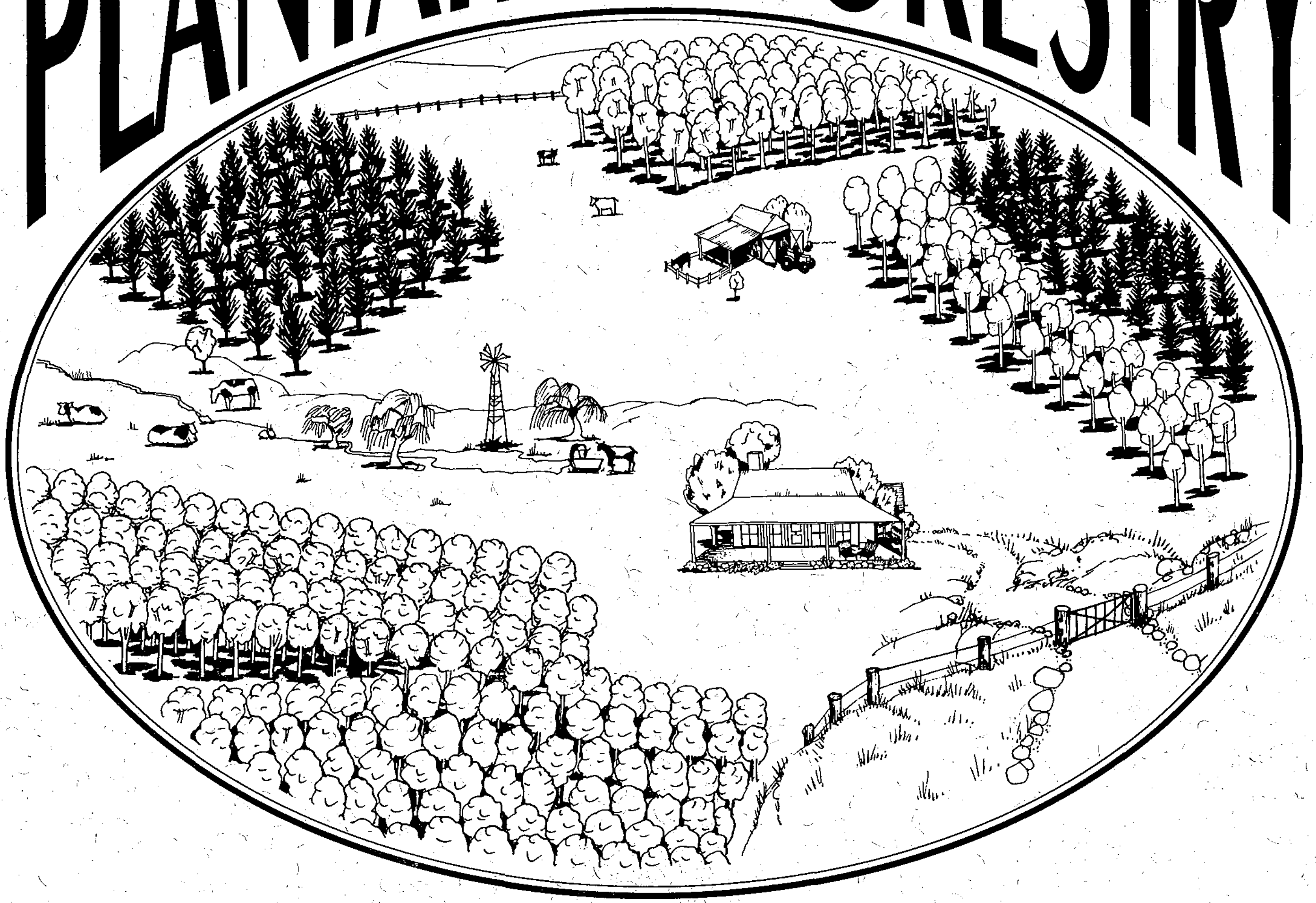
PLANTATION FORESTRY



IN WESTERN AUSTRALIA
ACHIEVEMENTS AND PROSPECTS

by S R Shea and P N Hewett

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PLANTATION FORESTRY IN WESTERN AUSTRALIA - ACHIEVEMENTS AND PROSPECTS

S R Shea and P N Hewett

Abstract

A softwood plantation program was initiated in Western Australia more than four decades ago. The program was aimed at ensuring that sufficient sawlogs were produced from plantations and the native forest to ensure WA's self sufficiency in sawn structural timber.

Projections of the domestic demand and supply for sawn timber were reviewed in 1987. It was concluded that it would be necessary to plant 2,500 hectares of softwoods per annum to the year 2010 to complement the native forest resource to ensure sufficient sawlogs were available to meet Western Australia's requirements. A large export market for hardwood fibre, suitable for the production of high quality paper, which could be supplied from short rotation hardwood plantations, was also identified.

Commercial tree plantations can make a major contribution to reversing environmental degradation in the south-west of Western Australia. But the requirement for tree planting for environmental purposes greatly exceeds Western Australian demand for products from commercial plantations. Increasing the commercial viability of tree plantations by greater efficiency and marketing will increase the environmental benefits to the State by increasing the number of trees that can be planted at no cost to the taxpayer or the farmer.

In south-western Australia there is a <u>potential</u> land area which could support commercial tree plantations of approximately 500,000 hectares. Most of this land is in private ownership and has been cleared for agriculture. A variety of planting and financial strategies have been developed which permit the private landowner to integrate tree plantations into the farm without loss of farm income and without disturbing the social infrastructure of rural communities.

Economic analyses based on costs and yield from actual afforestation projects indicate that high quality wood can be delivered to the mill door either within the State or overseas (depending on product) at costs equal to or less than potential interstate or overseas competitors.

The Western Australian tree planting program is underpinned by detailed technical studies and operational experience of site selection, growth and wood quality prediction, establishment and management of target species. The existence of an active research program in the public, tertiary and private sector should ensure that Western Australia's comparative advantage can be maintained.

A major constraint on the implementation of an increased plantation afforestation program in Western Australia is the availability of capital funds. In the past, either State or Federal Governments have been the only significant investors in the tree plantations in Western Australia. The unfavourable cashflow profile, the lack of liquidity, the taxation system which is a disincentive to investment in tree plantations and the perceived lack of resource security by potential overseas investors, are a major impedance to the generation of private capital into plantation projects.

The major economic and environmental benefits of an expansion of commercial tree plantating in Western Australia may be justification for government intervention to create a more conducive environment for investment in tree planting.

Introduction

Western Australia initiated a tree plantation program more than four decades ago. The program was commenced in anticipation of the need to meet the deficit between the capacity of native forests to supply sawlogs sufficient to meet local requirements and the anticipated demand for sawn timber in Western Australia. In 1987, the plantation program was re-evaluated as part of an overall review of forest management and the timber industry in Western Australia. [Forest Management Plans; Timber Strategy CALM (1987a)(1987b)].

Apart from the need to reappraise the Western Australian timber supply demand projections, three new developments which had occurred in the period since the original plantation program was initiated needed to be considered. Firstly, the world demand for wood fibre, and in particular hardwood fibre for high quality paper production, had increased substantially. Secondly, the potential to increase the value of the native forest resource by increased production of value added products was identified. Thirdly, community concern with the impact of clearing native vegetation on the environment of the south-west of WA had generated a large demand for tree planting for environmental purposes.

The existing plantation resource

The existing area of private and public hardwood and softwood plantations is shown below in Table 1.

TABLE 1

AREA OF PUBLIC AND PRIVATE PLANTATIONS IN WESTERN AUSTRALIA (as of 31 December 1989)

PUBLIC PLANTATIONS

Species	Area (ha)
Pinus radiata (1)	39 062
Pinus pinaster	29 346
Exotic eucalypts (2)	11 000
(1) includes 'sharefarming' softwood	2 741
(2) includes 'sharefarming' hardwood *(E. globulus)*	5 810

*Includes 4,000 ha (gross) of exotic eucalypts in plots and on rehabilitated areas.

PRIVATE PLANTATIONS

Species	Area (ha)
Pinus radiata	17 090
Exotic eucalypts (principally *(E. globulus)*	4 870

The demand for tree plantation products

Estimated supply/demand scenario for structural sawn timber in Western Australia

The 1987 review of forest management in Western Australia included a detailed review of the capacity of native and plantation forests to provide sawn structural timber for Western Australia. The result of this analysis is summarised in Figure 1. [(Western Australian Timber Strategy, CALM 1987b)].

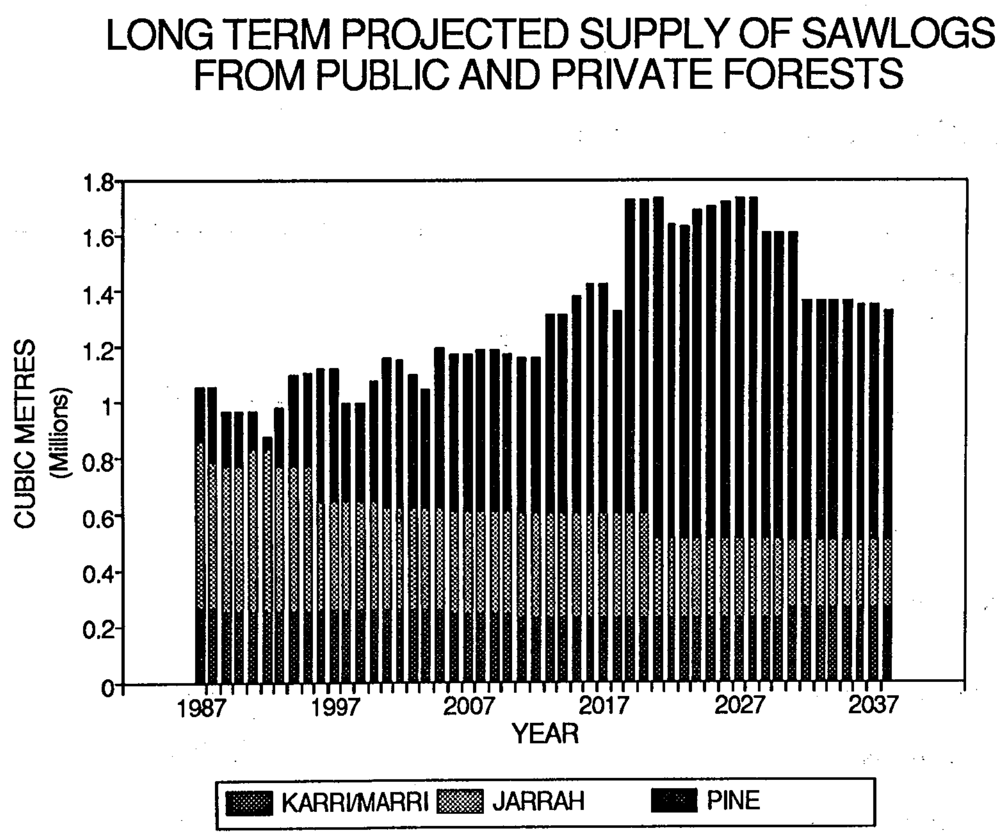


Figure 1

The Department of Conservation and Land Management's high demand curve assumes net exports (predominantly of high value products) will be equal to 10% of hardwood sawlog production in 1990 and increase to 30% of hardwood production by the year 2000 (Figure 2). It is probable that this assumption is conservative. The potential market for value added hardwood products relative to the capacity of Western Australia to supply them is large and there has been significant investments in value adding plant since the introduction of the Timber Strategy. Some hardwood sawmillers in Western Australia are planning to increase their value added production to 50 per cent of their log intake.

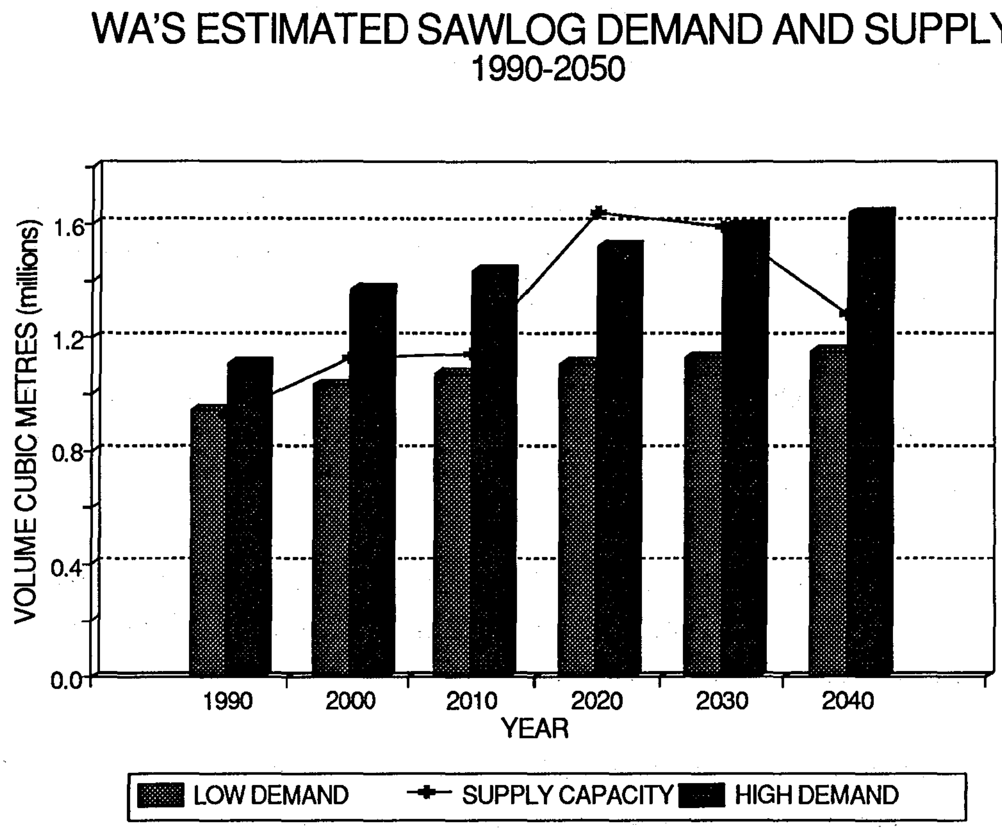


Figure 2

The reduction in the quantity of hardwood logs available for structural products, because of their use for value added products, will be partially compensated for by the increased use of low grade hardwood logs for sawn timber production. For example, the quantity of Marri, *Eucalyptus calophylla* (a species which has primarily been used to produce woodchips) which has been processed to sawn timber, has increased to 30,000 cubic metres per annum.

If it is assumed that the net hardwood structural sawn timber supply remains as predicted and if a 2,500ha per annum plantation establishment rate is maintained until the year 2010, the supply of structural sawn timber will approximate the anticipated Western Australian demand (Figure 2).

The estimated supply/demand scenario for wood fibre for particle board and medium density fibre board production

A particle board plant was established in WA by Westralian Forest Industries in 1976. It currently consumes on average 300,000 cubic metres per year of softwood roundlogs from thinnings and sawmill residue. Approximately 10% of the product is exported.

A medium density fibre board plant owned by Westralian Forest Industries commenced operation in October 1990. Its consumption of softwood logs and sawmill residue in 1991 will be 36,000 cubic metres. Approximately 50% of the output of the plant will be exported.

Over the next decade these two plants' consumption will rise to approximately 550,000 cubic metres. Approximately 60 per cent of this fibre will be derived from softwood thinnings. The remainder will come from sawmill residue.

Both plants have the capacity to accept a proportion of hardwood fibre, but it is not possible to predict the quantity which may be used until further technological and economic evaluations are completed.

Economic factors will restrict the supply of fibre for medium density fibre board and particle board production to plantations within an average 70km radius of the two plants, which are located at Kewdale and Bunbury.

The existing and proposed softwood plantation resource will generate sufficient resource to meet the requirements of the two panel board factories at their proposed level of production. The increased demand for fibre residue from the expansion of these two factories will ensure that it will be possible to ensure that thinning of both public and private softwood plantations will be able to be carried out commercially and on schedule. In the past, the absence of a market for softwood thinnings has caused significant silvicultural problems and in particular has been a major disincentive to private investment in softwood plantations.

The demand for hardwood fibre for paper production

Projected growth of world consumption of paper and paperboard is expected to average 2.25% per annum and reach 270 million tonnes by the year 2000. [Figueiredo (1987)]. This has resulted in an increase in the demand for wood fibre. There has been a disproportionate increase in the demand for high quality paper. This is reflected in the increased demand for Eucalyptus fibre because of increased recognition of its superior qualities for the production of high quality paper.

Groome (1987, 1989) has estimated the demand for hardwood fibre by Japan and the potential supply sources for that country. He concludes that by the year 1998 there will be a deficit in the world capacity to supply Japan's demand for hardwood fibre of 5.7 million tonnes per year. It would be necessary to establish between 200,000-300,000 ha of high yielding Eucalyptus plantations to meet this anticipated deficit in the supply of high quality wood fibre to Japan alone.

Western Australia currently exports 680,000 tonnes per year of hardwood (*E. callophylla*/*E. diversicolor*) woodchips, a by-product of sawlog harvesting in native forests, to Japan for high quality paper production.

If a pulp mill were established in Western Australia, it would require an input of between 1.4 and 1.6 million tonnes of wood fibre. It would be necessary to establish between 50,000 and 70,000 hectares of eucalyptus plantations to supply this resource on a sustained basis, if it was assumed that all of the fibre was supplied from plantations.

The existing public and private hardwood plantations of *E. globulus* will produce approximately 200,000 cubic metres per annum (assuming a mean annual increment of 20 cubic metres per hectare per annum) by the year 2000.

The demand for tree planting

The removal of native vegetation to allow the establishment of agricultural crops has had a profound and unfavourable effect on the environment in Western Australia.

The removal of native vegetation causes water tables to rise because the transpiration from agricultural crops is significantly less than that of native vegetation. The effect of rising water tables is to release salt which is stored in the soil profiles over a large proportion of the landscape [(Schofield et al (1989)]. This has resulted in extensive stream and river salination and the loss of highly productive agricultural land. It is estimated that 250,000 hectares of farmland within the 600mm isohyet has been made unproductive by salination and/or water logging [Malcolm (1983)].

There are legislative and voluntary constraints on the clearing of native vegetation in Western Australia, but the effect of previous clearing is still continuing. The time lag between clearing and the intersection of the water table with the soil surface may exceed thirty years. A significant proportion of the extensive clearing that has taken place has occurred within the last thirty years, particularly in the south coastal region east of Albany/Mt Barker.

The problem is being compounded throughout the south-west by the decline of remnant native vegetation in agricultural areas which is occurring as a consequence of the original clearing. Salination, waterlogging, infection by the soil borne fungus *Phytophthora* *cinnamomi*, exposure, invasion of pasture species and soil compaction by stock, are all contributing to a massive decline in remnant native vegetation on farmlands.

The potential value of tree planting schemes on catchments, which reduce salination of existing sources of water for irrigation and domestic use, is large. For example, the reduction of salinity levels to below 500 milligrams per litre in the Wellington Catchment, which currently yields 69 million cubic metres of water per annum is conservatively estimated to be worth 40 million dollars per annum (pers. comm. Western Australian Water Authority).

The replacement of native vegetation by agricultural crops, which require the application of large quantities of fertiliser, has also caused eutrophication of estuaries, streams and wetlands throughout the south-west. The discharge of fertiliser into streams and wetlands has been significantly aided by the rise in water tables, which results in greater overland flow of water and where duplex soils are present, greater lateral flow within surface soil horizons.

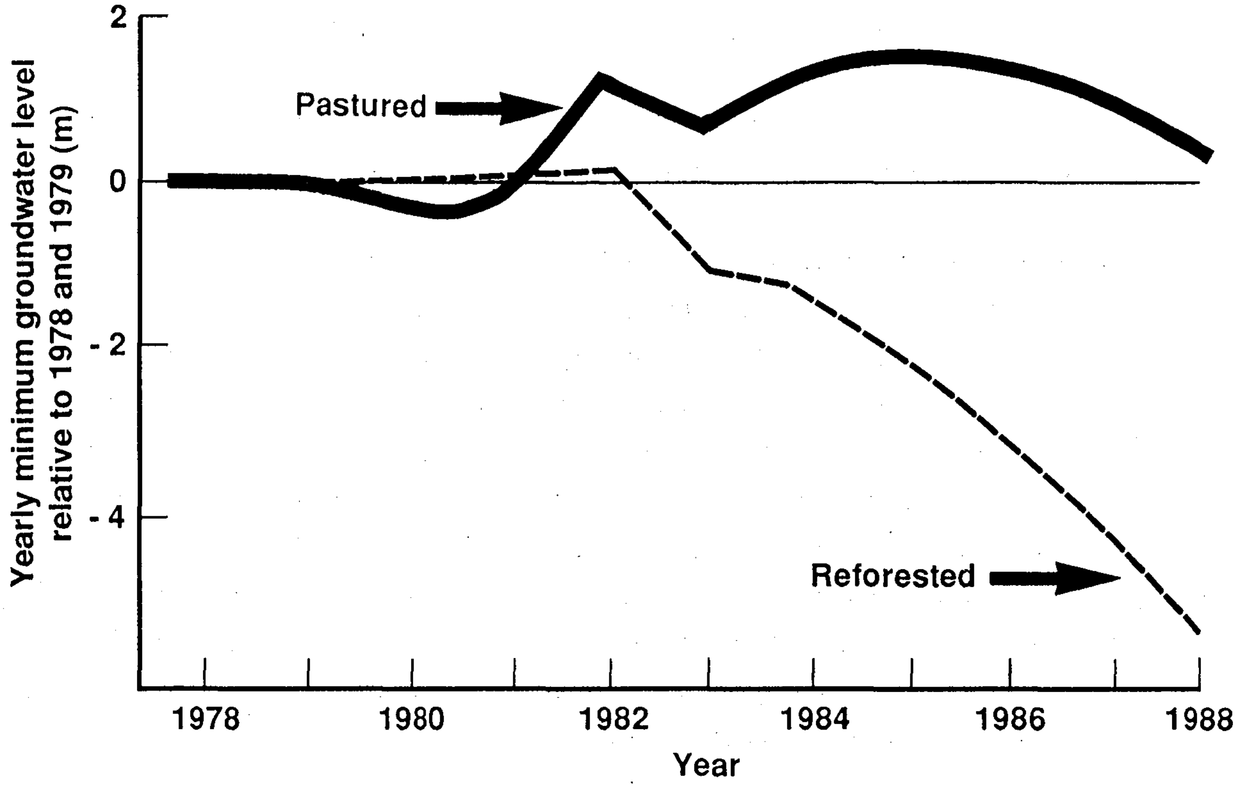
Excess surface water movement, the destruction of soil structure by salination and the exposure of soils to wind has also resulted in extensive erosion.

Commercial tree planting on farms would make a major contribution to alleviating these major regional and on-farm environmental problems [Shea and Bartle (1988)]. Research carried out over a period of twenty years has demonstrated that it would be possible to reduce water tables by the establishment of tree crops, Figure 3 (Schofield et al 1989). It had been assumed that native trees species would be required to achieve the reduction of water table levels. But it has now been demonstrated that fast growing eucalypts can cause large reductions in water table levels within five years.

Native vegetation, if it was established at pre-clearing densities, would result in a reduction in water tables. But the growth rates of native vegetation and consequently the rate of leaf area development, are between 90% to 50% lower than *E. globulus* plantations. At these growth rates, native tree species are not commercially viable and the rate of water table lowering too slow.

Remnant native vegetation decline can be alleviated by establishing tree crops surrounding islands of native vegetation because of the reduction in water table levels and exposure. The cost of fencing areas of remnant vegetation, when it is combined with commercial tree planting, is offset by the returns from commercial planting.

The establishment of strategically located tree plantations on farms can also increase agricultural production by reducing wind and water erosion, providing shelter for animals



Groundwater drawdown at Stene's farm in the Wellington Catchment

Figure 3

and reducing the adverse effect of wind on crops. It has been estimated that shelterbelts could increase pasture production by 10% to 20% and decrease lambing losses by 20% to 50% [Bird (1988)]. The effect of shelter belts on Lupin yields at Esperance are shown in Figure 4 (Bicknell, pers. comm.).

There have been few quantitative analyses carried out to determine the costs and benefits of tree planting on agricultural production and each farm would have different ratios. The data demonstrating the beneficial effects of the planting and agricultural production, however, suggest that on many farms the loss of land for agricultural production as a consequence of tree planting would be negligible if up to 20% of the farm was planted, provided trees are strategically located. The farmers return on the land from tree planting would, in these situations, represent a net increase in total farm income.

The percentage of cleared farmland which would have to be reforested to achieve water table reduction will vary from catchment to catchment and farm to farm. It has been estimated that as much as 45% of the landscape may need to be re-established with trees to achieve significant reductions of the water tables. [Schofield et al (1989)]. However, there is increasing evidence that the proportion of the farm that is required to be reforested to cause significant reductions in water tables can be reduced by strategic site selection and drainage design. For example, trees can be placed on areas where soil and groundwater are preferentially recharged, where tree roots can gain ready access to deep water storage, where the whole profile water storage capacity is large and where such profiles can have their recharge enhanced by drainage design. The location of trees in belts will also maximise evapotranspiration (Bartle pers. comm.).

If it is assumed that on average 25% of cleared farmland would have to be reforested within the 600mm rainfall isohyet (Figure 5), an area of 300,000 ha of cleared farmland would need to be planted with trees to achieve significant reductions in salination and eutrophication.

Pre-requisites for commercial tree planting

Climate and soil suitability

The region suitable for commercial tree plantation extends from south of Perth to east of Albany (Figure 5). Western Australia has a Mediterranean climate with the majority of the rainfall occurring in the months from June to September.

Rainfall is the principal determinant of tree growth and survival. The 600mm rainfall isohyet has been assumed to be the limit for commercial planting. But it is possible that

WINDBREAK EFFECT ON CROP YIELD

Lupin yield between parallel windbreaks

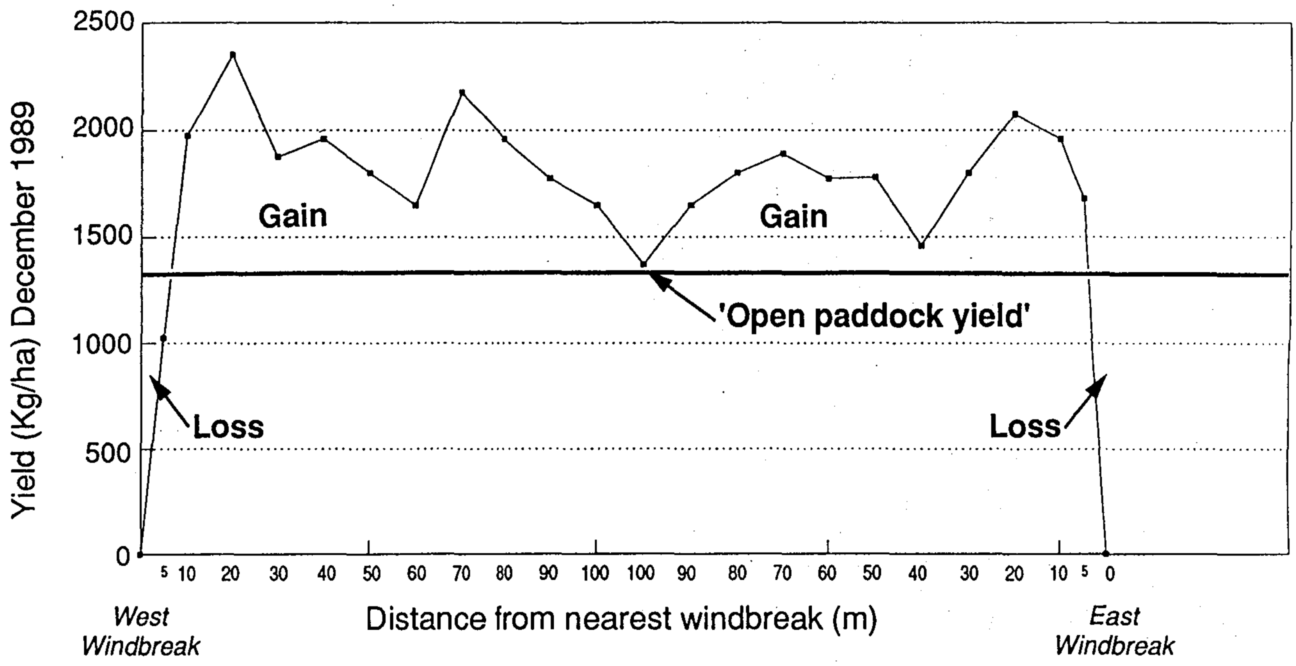
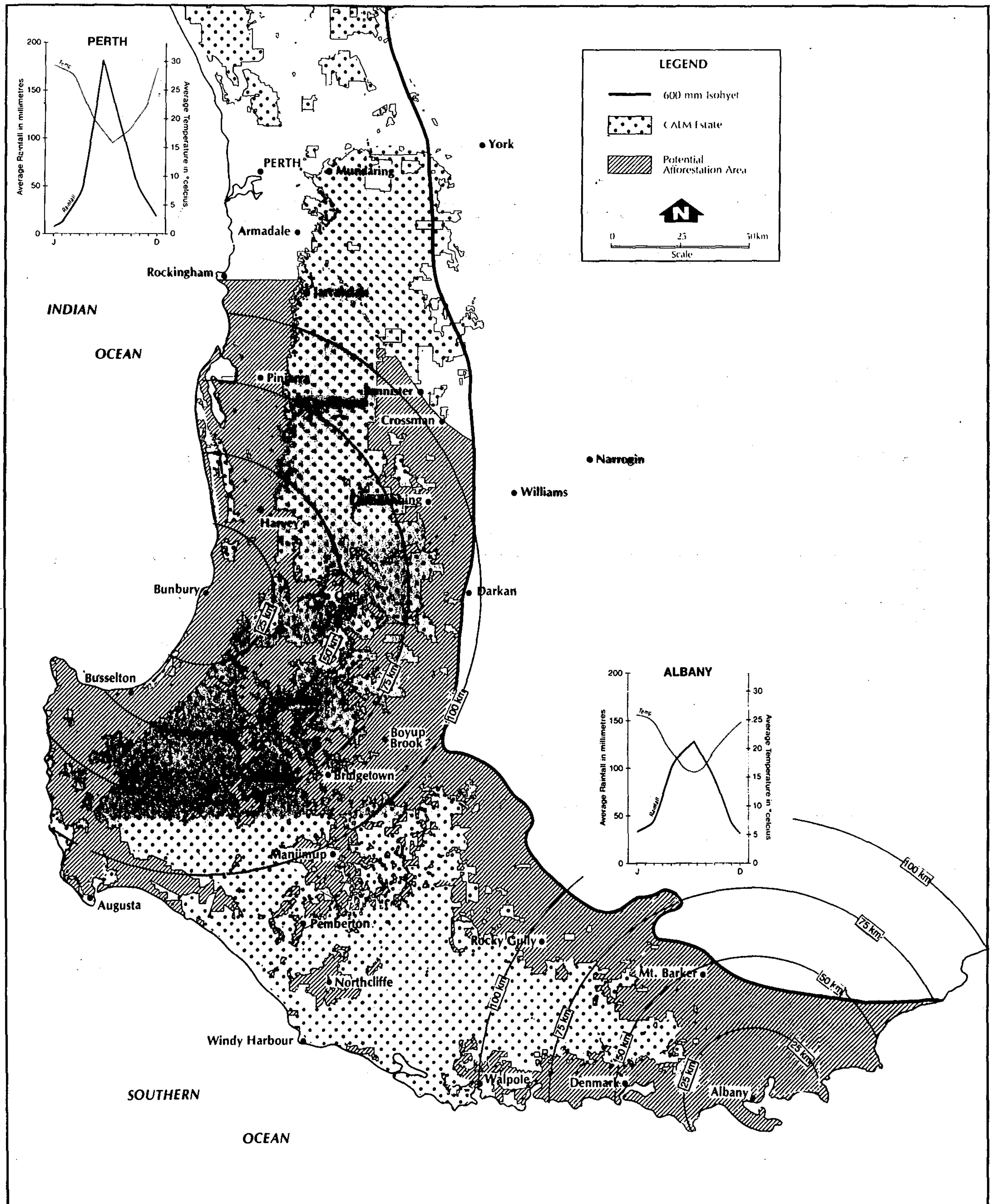


Figure 4



AREA WITH POTENTIAL FOR HARDWOOD AFFORESTATION

Figure 5

the planting zone may be extended beyond this limit by reducing planting density, thinning, and in the case of hardwoods, by reducing rotation length.

Tree growth is related to rainfall, but within the region growth varies markedly according to soil type. The principal soil factors affecting tree growth are soil depth, texture and fertility.

The relationships between soil type, rainfall and growth have been determined from correlations with growth plots and existing plantations throughout the region.

Pinus radiata (the principal softwood plantation species) tree growth varies from 10 cubic metres per hectare/annum to 25 cubic metres per hectare/annum and is managed on a 30-year rotation. Site requirements for *P. radiata* are demanding. Generally this species can only be grown in relatively high rainfall areas (>700mm) and on soils with a minimum depth of 90cm which have a relatively high fertility level. Consequently, suitable sites can be relatively easily identified.

Pinus pinaster has been extensively planted on the Swan Coastal plain on sites which are too infertile for *Pinus radiata*. Currently, this species is only being planted when *P. pinaster* stands are being re-established after clearfelling. The species may be planted more extensively in the future for environmental purposes but its relative low growth rates currently makes it uneconomic when it is grown for timber production alone on most sites.

Eucalyptus globulus, the principal hardwood plantation species, has been established in trial plantations throughout the region over a period of forty years. Permanent inventory plots have been established in sixty of these plantations. Two thousand trees have been measured. Five hundred trees were destructively sampled for laboratory analysis. These data, amounting to 80,000 individual measurements, form the basis for the estimation of growth yield for *E. globulus* plantations. Wood quality (basic density, pulp yield) has also been obtained and related to climatic and site characteristics. Models have been developed which predict the volume, basic density and pulp yield of *E. globulus* stands over time. The models have been validated in the field. Prediction of site index (a measure of the potential productivity of a site) from environmental inputs resulted in a mean error of 0.5m Â 0.9m is incurred. Likewise, when predicting stand height development the error is 0.1m Â 0.1m (Inions per.comm.).

Growth rates for *E. globulus* vary from 10 to 50 cubic metres per hectare per annum and are managed on a 10-year rotation with the possibility of two further 10-year rotations based on coppice. Basic density averages 550 kg per cubic metre and screened pulp yield averages 54%.

E. globulus can be grown successfully on a much wider range of site types and requires less rainfall (>600mm) than *P. radiata*. But, paradoxically, site selection is more critical because site suitability may change markedly over small distances. Variation in site productivity on a farm which was assessed using the model developed to predict *E. globulus* growth rates is shown in Figure 6 (Inions pers. comm.). Failure to detect site changes, many of which may be caused by factors such as soil nutrient levels which are not readily apparent, can result in lower average yields which can significantly affect economic viability.

More than thirty tree species are currently being evaluated in extensive field trials. The growth performance of some of these species is promising and they may be commercially viable. But it is not possible, at this stage of their development, to guarantee that they will be commercially viable.

Land availability

Of the 1.8 million hectares of freehold land in the region 25% is uncleared (Figure 5). As it is not proposed to clear native vegetation to establish plantations, 1.45 million hectares of this area is potentially available for tree planting. It is estimated that approximately one-third of this area - 500,000 hectares - could grow *E. globulus* at rates which are competitive with agriculture.

It is estimated that the land base available for *P. radiata* is approximately one-fifth of the *E. globulus* land base.

The actual area of land that could be available for commercial tree planting will depend on -

- The difference between the average cost of production (from an aggregate of the land base) of a unit of wood product delivered to the end user and the price the end user is prepared to pay.
- The willingness of private landowners to participate in tree planting schemes.

The former is determined by a number of factors which are discussed below. The latter, in part, will be determined by the return a private landowner receives per hectare for tree planting relative to other uses (the opportunity costs). But it will also depend on a number of other factors which are not directly related to the rate of return per hectare.

E. GLOBULUS SITE PRODUCTIVITY ASSESSMENT FOR A TYPICAL FARM

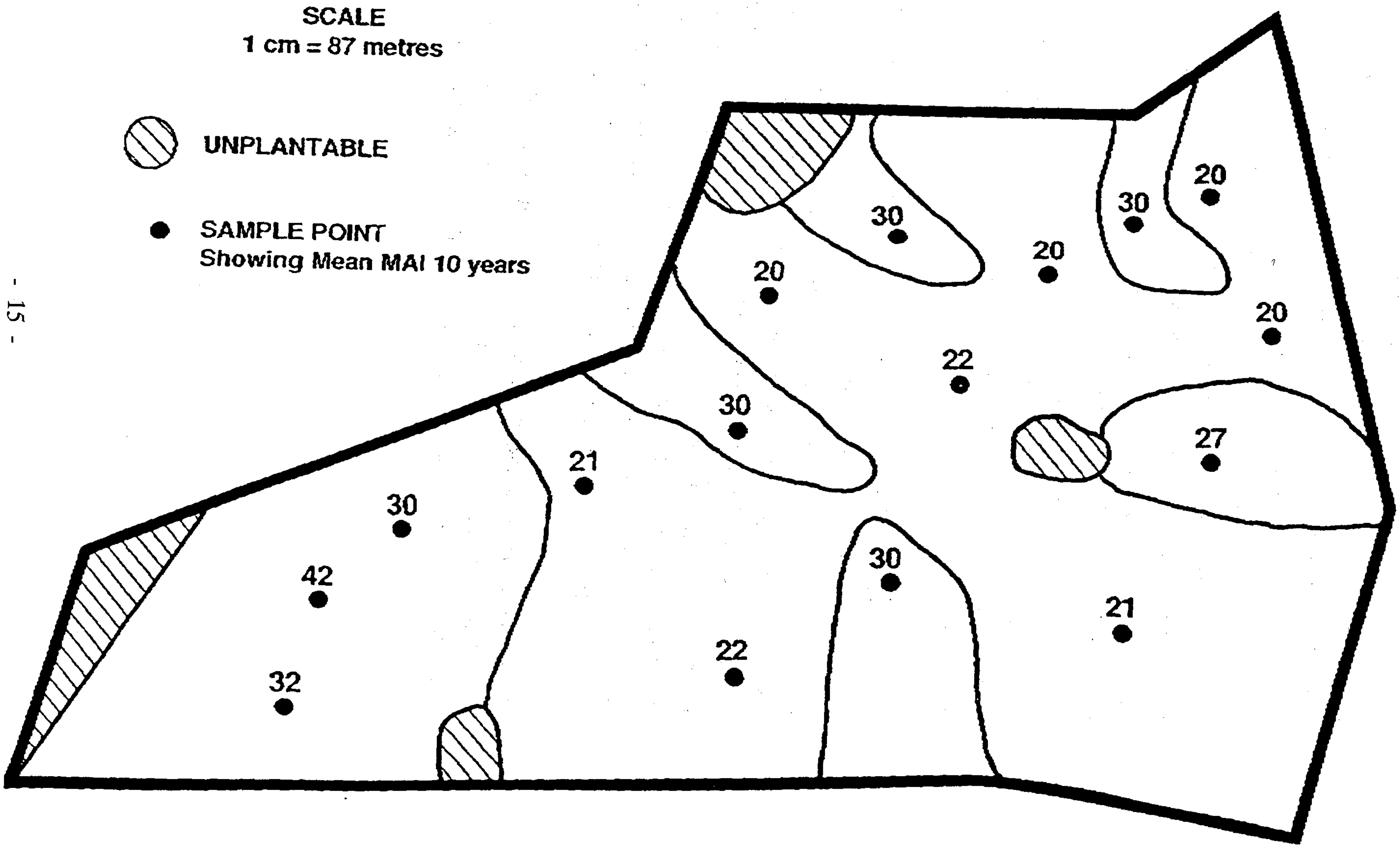


Figure 6

Participation of private landowner

- **Sharefarming**

One of the principal disincentives to farmer participation in commercial tree planting in the past has been the time lags between plantation establishment and positive cashflows. In 1985, a "sharefarming" scheme was introduced by the Department of CALM to address this problem. Under this scheme, landowners are paid an annuity commencing in the year of planting and receive a percentage of profits from the final crop. Annuities are indexed according to the Consumer Price Index. (More recently a maximum cost price index has been applied). The landowner can maximise either his annuity payments or the return at the time of harvest, except that the minimum proportion returned as a percentage of final crop profits must be 5%. The requirement that the landowner must accept a percentage of the final crop profit as part payment for use of the land was introduced to ensure "ownership" of the plantation. Landowners entering the scheme are given first right of refusal to undertake plantation maintenance, such as firebreak construction and pruning.

The maximum annuities that can be paid are determined by assessment of site productivity, costs, projected returns for the products produced and the internal rate of return required. Site productivity affects maximum annuity payments, but distance to mill or port and wood quality (in the case of hardwood plantations) are also major factors. The actual annuity (which cannot exceed the maximum rate) is determined by negotiations with the landowner. Actual annuity payments vary according to a number of factors including the market conditions for agricultural products, the farmer's perception of the returns he is receiving for alternative land use activities, and on-farm environmental benefits of tree planting.

Each landowner entering the scheme signs a legally binding contract which specifies the obligations of the landowner and the Department. The data on the sharefarming contracts which have been entered into to date are shown in Table 2.

TABLE 2

HARDWOOD AND SOFTWOOD SHAREFARMING (1985-1990)

HARDWOOD SHAREFARMING	
Total area	5 810 hectares
Average size	102 hectares
Range	2 - 674.2 hectares
Number of landowners involved	46
Minimum size	20 hectares preferred minimum
HARDWOOD TIMBERBELT PLANTINGS	
Total area	1 332 hectares
Average size	10 hectares
Number of landowners involved	129
Minimum size	No minimum size requirement
SOFTWOOD SHAREFARMING	
Total area	3 427 hectares
Average size	127 hectares
Range	14-569.8 hectares
Number of landowners involved	27
Minimum size	40 hectares preferred minimum

- **Integration of trees into farms**

The introduction of the 'sharefarming concept' in 1985 represented the first step towards developing a program which would lead to integration of trees as a crop into normal farming practice. Sharefarming was designed principally to address the financial barrier to the acceptance by farmers of trees as a legitimate commercial crop. It represented a quantum leap from the practice of establishing large plantations on publicly owned land or repurchased farms. But since its introduction the concept has been developed and refined to the point where tree planting on farms can now be integrated into the total farm plan in a way which eliminates social disruption, optimises financial return to the investor and farmers and maximises the on-farm and regional environmental benefits of tree planting.

There is considerable resistance in the rural community to perceived economic and social disbenefits associated with broadscale tree planting. It is unlikely that tree planting would cause reduced economic activity provided the market is not distorted. But the planting of whole farms with tree plantations can reduce on farm occupancy and result in the reduction of community facilities, such as schools and bus transport. By integrating tree planting into the farm, these adverse social costs are avoided. Tree planting which is integrated into farms contributes to rural community stability by contributing to the diversification of farm income.

By integrating tree planting into the total farm plan, areas on the farm most suitable for production forestry are targeted. This increases the potential to maximise environmental benefits and avoid reductions in agricultural production. For example, buying of a whole farm for replanting may result in areas more suited for agriculture being planted to trees and the clearing of native vegetation. The evaluation of tree planting options in the context of the total farm plan permits the farmer to offer land in areas which are less suitable for agriculture and to strategically locate the plantations to maximise environmental benefits without compromising the commercial viability of tree planting.

Integration of tree planting into the farm has been made easier by technological advances. For example, sheep can be grazed in *Eucalyptus globulus* plantings nine months after establishment (Mattinson per. comm.), increasing the potential to utilise tree planting areas for agricultural production for a greater proportion of the tree rotation. Accurate site identification and yield prediction permits optimisation of commercial timber production and the on farm environmental benefits of tree planting.

Commercial tree planting on farms often has been limited to block plantings or widely spaced trees to accommodate grazing. These two options remain available where appropriate. But planting trees in timberbelt configurations - belts of trees approximately 25-40 metres wide - in many situations provides a greater opportunity to optimise wood production, agricultural and environmental benefits.

Thirteen hundred hectares of 'timberbelts' have been planted in Western Australia. Under the scheme, landowners provide land and specified managerial services in return for the environmental benefits of tree planting on the farm and a proportion (determined by the relative inputs of the landowner and the Department) of the return from selling the timber at year ten.

It is now possible to offer landowners a number of tree planting schemes ranging from single large block plantings with maximum annuity payments and minimum farmer participation in management, to small timber belts with no annuity payments and maximum farmer participation.

The presence of an existing forest management, logging and processing infrastructure, low road construction and transport costs make it possible for a flexible planting strategy without increasing per unit costs. In fact there is some evidence to suggest that planting schemes which involve maximum farmer participation may be more efficient, provided there is adequate technical support, because of the low overheads associated with individual farmer enterprises.

The maintenance of "rural community goodwill" will have a more important effect on land availability for commercial tree planting in the long term than economic or technical factors. This requires that government agencies and private companies promoting tree planting are conscious of the need to integrate this land use into the existing practices and to ensure genuine landowner participation and "ownership" of tree planting ventures.

Economic Viability

Price

- Softwood sawn timber

The price for softwood sawlogs is determined by the State Government based on a "cost of growing" plus profit formulae (Timber Strategy, CALM 1987). Currently, the price charged for logs at the stump is slightly higher than the Australian average. The Government's control of price is a consequence of its dominant position as a softwood log supplier in the Western Australian market. It is possible that external market forces could influence the price of softwood sawlogs in the future, but competitors suffer a severe cost disadvantage because of distance. The cost of transporting sawn timber from South Australia, the nearest competitor, is equivalent to an increase in royalties of approximately $30 per cubic metre at the stump. This represents approximately a 100% increase on existing log prices. However, in periods of economic recession pine sawn timber is sold into the WA market from Eastern States suppliers at discounted prices.

Another potential source of competition is from sawn timber imported from Asia. Approximately 90,000 cubic metres of sawn timber were imported to Western Australia from tropical and subtropical sources in 1989-90 at prices significantly below that being asked for Western Australian sawn timber. It is probable, however, that as a consequence of increasing international concern about the management of tropical rainforests and the imposition of more stringent conditions in the countries of origin that the quantity of sawn timber imported from this source will decrease.

The future price of softwood sawn timber, and consequently the price of softwood sawlogs, is in part influenced by the corresponding price of native forest sawlogs. Competition is constrained by the supply capacity of the native forest and native forest sawlog royalties have also increased significantly over the past three years relative to softwood royalties.

- Hardwood fibre price

The price of wood fibre or market pulp, like all commodities traded on the international market, is subject to cyclic variations in response to a number of factors (Figure 7). The real price (excluding the effect of currency variations) of wood fibre has increased markedly over the past five years and the increase is closely correlated to the price of eucalyptus pulp. A number of studies have concluded that there will be a real increase in the price of wood over the next thirty years of between .5% to 2% per annum [Grundy (1985) Business and Economic Research Ltd (1988)].

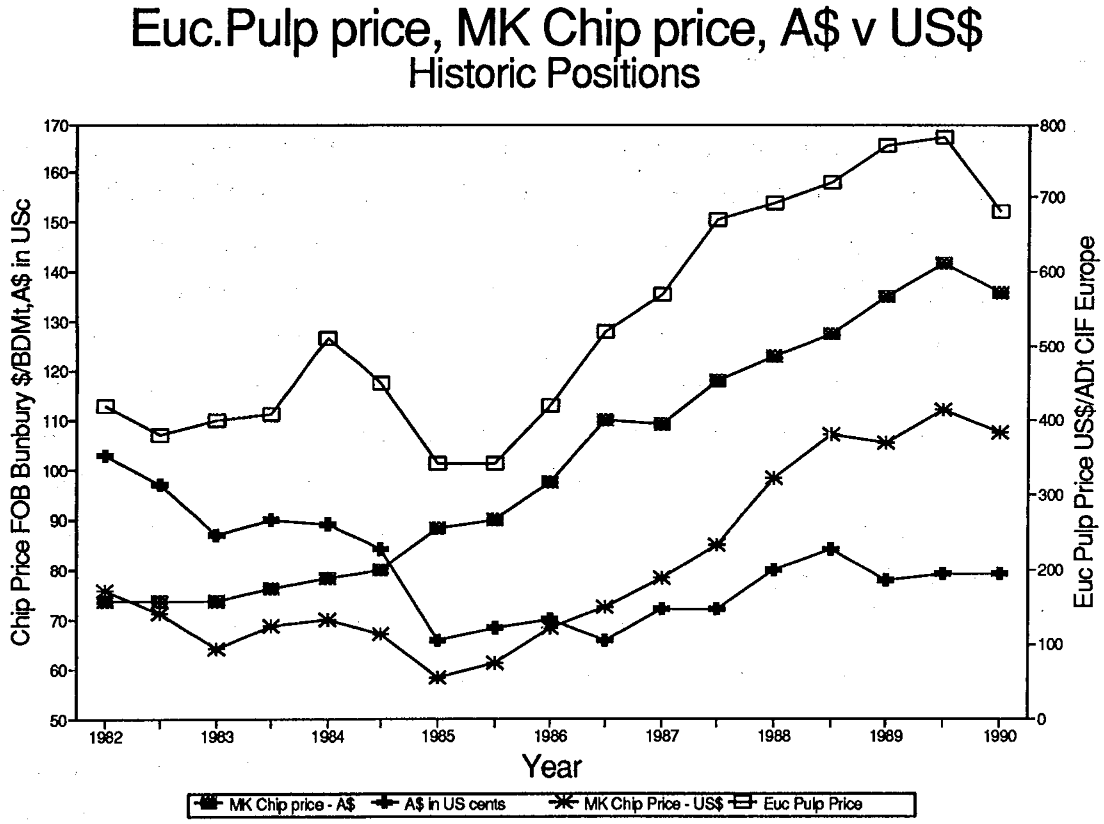


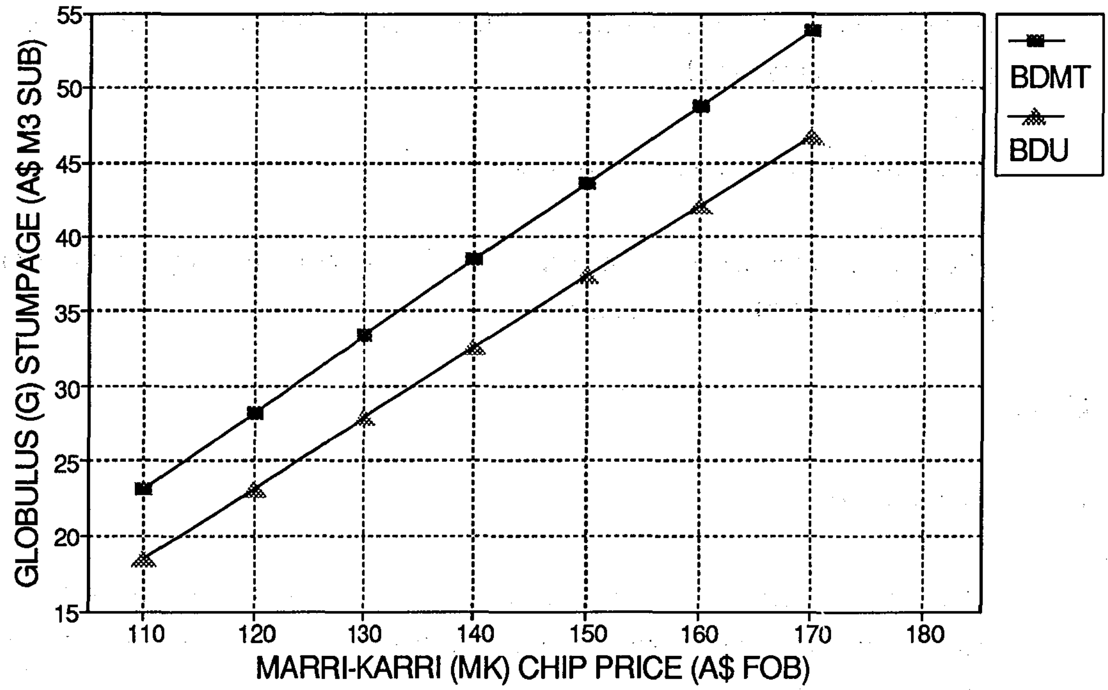
Figure 7

Our estimates of the price of *E. globulus* at the stump are based on an analysis of the existing price obtained currently for Marri/Karri (*Eucalyptus calophylla/ Eucalyptus diversicolor*) wood fibre at the port of Bunbury.

The relationship between the FOB price for Marri/Karri woodchips and *E. globulus* price at the stump is shown in Figure 8. The relationship has been calculated on the assumption that the extra yield of wood fibre derived from *E. globulus* would be reflected in a directly proportional increase in price. The price of *E. globulus* at the stump has been derived by subtracting the costs incurred from stump to ship assuming an annual haulage distance of 60km and 50km for logs and woodchips respectively. These costs are based on an analysis of the existing woodchip operation.

RELATIONSHIP FOB PRICE - STUMPAGE

BONE DRY UNITS OR BONE DRY METRIC TONNE



Asumptions

(i) Price, delivered to Japanese port, of pulp component of wood is same for MK as for G. Port of origin Bunbury WA.

(ii)

	MK	G
Basic density (kg/m^3)	630	550
Bleached pulp yield (%)	43	50
Ocean freight (A$ BDMT)	53	61

(iii) Operating costs typical:
Port $7.40 GMT, chip transport $5.00 GMT
Chipping $9.61 GMT, log extraction $12.00 GMT
Log haul $6.60 GMT

(iv) To arrive at stumpage, residual cost has been discounted 15% for harvesting and marketing overhead and contingency.

(v) Operational scale 1 million GMT + per annum.

Figure 8

A number of factors, such as future world supply/demand for wood fibre and whether buyers will pay the full premium for the higher quality fibre will influence the price that can be obtained for *E. globulus* fibre at the stump. But given the trend in price movements for Marri/Karri chip over the past several years and the fact that Marri/Karri chip currently is sold at the stump for $15 per cubic metre, it is probable that a stump price of between $20-$35 per cubic metre could be realised for *E globulus* fibre.

- Price of softwood fibre for particle board and medium density fibre board

The prices for logs produced for panel board production have been fixed by an Act of Parliament. Particle board logs are priced at $8.35 per cubic metre. Medium density fibre board logs (principally *P. pinaster*) is $10.07 per cubic metre. The price is indexed every three years according to the Consumer Price Index.

The price for sawmill residue for panel board production has been negotiated between Westralian Forest Industries and individual sawmillers and is subject to commercial confidentially.

- Hardwood price value added product

The current price for value added native forest hardwood (dry, dressed) ranges from $800 to $1200 per cubic metre.

Costs

- On farm costs

The current average costs of establishment and management per hectare of *P. radiata* and *E. globulus* plantations establishment on privately owned cleared farmland are shown in Tables 3 and 4.

These costs, expressed in 1991 prices, are based on analysis of actual costs incurred in the establishment and management of the 9,000 ha of plantations which have been established on farmlands in Western Australia by the Department of CALM in the period 1985-1990. It is unlikely that the cost of establishment and management will increase above the inflation.

TABLE 3

COST OF PRODUCTION

P radiata

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Activity/Cost																																
Land Cost	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	500	100
Establishment	851																															
Weeds/Infill etc		144																														
Low Prune/Cull						41																										
High Prune/Cull								43																								
Fertilizer				141			141					200								200						200		200				
Clean up debris																																209
Annual Maintenance	17	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	
Supervision & Overheads	217	89	40	82	36	49	74	49	36	36	41	88	36	36	36	36	36	36	41	88	36	36	36	36	41	88	36	88	36	36	41	58
Sub Total	1085	256	63	246	58	112	237	115	58	58	63	311	58	58	58	58	58	58	63	311	58	58	58	58	63	311	58	311	58	58	63	267
TOTAL (includes land cost)	1185	356	163	346	158	212	337	215	158	158	163	411	158	158	158	158	158	158	163	411	158	158	158	158	163	411	158	411	158	158	563	367

TABLE 4

COST OF PRODUCTION

E. GLOBULUS

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Activity/Cost																					
Land Cost	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Establishment	1175																				
Infill/Weed Cont.		100										100	100								
Fertilizer			100		100		100					100		100		100					
Harvest Cleanup																					200
Coppice Prune												250									
Annual Maint		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Supervision/ O'heads	150	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
TOTAL	1325	140	140	40	140	40	140	40	40	40	40	490	140	140	40	140	40	40	40	40	240

- Land costs

Land values per hectare in the target area vary from $1000 - $5000. But it is unlikely that significant areas of land can be obtained by whole farm purchase. It is possible to use land values as a guide to annual rental costs.

A more relevant guide to annual land rental costs is the return the farmer can expect from the agricultural activity which would be displaced by tree planting. But prices for agricultural commodities also vary.

The relationship between return from agricultural production and the market price for land leased for tree planting can also be significantly modified by tangible and intangible factors. For example, if the on-farm benefits of tree plantations, such as shelter and grazing potential and land reclamation, are maximised for the landowner, the cost of land can be reduced significantly.

The preparedness for landowners to accept payment for the use of land in the form of a proportion of the proceeds of the crop at time of harvest rather than as an annual rental charge is also markedly influenced by the degree to which tree planting can be integrated into the farm. In general, the more successful the integration of trees onto the farm, the smaller the effect on annual agricultural income. Annual rental fees for tree plantations vary from $40 to $140 per hectare depending on site productivity.

- Farm gate to mill door costs

Traditionally, foresters in Australia have been preoccupied with the cost of production of a unit volume of wood at the stump. But the cost per unit of <u>utilisable product</u> at the mill door, relative to competitors, is the ultimate determinant of commercial viability. Harvesting and transport costs contribute significantly to the total cost and these costs are markedly affected by wood quality, density and moisture content.

Pinus radiata

The current average cost per cubic metre (including royalty payments) of first grade and second grade *P. radiata* delivered to the mill door is $90 and $60 per cubic metre respectively.

Hardwood fibre

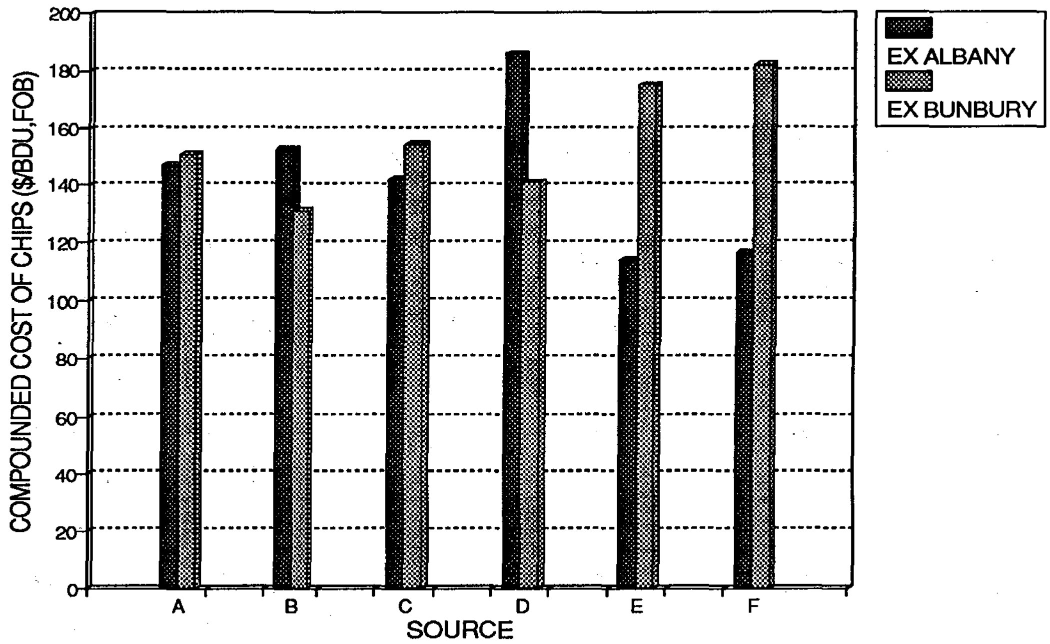
Harvesting, transport and processing (chipping) costs of hardwood fibre are affected markedly by wood quality (moisture content, density and pulp yield) because they affect the per unit cost of the fibre used in paper production.

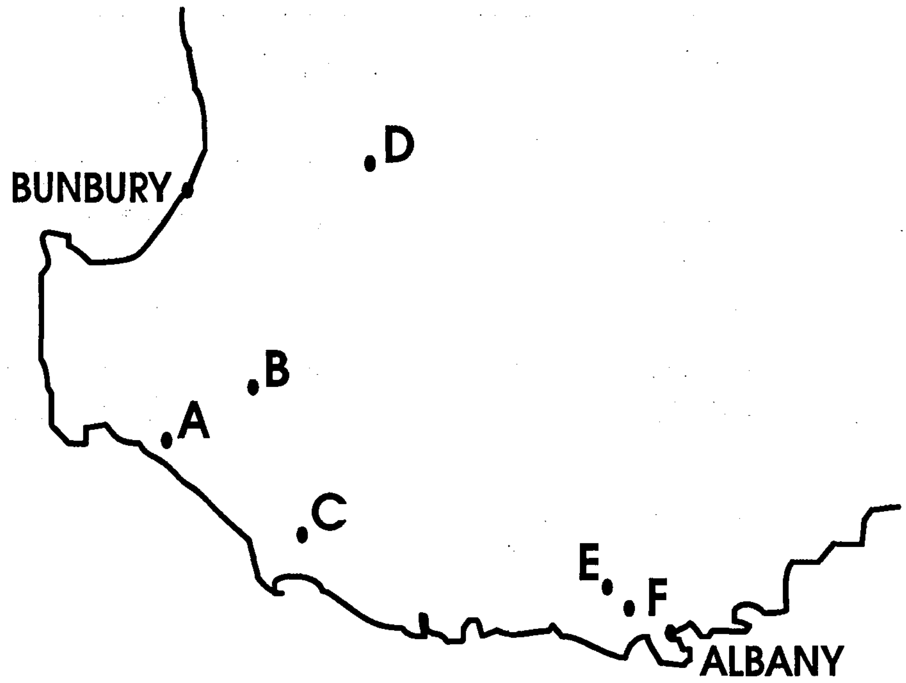
Pulp yield is primarily determined by genetic factors and averages 54% (screened) for Western Australian *E. globulus*. Density is influenced by rainfall and site characteristics, but averages 550 kg/cubic metre.

Transport and harvesting costs are $14 per cubic metre and $1/10km/cubic metre respectively.

The effect of these interesting facts on the cost per bone dry unit FOB at the port of export is illustrated in Figure 9, which shows the cost of production of *E. globulus* fibre from actual farms distributed through the target planting area. This analysis demonstrates in particular that high growth rates do necessarily correlate with low costs per unit of utilisable wood product at the port of export.

Costs per Bone Dry Unit of *E. globulus* fibre FOB at Bunbury or Albany from farms at different locations and site productivity





FARM	MAI	DENSITY	DISTANCE ALBANY	DISTANCE BUNBURY
A	27.5	540	160	176
B	40	510	232	136
C	30	500	140	196
D	20	570	282	84
E	30	550	30	302
F	25	579	20	312

Figure 9

TABLE 5

Estimated cost of production E. globulus fibre
Bunbury region

Site Categories	Distance from Port (km)	Estimated Area (1000's ha)	Volume (m3) at Year 10	$/BDU 1st Rotation	$/BDU 2nd Rotation
1	30	135	250	117.00 *(107.47)	101.00 (92.78)
2	50	150	300	113.94 (104.66)	100.86 (92.65)
3	75	221	320	112.48 (103.32)	100.53 (92.34)
4	90 (low rainfall)	264	200	130.51 (119.88)	113.02 (103.32)
5	90 (high rainfall)	88	360	118.00 (108.39)	106.00 (97.37)

* Bone dry metric tonnes equivalent in parentheses

TABLE 6

Estimated cost of production E. globulus fibre
Albany region

Site Categories	Distance from Port (km)	Estimated Area (1000's ha)	Volume (m3) at Year 10	$/BDU 1st Rotation	$/BDU 2nd Rotation
1	60	31	125	167.74 *(154.08)	138.00 (126.76)
2	40	15	175	136.00 (124.93)	115.00 (105.64)
3	30	53	275	109.00 (100.12)	95.00 (87.26)
4	40	18	250	115.00 (105.64)	101.00 (92.78)
5	35	20	275	110.00 (101.04)	96.00 (88.18)
6	70	7	275	117.00 (107.47)	103.00 (94.61)
7	90	53	200	135.00 (124.00)	117.00 (107.47)
8	60	57	200	132.00 (121.25)	113.00 (103.80)
9	80	16	300	102.00 (93.69)	93.00 (85.43)
10	45	26	275	112.00 (102.89)	98.00 (90.00)
11	35	12	275	110.00 (101.04)	97.00 (89.10)

* Bone dry metric tonnes equivalent in parentheses

The average estimated delivered cost of hardwood fibre (solid logs) produced from site types located at varying distances from the ports of Bunbury and Albany, are shown in Tables 5 and 6. These calculations assume all costs incurred from establishment to harvest are compounded at a rate of 8% per annum. The tables also show the approximate area of land available in site categories in the Bunbury and Albany regions which are the ports from which hardwood fibre would be exported.

The average cost of production per bone dry unit of *E. globulus* fibre will depend on the proportion of each different site category planted over the plantation project. To achieve a land area sufficient to provide a project of sufficient size to justify infrastructure costs (annual production of 750,000 to 1,500,00 tonnes per annum) planting would have to be dispersed over all of the site categories listed in Tables 5 and 6.

Assessments of the land productivity and cost of production (assuming that up to 20% of cleared agricultural land would be available) have shown it would be possible to produce between .75 to 1.5 million tonnes of *E. globulus* fibre per annum to the ports of Bunbury or Albany at a cost of between $100 to $130 per bone dry metric tonne FOB.

Reliable data on the cost of production of high quality wood fibre from other potential supply sources are difficult to obtain. The estimated 1989 CIF Japan cost per bone dry metric tonne and per bone dry unit from three existing suppliers has been documented by Bills (1991) Table 7.

TABLE 7

1989 prices for hardwood woodchips from three sources (After Bills 1991)

A$ = 0.78 US$		USA south mixed HW	Chile Beech	Tasmania native HW
Selling price FOB (1989/90)	A$ BDU	116.67	119.23	158.00
	A$ BDMT	107.17	109.52	145.14
Sea freight	A$ BDU	78.68	81.90	51.54
	A$ BDMT	72.27	75.23	47.34
CIF Japan wood	A$ BDU	195.35	201.13	209.54
	A$ BDMT	179.44	184.75	192.48

These data indicate that high quality wood fibre produced in Western Australia, can be delivered to pulp mills in south-east Asia at a cost comparable to, or less than, fibre produced from other sources of interstate and overseas hardwood fibre. This comparison does not allow for superior wood quality of Western Australian *E. globulus* fibre.

Internal Rates of Return

- *Pinus radiata*

  The real internal rates of return for softwood plantations established on agricultural land under the sharefarming scheme is between 5% to 6%. This assumes that existing costs will not exceed inflation rates and that the existing prices for softwood products will be maintained in real terms.

- *E. globulus*

  The real internal rate of return from *E. globulus* plantations assuming price at the stump of $24 per cubic metre may be as high as 20% on individual properties (excluding the effect of tax deductions and tax liabilities). However, for a scale project of in excess of 50,000 ha the real rate of return is estimated to be between 8% to 16% because to achieve land area required a mix of soil types with varying productivity and distances from the ports would have to be utilised.

  The sensitivity of the internal rate of return to the major cost and revenue factors is shown in Figure 10. Two of the most sensitive parameters - growth rates and wood density - can be accurately predicted and consequently it is unlikely that the actual average of these parameters would vary significantly from the base case figure. The base case price ($24/cubic meter) which has been assumed is the lower end of the range of estimated future prices. The effect of the other major parameters on the internal rate of return is marginal and in any case they are unlikely to vary significantly from the levels assumed in the base case.

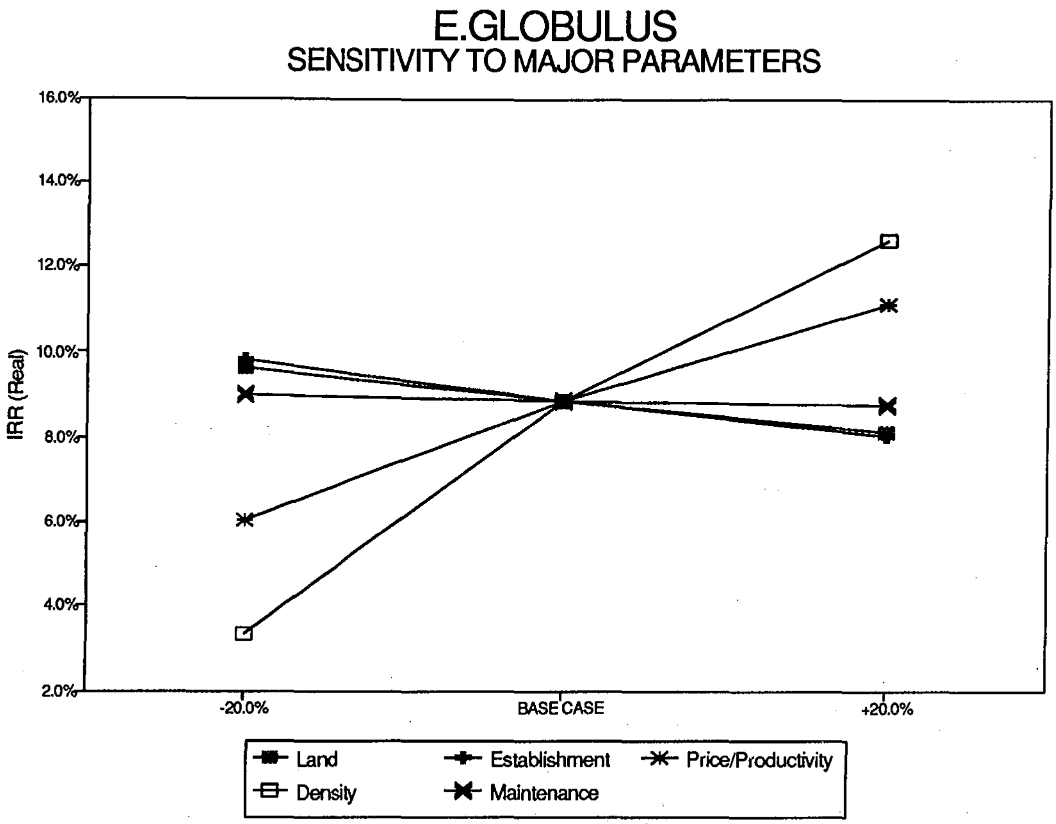


Figure 10

Security

The long term nature of tree crops increases the importance of the risk factor which must be considered by investors and potential end users of the product. Even the most economical and technically sound tree planting project is unlikely to succeed if risks are not minimised.

- **Political stability**

  In a number of regions of the world where wood fibre can be produced rapidly and at low unit costs, political instability at the State and local level threatens the security of a plantation resource. For example, in some countries there has been systematic sabotage of tree growing programs by disaffected community groups.

  In the past there has been resistance to whole farm tree planting in Western Australia from local government authorities and farmer organisations. But these objections to tree planting have been removed by the integration of tree planting into traditional agricultural practice.

The on-farm and regional environmental benefits of tree planting schemes on cleared agricultural land have been recognised by individual landowners and the community and ensures strong political support of State and Local Governments.

- ## Management integrity and competence

There have been a number of tree plantation schemes promoted by private individuals or companies at various times over a period of years that have failed because of incompetence and dishonesty, or in some cases, both. This has had a negative effect on the perception of potential investors even though there have been a number of very successful projects.

While it has been demonstrated that it is possible to grow trees successfully in the south-west of Western Australia, small management errors can result in major reductions in yield performance or failure. Site selection and establishment in particular is critical. Post establishment management is not demanding, but must be consistent.

The development of a code of practices for forest investment companies by the Australian Forest Development Institute has contributed to lessening these problems, but a more rigorous monitoring of both investment schemes and management competence and integrity by the government and private associations is essential.

- ## Fire and disease

Western Australia experiences high fire hazard conditions between 4-6 months every year. An extensive departmental and volunteer bush fire brigade organisation, however, minimise the fire risk to plantations. For example, over a period of 20 years, less than 1% of the plantation resource in Western Australia has been destroyed by fire. The dispersal of plantations of both hardwood and softwood species as a consequence of the integration of tree planting into farms has further reduced the risk of large plantation losses by wildfire.

P. radiata and *E. globulus* have been widely grown in Western Australia for forty years. During this period there has been no significant damage or death of these species caused by insect or fungal pathogens.

- ## Technical advances

Advances in tree growing technology, particularly tree breeding, are occurring at a rapid rate. Tree planting projects which are not capable of capitalising on these advances will not be competitive in the long term. In Western Australia, there are well established tree breeding programs for the two principal commercial species which are linked to a national program. In addition, operational silviculture techniques have been developed from both species over a period of decades and extensive species trials have been established on a wide range of sites and operational agroforestry trials are well advanced.

- **Demand and price of product**

The rate of establishment of *P. radiata* plantations has been linked to relatively conservative estimates of the Western Australian requirement for sawn timber. While the price will be subject to external competition, the cost of production in Western Australia compares reasonably with potential competition and locally produced softwood has a significant advantage because of reduced transport costs.

The future demand for, and price of, wood fibre or pulp will be affected by a number of factors. However, our analyses indicate that unless there are dramatic changes in the world supply/demand situation, existing prices should at least be maintained and probably will increase.

Capital

The financing of the bulk of the Western Australian plantation program in the past has been provided by the State and Federal Governments. While the WA Government is committed to financing the softwood afforestation program in Western Australia, it would prefer that the private sector did so. The Western Australian and Federal Governments continue to fund hardwood plantations, but it is unlikely that the level of capital funding necessary to achieve a large scale hardwood plantation program will be available from the public sector.

The relatively low rate of investment by the private sector in Australia in forests projects can in part be attributed to an investment culture which is biassed to speculative rather than wealth creating investments. But forestry investments, even though they have been shown to yield real rates of return (5%-16%), which compare favourably with alternative investments, are unattractive to many investors because of their unfavourable cashflow profile and lack of liquidity.

Current Australian tax laws are also a disincentive to forestry investment because they do not accommodate sufficiently the uneven income and cost flows. The modification of the prepayment of deduction provisions in 1988, which limited the deduction of expenditure in the first 13 months to the financial year in which the investment is made and restricted the deduction of future expenditure to the year in which the expenditure is made also is a major disincentive to investment in commercial tree planting.

Approximately two-thirds of the expenditure on tree planting is incurred after the first 13 months. Most investment schemes are structured so that total cost of the project is obtained at the commencement of the project and the funds not expended in the first year placed in a low interest bearing trust fund to be called on when required. Thus a significant proportion of the investor's funds are locked into relatively low interest bearing investments without the benefit of a tax deduction.

A variety of proposals have been made to remove these disincentives [CALM (1990)] and the taxation law as it relates to the environment is being reviewed [Hawke (1989)].

The perceived lack of resource security is also another factor contributing to the reluctance of investors, particularly overseas investors, to commit funds to commercial tree planting projects. There is concern that there may be constraints placed on the export of wood fibre produced from private plantations.

CONCLUSIONS

The Western Australian demand for sawlogs can be met from native forest and softwood plantations at costs equal to or less than external sources. Increasing demand for softwood fibre for the production of particle board and medium density fibre board in Western Australia will ensure that there will be a market for softwood thinnings and softwood sawmill residue. This will improve the profitability of softwood plantations and ensure that optimal silvicultural regimes can be implemented.

Western Australia can produce high quality hardwood from Eucalyptus plantations for paper production for the South East Asia market at delivered costs significantly less than current or projected delivered costs from overseas or interstate sources.

There is a potential cleared agricultural land base in Western Australia of approximately 500,000 ha and 100,000 ha for hardwood and softwood plantations in south-western Australia.

A proportion of future tree planting could be achieved by whole farm purchase but the majority of the land base required will only be achieved by integrating tree planting into farms. This will involve joint ventures between farmers and tree planting proponents with financial, planting strategies and management practices designed for each farm.

Integration of tree planting into farms will optimise the commercial, on farm and regional environmental benefits of tree planting.

Western Australia has the potential to capitalise on the increasing Western Australian and world demand for wood fibre products. An expansion of the commercial hardwood and softwood plantations estate by more than 100,000 hectares within ten years is achievable. In addition to the economic benefits, a tree planting program of this scale would provide a new source of income to farmers, thereby contributing to the stabilisation of rural communities and result in a significant amelioration of land and water degradation in the south-west of the State. The only constraints on this potential being realised are the perceived and real disincentives to investment by the private sector in tree planting.

REFERENCES

CALM (1987a) Forest Region Management Plans, Department of Conservation and Land Management, Western Australia.

CALM (1987b) Timber Production in Western Australia. A strategy to take Western Australia's forests into the 21st century. A component of the Regional Management Plans, (CALM 1987a).

Figueiredo, R.A. (1987). Eucalyptus Pulp : Developments Worldwide and Supply Potential. Proceedings Expo Paper Asia, Tokyo, June 1987.

Groome, J.G. (1987). Woodchip Supplies to Asia : Overcoming the Deficit. Proceedings Expo Paper Asia, Tokyo, June 1987.

Groome, J.G. (1989). Demand and Supply of Raw Materials in East Asia. AUSNEWZ, Investment and Trade Opportunities in Pulp and Paper in the Pacific Rim.

Schofield et al (1989). Vegetation Strategies to Reduce Stream Salination of Water Resource Catchments in South-West Western Australia. Water Authority of Western Australia, Report No. W.S.33.

CALM (1990). Review of Taxation Arrangements Relating to Prevention and Treatment of Land Degradation. A submission to the Department of Primary Industries and Energy.

Hawke, R.J.L. (1989). Our country our future. Statement on the environment by the Hon R.J.L. Hawke A.C. Prime Minister of Australia.

Shea and Bartle (1988). Restoring Nature's Balance. The potential for major reforestation of South Western Australia. Landscope Vol. 3 No. 3.

Bird, R. (1988). Financial Gains of Trees on Farms through Shelter. Proceedings of Bicentennial Forestry Conference Albury/Wodonga.

Malcolm, C.V. (1983). Wheatbelt Salinity : A Review of the Salt Land Problem in South Western Australia. Department of Agriculture Technical Bulletin No 52.

Grundy, D.S. (1985). Developing the Economic Arguments for Investments in Forests : A Survey. Proceedings of the Twelfth Forestry Conference, Ministry of Forests, B.C. Canada.

Business and Economic Research Limited (1988). "Valuation prices for wood in New Zealand Exotic Forests" (Quoted in Levack, H. Development of Valuation Procedures for Commercial planting in New Zealand" Commonwealth Forestry Review Vol. 63(3) September 1989.

Bills, D.J. (1991). Medium term market prospects for woodchip exports. Proceedings of Woodchips and Integrated Harvesting Symposium National Agricultural and Resources Outlook Conference 1991.

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