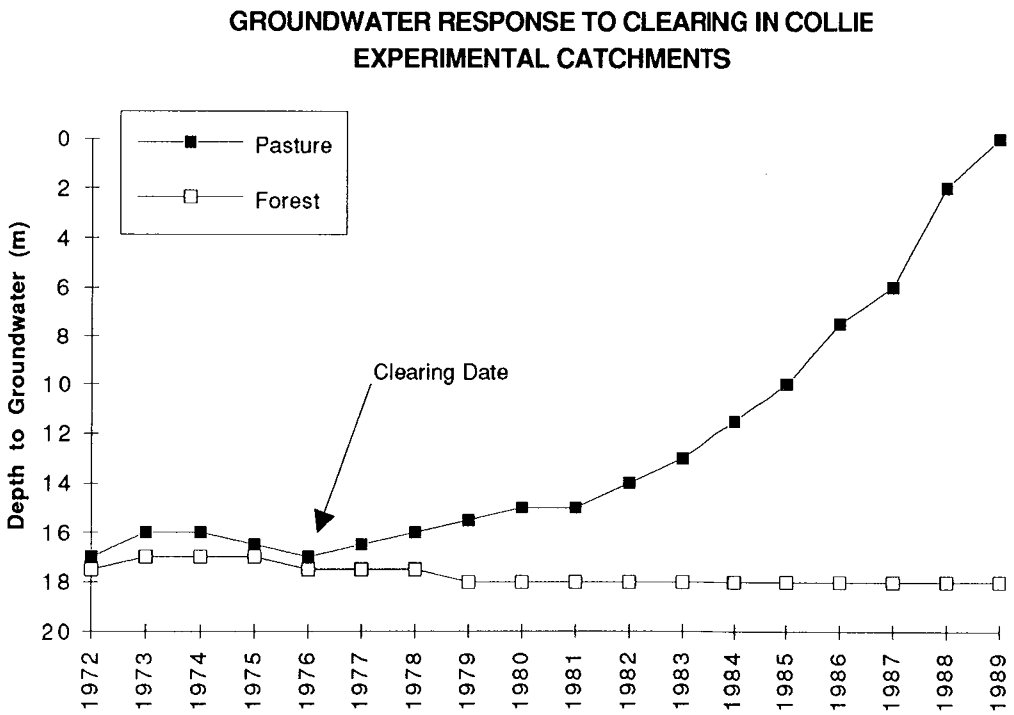


Table 2: A summary of land degradation problems in WA

Problem		Extent of Damage
1.	Dryland salinity	3 percent now - 15 percent projected
2.	Stream salinity	All streams/rivers degraded
3.	Water logging	Variable up to 3 million hectares
4.	Water erosion	2 million hectares vulnerable
5.	Wind erosion	Intermittent/universal
6.	Soil acidification	10.5 million ha vulnerable
7.	Soil structure decline	3.5 million hectares affected
8.	Subsoil compaction	8.5 million hectares affected
9.	Remnant vegetation decline	Extensive, some severe
10.	Nature conservation	All wetlands, rivers, estuaries degraded, 260 rare and endangered species

Source: Select Committee into Land Conservation (1990)

There are several processes contributing to soil and water degradation. Perhaps the major factor causing the deterioration of soil and water systems is the rise of water tables. This is because pasture and crops consume less water than the native vegetation it replaced.

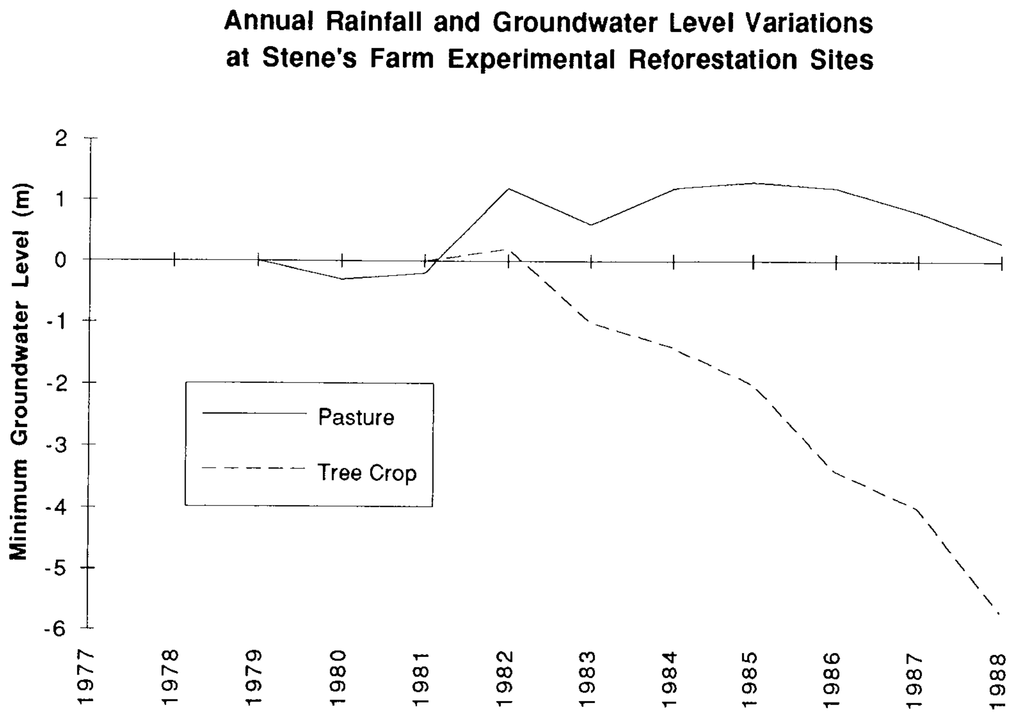
This phenomenon of inadequate water use and accumulating groundwater is universal in our agricultural lands. The rate of accumulation is slower in lower rainfall areas. It can also be slowed by improved water use under more skilful agricultural practice. However, even with the best practice of using annual plants it is not possible to prevent some leakage to groundwater. Summer rainfall, exceptional wet winters and occasional poor performance in crops and pastures will be enough to ensure that groundwater rise continues. Eventually the groundwater system opens up enough surface discharge capacity in lower landscape areas to balance the unused excess water from upslope. In this process salts stored in the subsoil are also discharged resulting in the characteristic salt seeps or salt scalds that blight our agricultural landscapes. It is projected that the eventual area damaged by saline discharge will be 15 percent of total land, or some five times more than at present. In regions with low relief the area of salt land will be greater.

The role of tree crops

The only practical way to prevent and reverse this process is to systematically incorporate a perennial, deep rooted, high water use component into the agricultural system.

There is a substantial theoretical basis for justifying the use of perennial woody crops to lower water tables. It is only comparatively recently the results of controlled field trials have become available. The capacity of a tree crop to lower water tables is illustrated in Figure 6 (Water Authority 1989).

Figure 6



There is no doubt that tree crops can significantly lower water tables but it is not possible to accurately quantify the relationship between the percentage of area that is revegetated with tree crops and its long-term effects on water table levels on the farm and in the subcatchment. The patterns of subsurface water flows in catchments is often irregular and difficult to identify. This, together with the absence of data on the effect of different patterns of tree crop distribution on water consumption, is a major research deficiency.

Despite that deficiency it is obvious that establishment of tree crops on a proportion of cleared agricultural land in a catchment will increase water consumption and, at the least, reduce the rate at which water tables are rising.

Tree crops and traditional agriculture

Notwithstanding the broadscale community support for tree establishment, there are still myths perpetuated which suggest that some tree species have an adverse effect on soil properties. It has been claimed that conifer species, probably because they are "exotic", cause a deterioration in soil properties. There is no scientific evidence that any tree species has caused soil deterioration. Similarly, doubts have been expressed about the long-term sustainability of tree crop plantations. But there is no evidence that tree crops are not totally sustainable (Evans et al. 1993).

There is also increasing scientific data available which indicates that tree crops integrated into the farm can improve productivity as well as sustainability. This potential has been well demonstrated by Moore et al. (1991). Using wide-spaced pine trees in pasture in an 800 to 900 mm rainfall area, they observed a productivity increase of some 40 percent.

Production from **10 ha** mixed trees and pasture	=	Production from **8 ha** pure plantation	+	Production from **6 ha** pure pasture

The "agroforestry" effect - enhanced productivity from mixtures

The explanation for this effect is simple in concept: the mixture of tall, perennial, deep rooted trees and shallow rooted, annual legume based pasture makes better use of resources (water, nutrients, sunlight and carbon dioxide), and generates a more favourable local climate for plants and animals within the tree covered area. Clearly the components of the mixture are not fully in competition with each other and can also complement each other's performance.

Although this result was achieved by using wide-spaced pine trees, the principle will equally apply to any mixture of diverse plants that achieves complementary use of the resources of the land. The best potential for mixtures will come from taller, non-grazing species where greater water use capacity and shelter benefits will be provided. The value of the commercial return from the tree component will be another major determinant of success.

The shelter component of the agro-forest effect can be substantial. For example, Bird (1988) demonstrated that up to 20 percent of farmland in a typical southern Australian environment could be converted to shelter plantings without loss of agricultural production.

The cost of treatment for land degradation

The establishment of tree crops to assist land and water rehabilitation will be an essential component of any land care strategy, but the costs will be very large.

Table 2 gives the estimated scale and cost for the treatment of land degradation through tree planting in Western Australia (Bartle 1992). Three million hectares of planting and $2 billion of investment are required to make a substantial impact on land degradation.

Table 2: Cost of tree planting for treatment of land degradation

	Range	Mean
Required cover (%)	10 to 30	20
Area to plant (million ha)	1.6 to 4.8	3.2
Tree cover (stems/ha)	400 to 1000	700
Unit cost ($/ha)	400 to 1000	700
State cost ($ billion)	0.64 to 4.8	2.24
Average farm cost ($thousand)	44 to 330	154
Annual State cost ($million/yr)	32 to 240	112
Annual cost/farm ($thousand/yr)	2.2 to 16.5	7.7
State maintenance ($million/yr)	20 to 140	67
Average farm maintenance ($thousand/yr)	1.3 to 10	4.6

Note:
1. Total WA farmland area of 16 million hectares
2. Average farm 1100 hectares
3. Annual costs over 20 year term
4. Maintenance costs 3%/year of initial planting cost

The percentage of tree cover suggested in Table 2 is deliberately vague. The reluctance to sharply specify percentage cover is appropriate since the trees need to be widely dispersed (in belts and small blocks) for effective integration. The tree planting target is most appropriately considered in terms of degree of dispersal not area. Nevertheless the amount of planting required is large and it will be difficult to finance the investment solely from the benefits within agriculture under present economic circumstances.

There are already extensive tree planting programs being undertaken by farmers, at their own expense, solely for the purpose of land and water rehabilitation. But it would not be possible, given the current financial status of the farming sector and the nation, to finance the scale of planting required to reverse the land and water degradation problem we face. In 1986 the Department of Conservation and Land Management commenced a program designed to actively exploit the obvious synergy between commercial tree crops and landcare (Shea and Bartle, 1988) and to seek sources of finance to fund a large-scale tree crop establishment program.

COMMERCIAL TREE CROPS

The species

There have been extensive trials of a large number of potential species (CALM is currently field trialling more than 44 species.), but the principal species used for commercial tree crops are *Pinus radiata*, *Pinus elliottii*, *Pinus taeda*, *Pinus pinaster*, *Eucalyptus globulus*, *E. grandis, E. saligna and E. camaldulensis.*

In Western Australia *P. radiata*, *P. pinaster* and *E. globulus* are the only species which are planted extensively for commercial purposes.

More recently CALM, in association with farmers, has established broadscale plantings of mallee eucalypts in the drier (less than 600 mm rainfall) areas of the State with the aim of establishing a eucalyptus oil industry and providing a way to fund land care in the lower rainfall areas of the State.

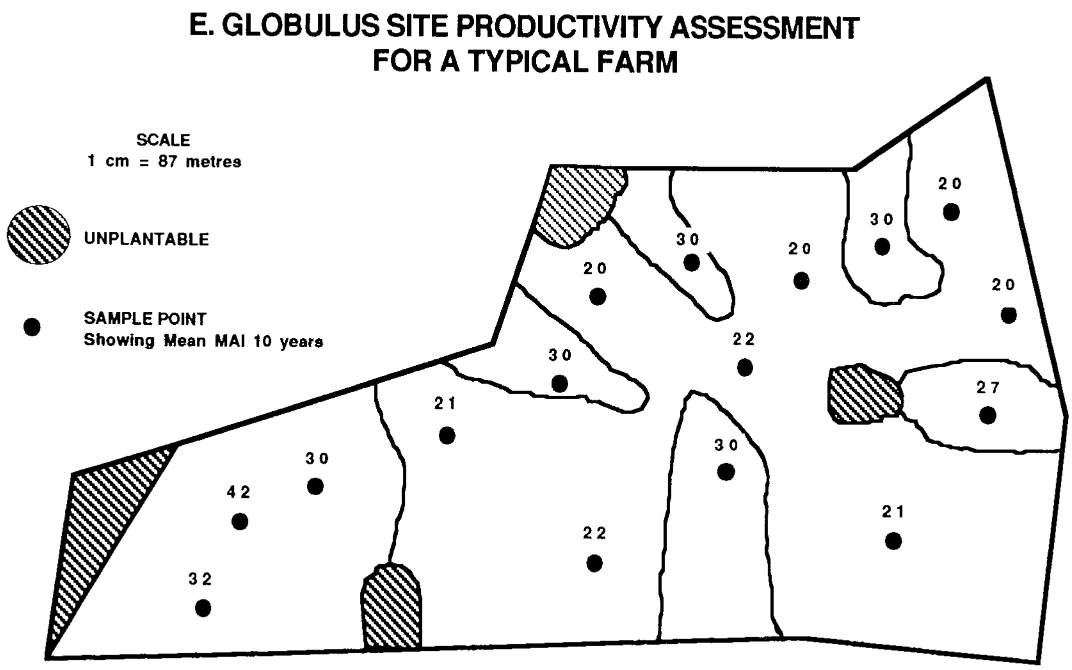
Cultivation technologies

The principal biological constraint on commercial tree crop establishment is rainfall. Currently in Western Australia commercial planting of tall timber crops is not undertaken where annual rainfall is less than 600 mm. It may be possible to extend the plantings into lower rainfall zones when there is a greater capacity to predict sources of groundwater within the landscape which trees can access.

It is possible to extend the planting of woody crops, for example mallee eucalypts, into lower rainfall zones.

Within the desirable rainfall zone and even within the farm site selection is critical. Relatively small changes in site characteristics can have a profound effect on productivity (Figure 7). Accurate and reliable site identification technologies are now available for each of the major commercial species (Beadle and Inions, 1990; Inions, 1991; Inions, 1992).

Figure 7



Cultivation (silvicultural) technologies have also been developed for each of the commercial species. Advances in cultivation and genetic improvement technologies for tree crops have been slow relative to agriculture. In part this is a consequence of the turnaround time for tree crops is measured in decades. But the investment in research that has been made is now being realised. For example, the productivity of *E. globulus* has been increased by 40 percent by tree improvement programs. A combination of tree improvement and improved fertiliser regimes has increased the productivity of *P. radiata* by 30 percent and reduced rotation age by five years.

It is now possible to achieve annual commercial wood production levels of at least 20 tonnes per hectare per annum for *P. radiata* and *E. Globulus*. On optimum sites *E. globulus* productivity can exceed 40 tonnes per hectare per annum.

Economics

There have been major improvements in the market for wood fibre products. In particular the development of markets for the intermediate crops generated by thinning of coniferous plantations has a major impact on the viability of pine plantations. In Western Australia this is a consequence of the successful establishment of processing plants which produce panel products (medium density fibreboard and particle board) for the domestic and export market.

The large increases in the price for New Zealand *P. radiata* products in Japan, Korea and North America suggests that the capacity to meet Australian domestic demand for structural timber will be significantly less than in the past. In Western Australia this factor, in conjunction with the progressive conversion of the native hardwood industry from the production of structural timber to value-added products, will increase the domestic market for locally produced plantation grown timber. There is no reason, however, why Western Australian structural timber could not also compete in the international market.

There is a significant market for high quality wood fibre for the production of paper (see above). The existence of this market has been confirmed by the fact that the largest pulp and paper companies in Japan and Korea have made large investments into hardwood plantations in Western Australia.

The above are established markets but there is the potential to develop markets for other tree crop products. For example, eucalyptus oil is an old established product with a range of traditional pharmaceutical uses. It is also an excellent natural solvent and the hope is that it might be able to penetrate large scale industrial solvent markets. These markets are soon to be opened up due to the scheduled withdrawal of some major existing solvent products under regulations to control ozone depletion.

Returns to farmers and investors

A large proportion of the cost of delivering a log to the processing plant is absorbed by harvesting and transport costs. Wood does have a low weight/volume ratio, consequently distance to processing centre or port can markedly effect the value of the log at the farm gate. A cost of 10 cents per tonne per kilometre can be assumed to be a reasonable estimate of transport cost.

The value of logs at the stump (before harvesting) varies according to species and log grade. Current prices for conifer species vary from $30 to $45 per cubic metre for logs which can be converted to structural timber. The value of thinnings which are utilised for panel products or pulp varies from $10 to $20 per cubic metre. Hardwood logs produced for the pulpwood market have a value of between $15 to $35 per cubic metre at the stump.

These prices are currently being achieved in Australia and probably do not totally reflect recent international price increases. We believe that it is reasonable to assume that in the long term the price trend will be upwards.

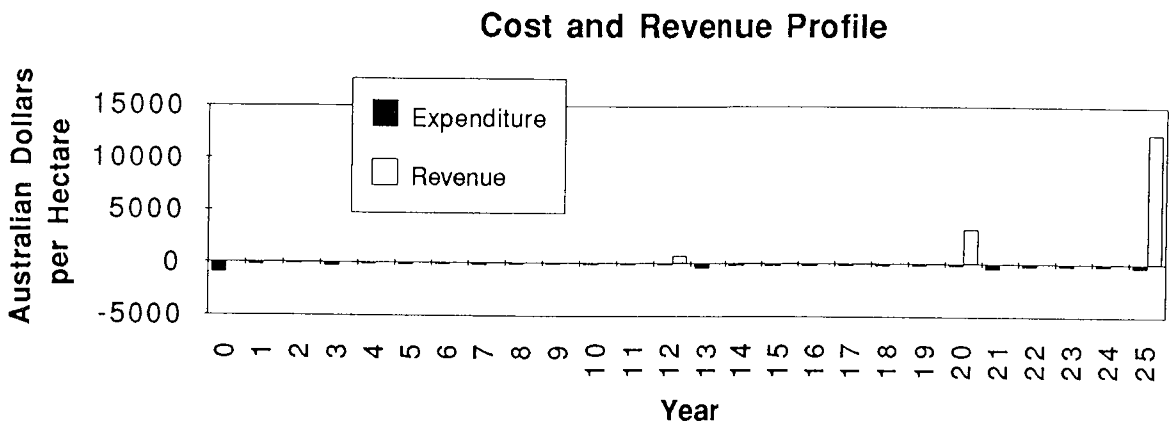
The value of the wood produced per hectare per annum is affected by site productivity, distance to market and the interest rate chosen to reflect the time value of money invested. In Western Australia, assuming that the capital required to establish and market the tree crop is provided by an external investor, the farmer would receive a lump sum payment at harvest equivalent to between $120 and $250 per hectare per annum, depending on productivity and farm location for pine and hardwood tree crops.

Under timber sharefarming schemes developed by CALM the farmer can obtain access to markets through sharefarm arrangements with the State and international buyers. The schemes are flexible enough to accommodate farmers' requirements. For example, the schemes enable the landowner to have minimal input into the tree crop, or at the other extreme the farmer may fund and manage most of the crop. Payments are made at harvest and/or as an annuity depending on the farmer's requirements for cashflow.

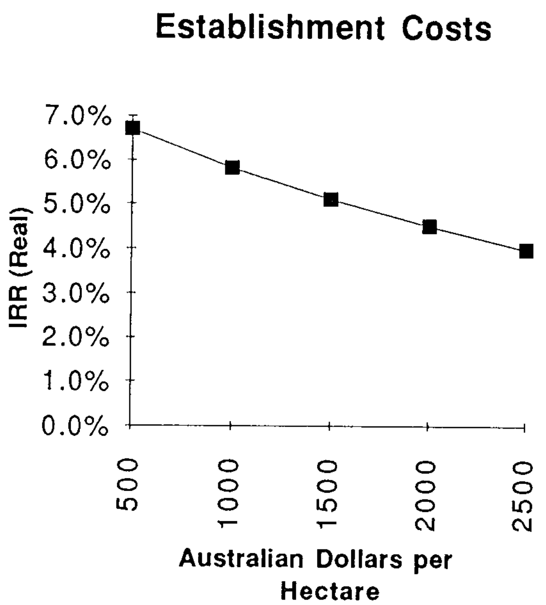
We have used an average silviculture and harvest regime for *P. radiata* and *E. globulus* tree crops to demonstrate the sensitivity of the return on tree crops to a number of critical factors (Figure 8a and 8b).

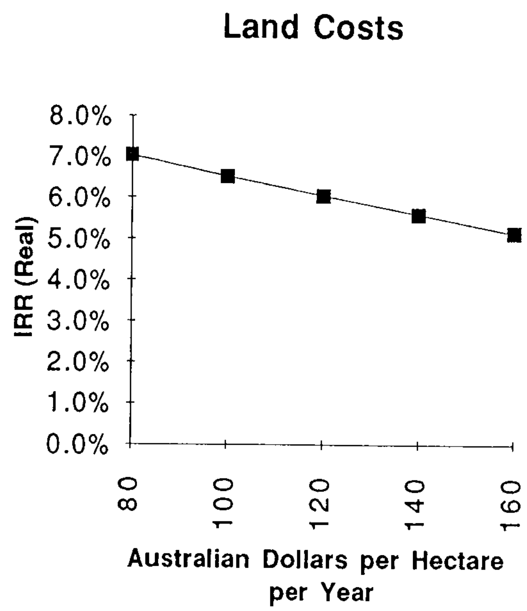
POTENTIAL RETURNS FROM PINUS RADIATA

Figure 8a



SENSITIVITY OF PROFITABILITY





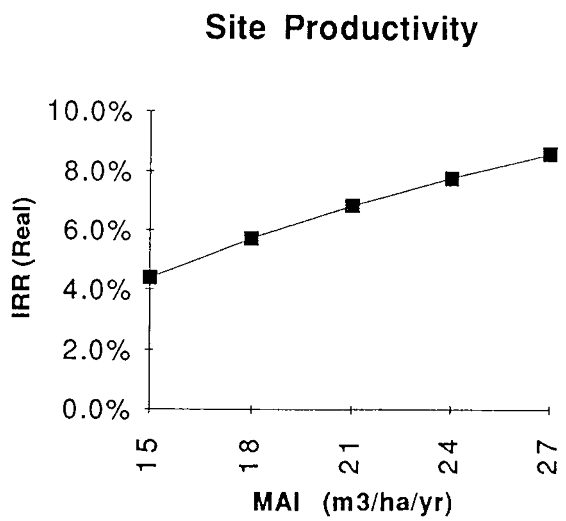
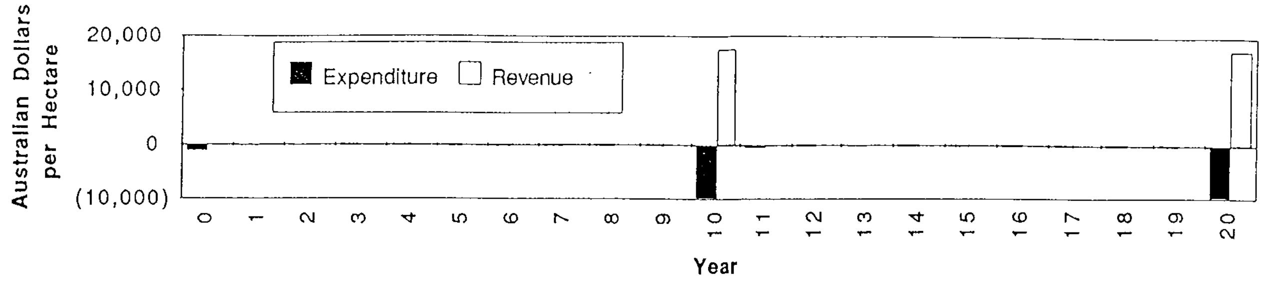


Figure 8b

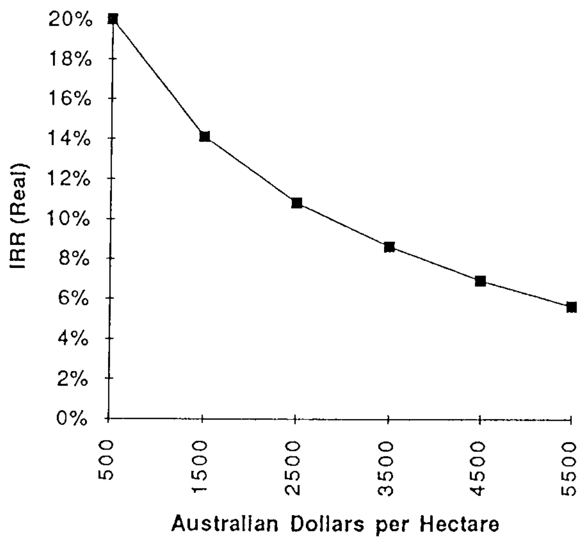
POTENTIAL RETURNS FROM EUCALYPTUS GLOBULUS

Cost and Revenue Profile

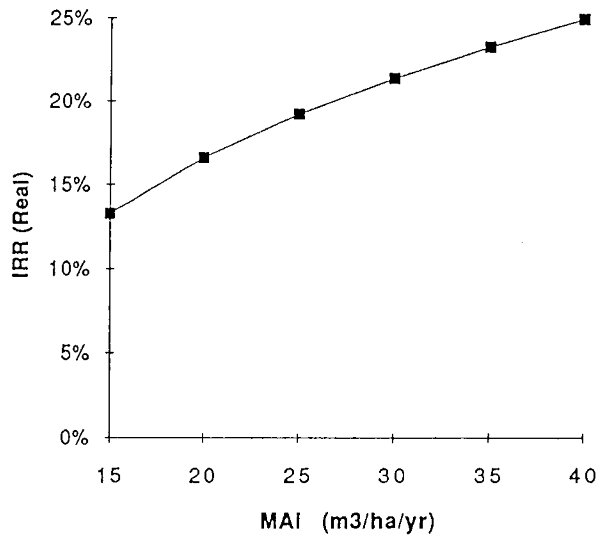


SENSITIVITY OF PROFITABILITY

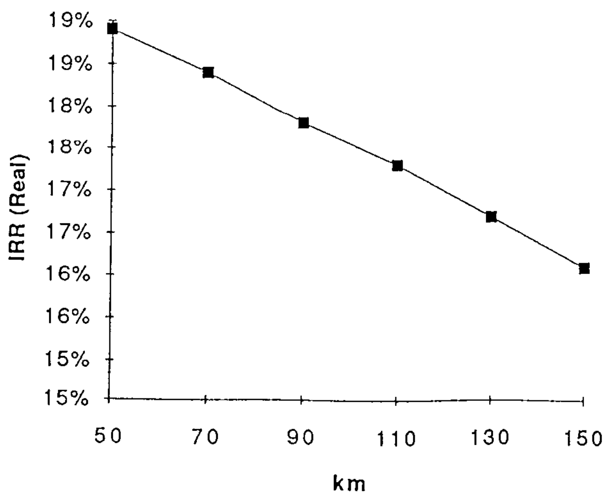
Establishment Costs



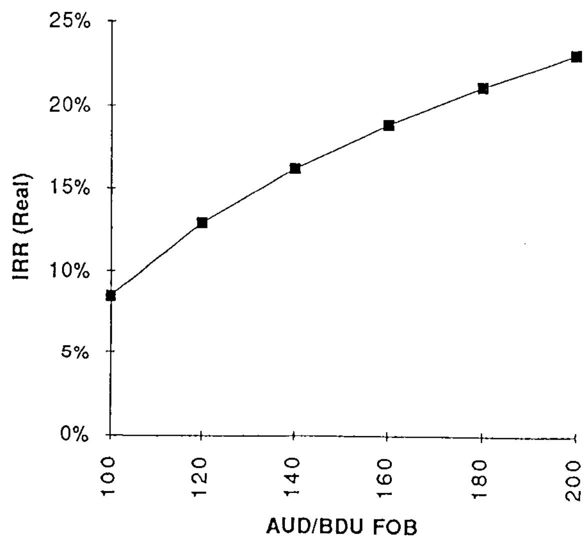
Site Productivity



Distance from Plantation to Mill



Woodchip Price



Even at the lower end of the range the estimated returns per hectare for these two tree crops, the rate of return compares favourably with broad acre agricultural crops. Tree crops are even more attractive if they can be integrated into the farm so that existing agricultural production is not reduced.

INTEGRATION

We believe that the key to the successful introduction of tree crops into Australian agriculture will require skilful integration into the agriculture systems and the farm business (Shea et al. 1993).

There are strong and legitimate concerns in the rural community about the sociological impact of fenceline to fenceline tree planting. Rural communities are concerned about the need to generate more wealth but they also want to ensure that there are farmers resident on farms so that facilities such as the school bus service is retained. Integration of trees into the farm ensures that the farmer stays on the farm.

Integration of trees into farms also allows for the optimum placement of tree crops for environmental and economic benefits. Skilful placement of trees in areas which maximise water consumption will increase the impact of tree crops on waterlogging and salinity problems. Inevitably there are sites within a farm where the productivity of tree crops is significantly less than agricultural crops. The technology which allows the optimum placement of trees on the farm is increasingly available.

Farmers may have the capacity to generate the funds necessary for the establishment of tree crops, but legal and financial packages have been developed which allow farmers to enter into partnerships with investors and/or end users of tree crop products which provide the capital necessary without loss of ownership or control of the farm.

CONCLUSION

During the last decade there has been concurrent development of a number of factors -

- the development of market opportunities for wood fibre products and a significant increase in international price of wood fibre;
- the recognition of the magnitude and severity of the land degradation problem in agricultural areas and the unequivocal evidence that the establishment of woody perennial crops that consume water throughout the year on a proportion of these lands will be an essential component of any successful landcare program;
- significant technological advances in tree crop technology;
- the development of legal and commercial mechanisms which provide the opportunity for farmers to be genuine partners in any large-scale tree crop establishment program;

which has provided the potential for the large-scale integration of tree crops into Australian agricultural systems.

In Western Australia we believe that this vision is being transferred into a reality. Over the last decade more than 30,000 hectares of commercial tree crops have been established on cleared agricultural land in partnerships with over 300 farmers. Two of the largest pulp and paper companies in Korea and Japan have demonstrated their confidence in the tree production potential in the south-west of Western Australia by committing themselves to large tree crop programs. There are over 1.3 million hectares of cleared agricultural land which has the potential to grow commercial tree crops in the south-west of the State. We believe it would be possible to establish over 200,000 hectares of commercial tree crops in partnership with farmers over the next 10 to 20 years in Western Australia. By skilful integration of this program into existing farms we are confident that net production from agricultural crops will not be reduced. A planting program of this scale will not totally solve landcare problems but it will make a significant contribution to the reduction of land and water degradation at no cost to the farmer. At the same time a new industry will be created which has the potential to generate more than half a billion dollars of export income per annum sustainably.

REFERENCES

Australian Bureau of Agricultural and Resource Economics (ABARE)

- 1990a, Australian Forest Resources 1989, Australian Government Publishing Service, Canberra.
- 1990b, Agriculture and Resources Quarterly, December 1990, AGPS, Canberra.

Bartle, J.R. 1992. Revegetation - how big is the job? Land and Water Research News 13. W.A.W.A.

Beadle, C.L. and G.B. Inions, 1990. Limits to growth of eucalypts and their biology of production. *In* "Prospects for Australian Forest Plantations". (Eds. J. Dargavel and N. Semple.) Centre for Resource and Environmental Studies. Aust. Nat. Univ.

Bird, P.R. (1988). Financial gains of trees on farms through shelter. In: Proc. International Forestry Conference for the Australian Bicentenary, Vol. 2 (Albury-Wodonga; Aust. Forest Develop. Institute).

Evans, J.E., P.J. Wood, J.O. Angwenyi, 1993. The place of plantations in sustainable tropic forestry. Commonwealth Forestry Conference, Kuala Lumpur.

Inions, G.B., 1991. Relationships between environmental attributes and the productivity of *Eucalyptus globulus* plantations in south-west Western Australia. Paper delivered to the third Australian Forest Soils and Nutrition Conference. Melbourne, October 1991.

Inions, G.B., 1992. Studies on the growth and yield of plantation *Eucalyptus globulus* in south-west Western Australia. Ph.D. thesis, University of Western Australia.

Moore, R.M., P. Jenkins, G. Anderson and P.R. Scott, 1991. Agroforestry with widely-spaced pine trees. Bulletin 4176, W.A. Department of Agriculture.

Select Committee into Land Conservation. Western Australian Legislative Assembly, 1991. Final Report.

Shea, S.R. and J. Bartle, 1988. Restoring Nature's Balance. The potential for major reforestation of South Western Australia. Landscope Vol. 3 No. 3.

Shea, S.R., J. Bartle, and G.B. Inions, 1993. Tree crops for farms. Landscope 8:2.

Shea, S.R. 1993. Sustainable management of forests for multiple benefits - is there anything new under the sun? Keynote address to 14th Commonwealth Forestry Conference, Kuala Lumpur, Malaysia. 13-18 September 1993.

W.A.W.A. 1989. Stream salinity and its reclamation in south-west Western Australia. Report of Steering Committee for research on landuse and water supply. Report No. WS52.