

**EXPLORING THE INDUSTRY VALUE CHAIN FOR MEDIUM
RAINFALL EUCALYPTUS SAWLOG AGROFORESTRY IN
WESTERN AUSTRALIA**

by

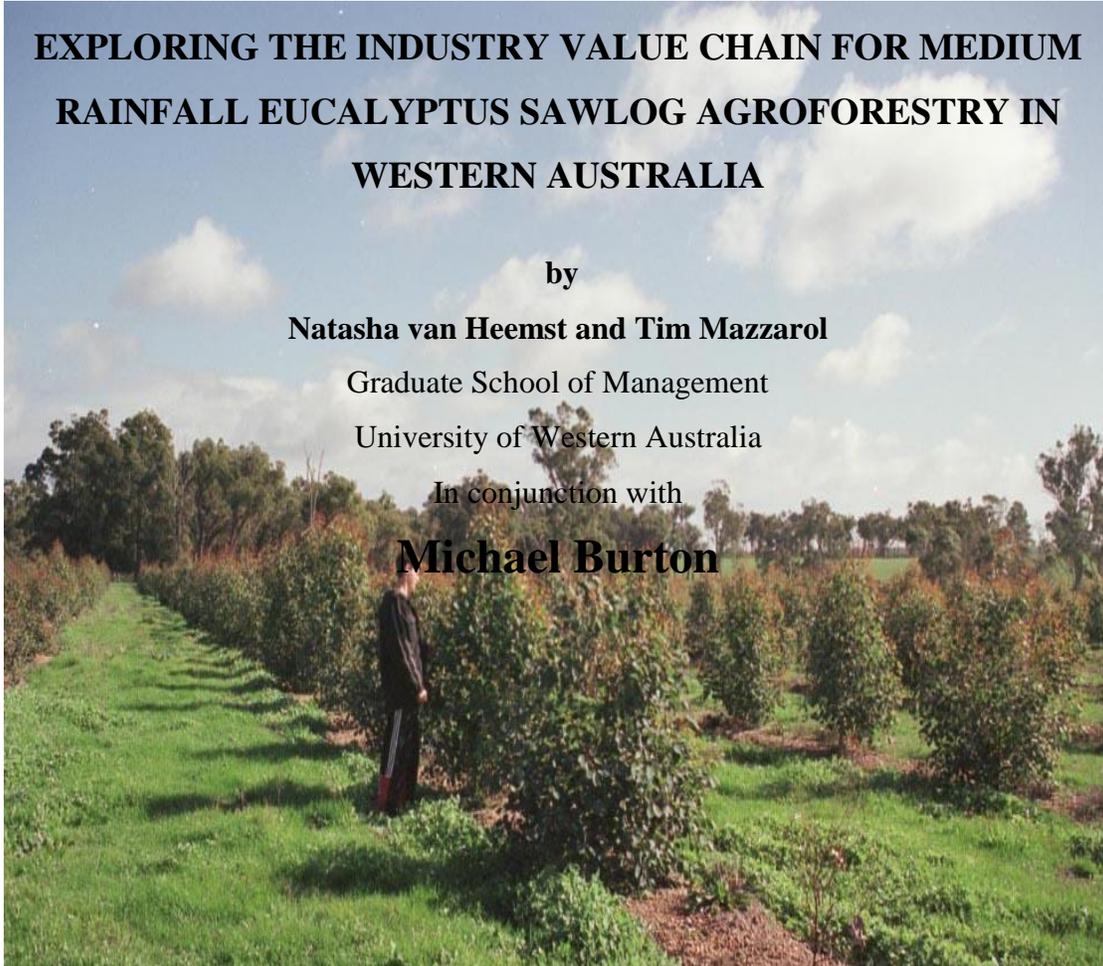
Natasha van Heemst and Tim Mazzarol

Graduate School of Management

University of Western Australia

In conjunction with

Michael Burton



GSM



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EXECUTIVE SUMMARY

INTRODUCTION

Agro forestry can be defined as the integration of trees within the farming system, often for direct benefits such as high quality logs, and/or indirect benefits including land protection (control of salinity and erosion), shade and shelter for stock, and enhancement of catchment health and landscape values (DAWA 2002; Stewart 2000). Farm forestry in this review, includes any trees on farmland which are managed to produce saleable products such as timber or oil.

The Forest Products Commission (FPC), Department of Conservation (DOC) and the Waters and Rivers Commission (W&RC) have jointly developed a vision for the establishment of a significant hardwood forestry resource in the medium rainfall zone (550 to 700mm rainfall per annum) of Western Australia. There is an intention that this establishment is to be one of integration rather than fence-to-fence or 'block' plantation in order to avoid the social disruption that has been witnessed further south in the higher rainfall zones associated with the bluegum forestry projects. Further, this will enable landholders to continue to manage sustainable farming operations in conjunction with the trees. The goal of this initiative is to help develop industries based on agro forestry that can provide multiple benefits for landowners, land care, water resources and regional economic development.

The primary strategy underlying this agro forestry initiative is to attract private sector investment and gradually expand the area of plantations throughout the Wheat belt. By 2030 it is anticipated that WA will be able to produce an annual output of 1.5 million m³ high-grade sawlogs. Stage 1 of the project aims to establish a resource capable of yielding an annual volume of 150,000m³ of sawlog, and concentrates on three catchments – Kent, Warren and Collie (Wellington). These catchments have been identified as Water Resources Recovery Catchments, with trees providing a mechanism for improving water quality.

The University of Western Australia's Graduate School of Management (GSM), with support from the UWA Department of Natural Resource and Agricultural Science (School of Natural Resource Economics), was tasked to examine and map the industry value chain associated with the development of this new Eucalyptus hardwood Agro forestry industry. The study builds upon the existing body of research undertaken earlier this year by the BIS Shrapnel Forestry Group for the W&RC.

The eucalypt sawlog scheme commenced in 2002 after a successful pilot program during 2001. Incentive funding of approximately \$550,000 was provided by W&RC to establish the pilot program. Despite the success of this initiative the size of the budget limited the total planting area. An initial target of 550 hectares was set (\$800 industry incentive, \$100 fencing allowance and \$100 scale incentive). However, due to a slow rate of adoption from farmers, the industry incentive was increased to \$1,000/ha and this had the effect of reducing the overall target.

Farmers in the Collie, Warren and Kent River catchments were targeted within the pilot scheme. A total of 481 hectares of trees were planted in the scheme this year, which used all available W&RC funds. All plantings were established at 1,000 stems per hectare, so a total of 481,000 trees were planted. Species planted included *E. saligna* (252 ha), *E. cladocalyx* (164 ha), *E. maculata* (51 ha), *E. botryoides* (7 ha) and *E. camaldulensis* (7 ha). Species selection was discussed with the landholder, however rainfall and other local conditions determine predominately which species is preferred in a particular location.

Seventeen landowners participated, 8 in the Kent catchment (330ha) and 9 in the Warren Tone (151ha). No participants undertook the scheme in the Collie Catchment. It is understood that this low participation by Collie farmers was due to some negative perceptions held within this community toward agro forestry.

For a successful commercial agro forestry industry to be developed, three key stakeholders must be engaged. The first of these is the grower, typically a farmer who makes available their land for plantations. The second is the investor, which in the case of the existing blue gum industry has been a dedicated agro forestry company raising financial capital through prospectus, and managing the plantations on land either purchased or leased from the grower. Finally, there is the end user. This is the timber processor, typically a manufacturer of timber-based products such as wood chips, paper pulp, particleboard, sawlogs or veneer. Each of these stakeholders is an important component or link in the industry value chain.

The following report investigates each of these stakeholder groups and explores the importance of each in the uptake and success of the program. The first section of the report provides an insight into the current market factors that will impact the demand for eucalypt sawlogs. The second section investigates the private investor, and the factors that will facilitate their involvement in this project. A comprehensive financial analysis has been provided that explores the factors likely to be important to each stakeholder's participation. Interviews with representatives from private sector tree farming companies have provided information on the perspectives of the investor. Additional interviews with farmers in the Kent and Warren/Tone River catchments provide data on the factors likely to inhibit their participation in this initiative. Finally, additional financial analysis has been investigated, to examine the attractiveness of the current eucalypt sawlog scheme in relation to existing land use activities.

MARKET OVERVIEW

Forestry plantations account for less than 5 percent of the total global forest area (3.4 billion hectares), but contribute around 30 percent of the total industrial wood supply (Fegely 2000). This contribution is expected to grow to 44 percent (0.7%/year) by 2020 (Fegely 2000). Global demand for wood products is anticipated to increase by around 1 percent per annum over the next decade, with the greatest market growth expected to be in Asia, specifically China (Fegely 2000, BIS 2001).

Eucalyptus plantations are estimated to be 14 million hectares, but are also expanding rapidly (Neilson 2000). Figure 1 shows a breakdown of the eucalyptus plantations worldwide. Australia currently has an estimated 300,000 hectares (0.2%) of global eucalyptus plantations. Brazil has the world's largest area of commercial eucalyptus plantations, with an estimated 2,995,000 hectares. Even though Australia is a small player in the timber market compared with the northern hemisphere, Australia is well positioned to take advantage of the expected increase in demand from neighbouring Asia (especially China).

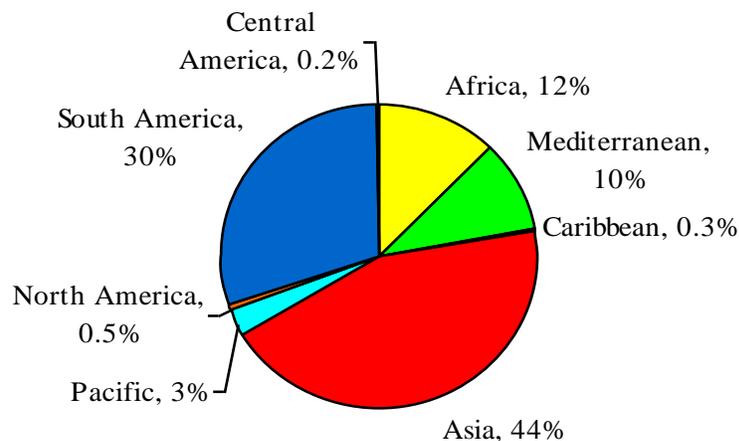


Figure 1: Area of eucalyptus plantations worldwide, expressed as a percentage.

Source: Adapted from Flyn and Shield, 1999, in Neilson 2000.

Australia is more or less sufficient in volume terms of timber, but is running an overall negative trade balance. During 1998-99 Australia produced a trade net export bill of \$1.4 billion and a trade net import bill of \$3.3 billion, which produced an overall negative trade balance of \$1.9 billion. The negative trade balance is a result of exports being generally low value woodchips, and imports being value added products (roughly 70% pulp paper products with sawn timber and wooden furniture making up around a further 20%) (Fegely 2000). This highlights the need for Australia to add value to our timber products.

Sawn wood

Global sawn timber production is around 420 million m³, with hardwood constituting approximately 25 percent of this total (BIS Shrapnel 2002b). Total trade in hardwood timber is 22 million m³ with South-East Asia, Africa, Brazil, US and Canada supplying the majority of this export market (BIS Shrapnel 2002b).

Consumption of sawn wood in Australia has not risen significantly since 1985, but has fluctuated between four and five million m³ a year, being strongly correlated with housing starts (ANU 1999b, ANU 2002b). The major use for sawn timber in Australia is for new residential buildings and renovations to existing buildings (70%). Another 10 percent of the sawn timber market is consumed by the non-residential building sector; furniture manufacturers consume an additional 10 percent (Zorzetto and Chudleigh 1999).

The volume of hardwood consumption has decreased significantly since 1984-85, while softwood consumption has increased 17 percent over this period (figure 2a and 2b). Currently 70 percent of sawn wood consumed is softwood, with the remaining 30 percent being hardwood.

The trend for substitution of softwood-sawn timber for hardwood-sawn timber might be a result of softwood timber usually being less expensive, and performing as well as hardwood does in many uses (ANU 2002). Substitution might also be encouraged from changes in the building industry, which allow the wider use of softwood-sawn timber for construction. There is likely to be an increasing threat in the future, as processing and treatment technology for softwood sawn timber is further developed to manipulate hardwood characteristics, such as strength and durability (Zorzetto and Chudleigh 1999).

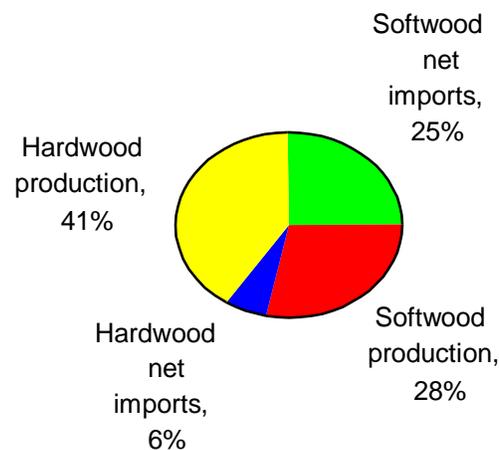


Figure 2a: 1984-85 hardwood and softwood consumption.

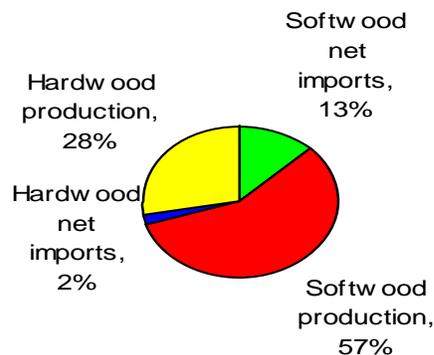


Figure 2b: 2000-01 hardwood and softwood consumption.

Source: ANU 2002

Furniture consists of two major sectors: high value, high quality hardwood furniture, and less expensive, poorer quality softwood furniture. It also segments into outdoor and indoor furniture. Of these, the highest value adding is in the indoor furniture. In general, substitution of hardwood for softwood, and vice versa, is thought to be less of an issue in these sectors; rather it is growth in one sector, at the expense of another sector (Zorzetto and Chudleigh 1999). The majority of hardwood-sawn timber consumed in WA is jarrah, which is used in the production of outdoor furniture (BIS Shrapnel 2002a). There will be a substantial reduction in availability of jarrah and karri sawlogs over the next two years. The current annual harvest of jarrah sawlogs is approximately 325,000m³, but this will be reduced to 140,000m³ per year beyond 2003 (BIS Shrapnel 2002a). Karri harvests will be similarly reduced from the present volume of 140,000m³ to 40,000m³ (BIS Shrapnel 2002a). Already, furniture makers in Victoria are sourcing sugar gum to substitute the old growth timber. The popularity of this timber is encouraging; with local supply outstripping demand (Hamilton pers. com). Therefore there is likely to be a market opportunity for high-grade eucalypt sawlogs for local furniture making in WA in the near future.

Recent trends in flooring and floor coverings have led to the reappearance in the popularity of native hardwoods. Over the past five to six years, a number of producers/manufacturers have promoted floors containing many of the natural “features” (BIS Shrapnel 2002a). The major area of growth in the timber flooring market is in home improvements.

Australia is becoming increasingly self sufficient in sawn timber. Currently Australia is a net importer of sawn timber (0.74 million m³), however more encouraging is that net imports of sawn timber have declined from 31 percent to 15 percent during the period 1984-85 to 2000-01 (figure 2), and ABARE predicts that before the end of this decade Australia will be self sufficient and will become a net exporter of sawn wood (Zorzetto and Chudleigh 1999). Given this trend towards self-sufficiency in timber, the majority of the expansion in plantation and farm forestry in WA will need to be focussed on export markets. Unfortunately eucalypt hardwood sawn wood is not as readily acceptable in the Asian markets

(Fegely 2000). The traditional products such as Oregon and Western Red Cedar are very well known and accepted products, and thus more promotion and marketing will be required in respect to any new eucalypt timber products.

Trends in sawn wood prices reflect the price for structural timber, due to it comprising 70 percent of total sawn wood used in Australia. Figure 3 shows prices for softwood and hardwood have generally increased in real terms since 1993. Softwood timber is usually less expensive than hardwood timber; however its price rose relatively faster than hardwood between 1992-93 and 1994-95, before falling back to hardwood. For the second time since 1989-90, the price index for hardwood timber is higher than softwood. In the latest report by ANU (2002), they state that this will have a “strong effect of further reducing the consumption of hardwood”.

Sugar gum sawlogs in Victoria are currently selling for between \$30 and \$60 per tonne on the stump (Hopkins 2002). If we assumed that timber prices will increase 1.3% per year in real terms as has occurred during the period 1989-90 and 2000-01, then this would give you a selling price of between \$39 and \$78 in 20 years time, and thus gives an indication of the expected price for eucalypt sawlogs in the future. This does not take into account any increased demand that is likely to occur into the future.

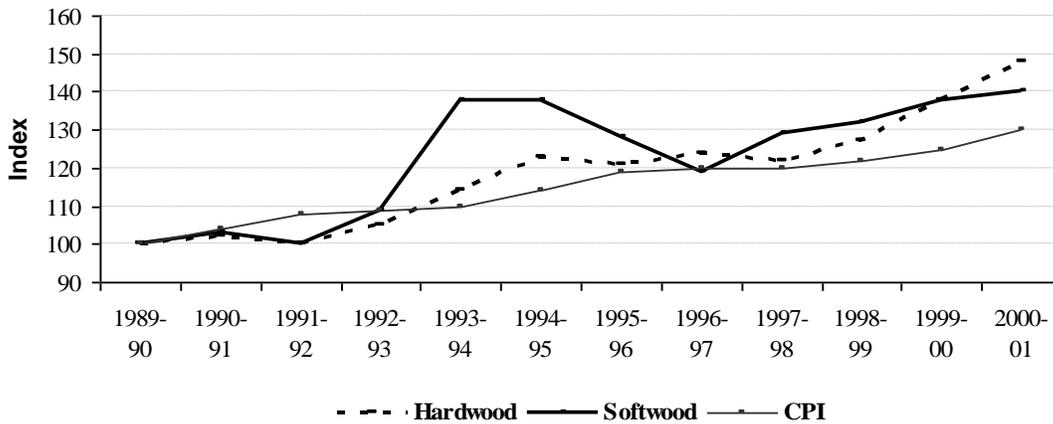


Figure 3: Prices of Australian structural timber.

Source: ANU 2002

Wood Panel Products

Wood based panel products refer to those products that have been “layered, glued or reconstituted” (RIRDC 1996). Products include veneers and plywood, particleboard, and Medium Density Fibreboard (MDF). Veneer is a thin section of timber that is often used to cover lower quality wood, plywood is based on thin sections of timber layered together, and particleboard and MDF are reconstituted boards (RIRDC 1996).

Worldwide production of wood based panels is around 140 million m³. Plywood is the major product, and with particleboard they constitute two-thirds of the global market (Fegely 2000). Plywood uses both hardwood and softwood, where as particleboard uses only softwood residues and MDF manufacturing is produced predominantly from softwood, but is manufactured in smaller amounts using hardwood mill residues (Zorzetto and Chudleigh 1999; RIRDC 1996).

Currently Australia consumes approximately 1.4 million m³ of plywood, particleboard and MDF each year, with approximately 50 percent being particleboard, 34 percent MDF and 16 percent plywood (Zorzetto and Chudleigh 1999). Australian consumption of these three products is increasing. The average annual rise in consumption during the period 1985 to 2001 of plywood was 3.1 percent, particleboard 1.6 percent and MDF 2.8 percent (ANU 2002b). As a proportion of sawn wood consumption, total consumption of the three panels was 28 per cent in 1992-93, rising to 35 per cent in 2000-01 (ANU 2002b).

One reason that is likely to have produced such a rise in demand for wood based products is the lower price demanded. One of the most advantageous qualities of MDF is that it can have the visual characteristics of dressed timber, but is less costly to produce than sawn timber if produced from timber waste (Zorzetto and Chudleigh 1999). The ABS statistics show that during the 1990s the price of plywood, particleboard and MDF has not risen as much as the price of structural timber therefore improving its price advantage over the years (ANU 2002b). This highlights the increasing demand and competition from wood based panels, and highlights the increasing need for sawn wood to become cost competitive with such products, by providing value for money.

Australia is currently a net importer of veneer and plywood and a net exporter of MDF (Zorzetto and Chudleigh 1999). The trend for all three types of products is increasing, although the percent share each product has of the total market is increasing only for MDF (Zorzetto and Chudleigh 1999).

Traditionally plywood and veneer have been sourced from mature, larger diameter trees. However new techniques, which utilise smaller diameter logs, have been recently developed, although not commercially proven. If these new techniques can be proven at a commercial level, this will have significant implications for low rainfall agro forestry (Zorzetto and Chudleigh 1999).

Other sawn wood substitutes

Consumption of other materials that substitute for sawn wood such as aluminium, steel and concrete is also increasing at the expense of sawn wood (ANU 2002b). Similar to wood based panels, the prices of these substitutes have also been falling relative to the price of timber, therefore becoming more competitive with sawn timber (ANU 2002b).

Fence posts and poles

The main difference between posts and poles is the age and size of the tree. Posts are used as inputs for vineyards and farm fencing, for landscaping and industrial use. Posts for use in vineyards are being sourced from softwood timbers, with hardwood species not being able to compete on price (Zorzetto and Chudleigh 1999). Posts for farm use, such as fencing usually use hardwood timber from existing native vegetation stands (Zorzetto and Chudleigh 1999).

Poles have an application in the electricity industry, although this may be declining due to competition from underground cabling. All new subdivisions in Perth for example utilise underground cabling for electricity distribution (Zorzetto and Chudleigh 1999). Future market opportunity for wood used in the production of electricity poles in Australia is therefore very limited.

Firewood

Production of firewood grown in the lower rainfall areas of Australia as a sole dedicated product is not likely to be economically viable. The greatest potential for firewood production from this zone could be as a by-product from other agro forestry systems, such as thinning from sawn timber production or residues from milling operations (Zorzetto and Chudleigh 1999). Sugar gum firewood is extremely popular in Victoria, and the local demand outstrips the supply (Hamilton pers. comm.).

Conclusion

To summarise, it seems that there is potentially a large market that may arise domestically from the locking up of old growth forests and internationally from China. The development of a new agro-forestry industry based on hardwood eucalypts has the potential to supply the local demand and a small proportion of the international demand. However if Western Australia is unable to plant a sufficiently large area of trees, it is doubtful whether a market as large as that of China would be interested in sourcing from us.

There is also an increasing amount of substitution occurring against hardwood sawn wood. In addition to competing with softwood for market share, hardwood timber is also threatened by substitutes such as wood-based panel products, aluminium, steel and concrete. With increasing technology, there is the potential for such substitutes to continue to increase over the next 25 to 30 years.

Under such circumstances it is difficult to make accurate predictions as to the future of the market for hardwood sawlog product produced out of WA over the next 50 years. While the demand for timber products, particularly veneers and sawlogs, appears to be substantial, the threats of new entrants and substitutes over this time periods makes the total size of this market unknown.

THE PRIVATE INVESTOR PERSPECTIVE

Private investment may come from two sources. The first is via investment companies, which are interested in the profit to be made through the timber, and the second is via companies, which are looking at ways to offset their carbon emissions. Private investment therefore requires the investing company to either buy the land from the farmer, or more commonly set up one of many joint ventures (these are discussed later the report).

Economic evaluation of forestry investments

The capital asset pricing model (CAPM) estimates the rate of return that is required for private timber companies to invest in timber plantations. According to the CAPM, the nominal required rate of return for a private timber investment company can be estimated to be to:

$$E(R_E) = R_F + [E(R_M) - R_F] * \beta$$

Where

$E(R_E)$ expected rate of return from the eucalypt project

R_F risk free rate of return

$E(R_M)$ market rate of return

β systematic risk parameter

The market risk premium [$E(R_M) - R_F$] is the amount than an investor expects to earn from an investment in the market above the return that can be earned on a risk free investment such as the current yield on government securities of the same maturity as the investment. According to NECG (2001), the historical Australian market risk premium is 7 percent.

The risk free rate of return is the return that an investor can make by investing in a riskless asset, often proxy by the rate of return on Treasury securities. The beta is a measure of volatility, or relative systematic risk, for stock or portfolio returns (Jones, 1998). The average beta coefficient (β), based on current listed timber companies, is 1.98 (table 1).

Table 1: Listed timber companies and there associate beta coefficient.

Company Name	Beta	Company Name	Beta
Gunns limited	1.02	Great southern plantations	3.51
Auspine limited	0.85	Evergreen forests	-0.1
Timbercorp	3.98	Forest enterprises	2.63

Source: AGSM 2002.

Assuming a risk free rate between 3.65 and 4.68 (risk free rate of a Commonwealth Treasury Bond with a maturity of 10 and 30 years, taken from the Financial Review on 08 October 2002), private timber investment companies can be expected to desire a nominal rate of return between 17.51 and 18.54 percent.

It is sometimes argued that a lower rate of return (such as 3% or 4%) is more appropriate for governments assessing forestry activities to allow for the important non-wood benefits produced by growing trees (Dayanandra et al. 2002). NSW State Forests aim for a rate of return of around 4 to 6 percent for hardwood plantations on the north coast, with any carbon credit trading forecasted of having the potential to increase this by 1 to 2 percent. Similarly the Queensland State forest agency is required to make a commercial return on plantations of 7 percent (Dayanandra et al. 2002).

A financial analysis of investors investing in eucalypt plantations for sawlogs in WA by BIS Shrapnel showed a real internal rate of return of 3.9 percent (BIS 2001). This was assuming land was leased at \$80/hectare/year. According to this analysis, and the above assumptions of required rates of returns by state governments, the eucalypt sawlog program would be profitable, but unlikely to be profitable in the eyes of private investment companies.

Carbon credits

Australia became a party to the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio Earth Summit in 1992 and signed the Kyoto Protocol in December 1997. The UNFCCC aims to stabilise emissions of greenhouse gases at a level that would prevent dangerous human-induced interference with climate. The Kyoto Protocol is an international treaty that builds on the UNFCCC, aiming to decrease greenhouse gas emissions from developed countries by an average of 5 per cent below 1990 levels (AGO 2002). The Protocol will come into force when it is ratified by at least 55 signatory countries that account for at least 55 per cent of total 1990 carbon dioxide emissions of developed countries. Presently Australia along with the United States of America has not ratified this agreement. It is expected that enough developed countries will move to ratify the Protocol to bring it into force probably during 2003 (AGO 2002).

The potential to obtain carbon credits from growing trees is presently up in the air, and the first step is for Australia to ratify the Kyoto Protocol. Even then the forestry sector must be accepted, and a reasonable system will need to be developed for trading carbon credits from tree plantations. Trees have a big potential to be used as carbon credits. Trees take up (or sequester) carbon dioxide from the atmosphere as they grow. The carbon is stored in the leaves, branches, stem, bark and roots. Following harvest, the parts of the tree that are not used, such as branches, twigs and leaves will emit carbon dioxide back to the atmosphere as they decay or are burnt. Harvested wood used for as example construction timber, can store carbon for many years, keeping it out of the atmosphere.

Despite a present emissions trading system, most governments involved with farm forestry are not dismissing the value of carbon credits in the future, and are holding the rights to the carbon credits that may arise in the future e.g. State Forests of New South Wales, West RFA scheme (Victoria) and CALM. Several companies including BP, Royal Dutch/Shell Group and Alcoa, have already internally set up goals to reduce greenhouse gas emissions, exceeding goals put forth in Kyoto. These speculative investments are in anticipation of carbon trading in the future, which will provide companies with an offset against future greenhouse liabilities.

"This isn't an act of altruism," says Aidan Murphy of Shell. "It's a fundamental strategic issue for our business" (Roston 2001).

Many companies see reducing greenhouse gas emissions as being critical to their staying competitive in the future. If the Kyoto protocol is ratified, then nations will either sell emission credits if they emit below their allowance or buy credits if they exceed permitted levels. Thus companies are either going to have to become more efficient in using fossil fuels, or find alternative green solutions such as wind power, wave power and solar power to produce goods and services as renewable energy sources.

During 2002, BP hit its target of reducing greenhouse gas emission 10 percent below 1990 levels, seven years ahead of schedule (Roston 2002). This was achieved partly through the establishment of *Pinus pinaster* plantations in WA for carbon credits, which FPC is involved with. BP has chosen *Pinus pinaster*, due to the extensive research on its carbon storage in comparison to other tree species.

The amount of carbon stored by trees and the value of carbon is extremely uncertain. According to Waterworth (2001) a plantation is likely to store between 1-10 tonnes of carbon per hectare per year over a 30-year period. However according to the AGO (2001), actively growing forests in Australia can sequester between about 3.5 and 35 tonnes of carbon dioxide per hectare each year on average over about the first 30 years of their life (AGO 2001).

The expected price that might be paid for stored carbon varies greatly, and has been stated as high as \$40/tonne (Ryan 2001). Recent predictions of permit prices in Australia in 2010 indicate a range from \$10 to \$50 a tonne of carbon dioxide. Prices for recent trades appear to be below the bottom end of this range (AGO 2001). Ryan (2001) suggests a much more conservative and realistic value would be to use \$5/tonne.

For a plantation that has a mean annual increment of 9m³/year (equivalent to 9 tonnes/year) and assuming a price of \$5/tonne, potential gross carbon annual income from such a plantation is \$18/ ha/year for stem volume only (assuming 40% carbon content), or \$36/ ha/year for stem and below ground growth. While this alone would not make a private plantation establishment profitable, it could add significant value.

FINANCIAL ANALYSIS OF INVESTMENT IN THE EUCALYPT SAWLOG INDUSTRY

Preliminary Comments

BIS Shrapnel's financial analysis for investors and farmers investing in growing eucalypts contains several shortcomings. Consequently further analysis is required. The shortcomings include:

- (i) The table presented for alternative scenarios for farmer compensation of loss of land use (pp. 79 of their report) has a number of problems associated with it. Their comparison of an equivalent annuity with that of an outright purchase of land is not a fair comparison. When an annuity is payed, land cannot be sold at the end of the timber harvest, however BIS Shrapnel have assumed that it can. Consequently in their analysis the IRR for the investor when purchasing the land is equal to when they lease the land, when in fact it should be higher. This incorrect calculation results in BIS Shrapnel's statement that the scenarios presented are equivalent to the investor to be incorrect. This statement would be more correctly stated as being equivalent to the farmer.
- (ii) A cost which is not accounted for which is likely to be incurred by the investor group to receive the same price for the land purchased are those which are associated with returning the land to a state for cropping (de-stumping and levelling).
- (iii) To calculate the equivalent annuity to that of purchasing the land outright, BIS Shrapnel have found the annual annuity that gives a present value of the land purchase. In their calculations they have discounted the annual lease payments for 22 years to year 0. This calculation has been done incorrectly. The correct calculation should have discounted 20 annual lease payments, with the annual lease payment in year 0 not being discounted, and the annual lease payment in year -1 discounted to year 0 (The IRR for purchasing land assumes land purchase occurs in year -1).
- (iv) Many of the costs outlined in BIS Shrapnel's report have since been revised. These differences are outlined in Appendix A of this report.
- (v) So far only best estimates or expected values of real internal rates of return have been assessed. Sensitivity analysis and simulation analysis provides a much more complete assessment of the effect of changes in the estimated variables on the internal rate of return and net present value. This places management in a better position to decide whether the project is too risky to accept, and which variables have a large impact on the viability of the project.

Introduction

The Australian government and industry have a vision that:

“by 2020, plantation forestry in Australia will be a sustainable and profitable long-rotation crop with significant private sector investment”.

An examination of the BIS Shrapnel report highlights at least two broad strategic directions facing the W&RC. The first is to develop the industry for largely commercial purposes and encourage private producers to undertake plantation tree farming with a view to commercially harvest the crop after a period of up to 25 years. The second is to view the industry as existing largely for environmental purposes, driven by a desire to see plantings that can assist in the management of water quality and salinity, and with the long-term potential to receive carbon credits, thus largely government driven. This section investigates which direction the new eucalypt project is likely to be more suited to.

Methods for allowing for risk in evaluation of forestry investments

Variables used in the cash flow spreadsheet were sourced from FPC and CALM. Due to the nature of this project, these estimates are subject to a high degree of uncertainty. This uncertainty stems from the long time horizon of the project, and thus the difficulty in predicting prices so far in the future, limited knowledge of information on growth rates, as well as inexperience and lack of knowledge about growing trees. In addition there are several areas of work where there has been no contractual precedence. These areas include culling, coppice control and the heaping of debris (Guille pers. comm.). For each variable in the cash flows an expected, pessimistic (worst case) and an optimistic (best case) variable was estimated. Table 2 presents a summary of the variables and a brief explanation for their prices and variability.

Table 2: Explanation of the key variables used in the analysis.

Key Variable	Explanation
Management	Covers the cost of a coordinating and supervisory presence throughout establishment and maintenance periods. This cost is largely dependant on the scale of both individual planting areas and the overall planting program. Bigger planting areas and larger programs bring down the unit cost due to economies of scale.
Weed control, fertiliser, insect management and parrot control	This varies widely from season to season and property to property. The "best guess" estimates supplied in these operations are estimates of what the average would be over a number of planting years. The worst case is where all plantings require a high level of control measures. The best case is where all plantings require minimal management.
Infill planting (seedling replant)	Plantation establishment success and growth rates are less predictable due to limited experience with these species in WA. The general rule for this cost has been 10 – 15 percent of establishment seedling and planting costs, and has been applied in this analysis.
Culling	This includes a level of debris management. Costs include concentrating the debris from two tree rows into one inter-row.
Stumpage	This is the net amount received by the grower after the subtraction of harvesting, processing and transport costs.
Mean Annual Increment (MAI)	This is the aggregate volume of harvestable timber produced in a year from the growth of trees in a eucalypt plantation. The growth is linear, and therefore a 20 year eucalypt plantation with a MAI of 9m ³ would yield 180m ³ (based on the best guess estimates). It is also assumed that additional growth beyond 20 years continues in a linear fashion.
Carbon credits	Figures were calculated based on the estimates of MAI given above. Carbon prices were based on recent trades and predictions given by (AGO 2001). The gross carbon annual income was calculated on stem and below ground growth, assuming 40 percent carbon content.

Due to the high degree of uncertainty surrounding these estimates, the calculated expected net present value (NPV) and real internal rate of return (IRR) are too only estimates. To see which key variables are likely to determine whether the project is a success or failure, sensitivity analysis and break-even analysis were undertaken. Investment risk has been assessed using simulation analysis.

Sensitivity Analysis

Sensitivity analysis has been employed to measure the sensitivity of profits to all key variables. Since most variables had high degrees of uncertainty attached to them, this included all of the variables within the cash flows, except planning, cost of seedlings and lease annuity. There were no relationships between the variables, and therefore no correlations were required. The NPV was calculated using the expected estimates for every variable except one, the value for which was either its optimistic or pessimistic estimate. This procedure was repeated until an optimistic and pessimistic estimate for each variable was performed, in combination with the expected values of the other variables. In addition the impact of costs (\$700/ha) associated with returning the land to a state for cropping (de-stumping and levelling) were also investigated. These costs however were not assumed in the base case where farmers are receiving an annuity.

Break-even analysis

Break-even analysis is the profit at which the present values of the project's cash inflows and outflows are equal, so that the NPV is zero. A break-even analysis was performed to see at what stumpage price and lease annuity the project would breakeven using different real discount rates (real IRR).

Simulation

Simulation allows a manager to consider the effects of changing all the variables whose values are uncertain. All relevant variables were specified according to a triangular probability distribution, based on the expected, pessimistic and optimistic variables collected. A computer simulation was then performed to provide a probability distribution curve of NPV's. The computer, randomly selecting values based on the distribution curves for each of the specified variables, generated Numbers in the simulation. New sets of values were chosen 500 times, which produced a cumulative distribution curve (CDC). From the CDC it is possible to access the probability of a project to produce a positive NPV.

Assumptions made in the investment analysis

Lease Annuity

A lease annuity of \$120/ha has been assumed for the basic financial analysis. This was based on the existing eucalypt sawlog scheme, which is currently paying farmer's an upfront payment of \$1,100/ha (includes \$100/ha scale incentive) and 15 percent of the clear fell value, which based on the most likely values for price and yield equals \$1,620/ha in year twenty. The equivalent annuity is approximately \$120/ha, discounted at a real rate of 7 percent (estimated cost of farm borrowing from the bank).

Tax

For ease, the tax component of the analysis has been simplified to 30 percent (company tax rate). It is assumed that all cash outflows are fully allowable as deductions in the year that they are paid. In most years there is no revenue from the plantation against which to offset these tax losses. It is however assumed that the investment companies will be able to claim these losses against income generated from other operations.

Discount Rate

The choice of discount rate will depend on the rate of return that is required. The capital asset pricing model (CAPM) was used to provide a risk-adjusted rate of return. According to the CAPM, the nominal required rate of return for a private investor investing in the eucalypt sawlog investment is estimated to be to:

$$\begin{aligned} E(R_E) &= R_F + [E(R_M) - R_F] * \beta \\ &= 4.16 \% + 7\% * 1.98 \\ &= 18.03 \% \text{ return} \end{aligned}$$

Where

$E(R_E)$ expected rate of return from the eucalypt project

R_F risk free rate of return

$E(R_M)$ market rate of return

β systematic risk parameter

The risk free rate was estimated from the average of a Commonwealth Treasury Bond with a maturity of 10 and 30 years, taken from the Financial Review on 08 October 2002. The nominal rates of return were 3.65 percent for the 10 year T-bond and 4.68 percent for the 30 year T-bond, therefore a 20-year risk free rate was estimated using the average, providing a risk free rate of 4.16 percent. The beta for the eucalypt sawlog investment was derived from the average betas of five listed timber companies. These betas were taken from AGSM (2002) and are provided in Appendix A. The Australian market risk premium [$E(R_M) - R_F$] was estimated to be 7 percent, taken from NECG (2001).

To calculate the real rate of return, the inflation rate needs to be subtracted from the nominal required rate of return. The inflation rate was estimated by averaging inflation over the last 10 years, which equated to 2.43 percent. Subtracting this from required rate of return gives a required real rate of return of 15.23 percent [$(1+18.03\%) / (1+2.43\%)$]. Therefore, in the following analysis, we have assumed a required real rate of return of 15 percent.

Buying versus leasing the land

When comparing scenarios of an investor buying the land with leasing the land, it is assumed that the investor can sell the land for the same price they bought the land in year -1 of the project but stumpage removal and levelling costs are incurred.

Comparing different length rotations

To compare a 20-year rotation with a 25-year rotation, the constant chain of replacement in perpetuity method was used. The two scenarios are mutually exclusive and therefore the alternatives are not directly comparable because the difference in lives means that they involve different cash flows. Using the constant chain of replacement in perpetuity method assumes that both chains continue indefinitely, and therefore the economic lives are equal. The constant chain of replacement in perpetuity method is calculated by the following equation:

$$NPV_{\infty} = NPV_0 \frac{(1 + k)^n}{(1 + k)^n - 1}$$

where:

NPV₀ = Net Present Value of each replacement

k = discount rate

n = the life of the project

Results

For each variable in the cashflows an expected, pessimistic (worst case) and an optimistic (best case) value was estimated. Table 3 presents a summary of the estimates used in the analysis.

Most of the costs associated with the establishment are reasonably predictable. Although these costs still have a range of values, this is a reflection of on site differences. For instance fertiliser costs will differ largely due to the type of soil and the past fertiliser regime. Plantation establishment success is less predictable due to limited experience with these species in WA. Establishment costs (not including management costs) ranged from \$625 for the optimistic values to \$890 for the most likely values to \$955 for the pessimistic values. These costs are still slightly less than establishment costs reported for growing eucalypt species for quality sawlogs in Victoria, which have been reported as being between \$900 and \$1400 a hectare (Hopkins 2002), and those reported by the Kondinin Group (1999) for growing eucalypts for sawlogs in the 600mm rainfall zone, which reported establishment costs of \$1200 per hectare. However they are higher than those reported by Moore (2002) for establishing *E. saligna* for sawlogs in the medium rainfall zone of WA, which report establishment costs between \$325 and \$502 per hectare. They are also higher than establishment costs used in the BIS Shrapnel report for this project, which used an establishment cost of \$595.50 per hectare.



Figure 4: Extensive earthworks are required prior to establishment of eucalypt plantations. A paddock, which has been ripped and mounded on a farm in the Kojonup shire.

Table 3: Parameters selected for sensitivity analysis.

	Most Likely	Pessimistic	Optimistic
Stumpage price (first harvest) - \$/m ³	60	30	90
Mean Annual Increment - (m ³ /ha/yr)	9	6	11
Carbon Price (\$/tonne)	5	10	15
Establishment costs \$/ha (all year 0)			
Management	400	550	350
Fencing & rabbit control	75	150	50
Ripping and mounding	120	150	80
Weed control	65	75	40
Planting @ 1000 stems/ha (5x2)	105	105	85
Fertiliser	80	120	50
Insect control	80	100	40
Parrot control	50	75	20
Operational costs \$/ha			
Parrot control (years 1,2,3,4)	50	75	20
Post plant weed control (year 1)	60	70	40
Infill Planting (year 1)	40	50	10
Culling 700spha (year 4)	280	320	210
Culling 120spha (year 6)	75	100	70
Pruning 300spha (year 4)	210	240	150
Pruning 180spha (year 5)	225	270	162
Pruning 180spha (year 6)	270	306	252
Coppice control (year 4)	60	80	40
Coppice control (year 6)	40	60	50
Heaping debris (year 4)	5	50	0
Heaping debris (year 6)	15	50	0
Annual management (years 1 to 21)	40	75	35
Annual maintenance (years 1 to 21)	35	45	30

Using the expected variables, the real internal rate of return (IRR) is 3.32 percent, and factoring destumping and levelling this is reduced to 3.05 percent. This is slightly less than what BIS Shrapnel previously calculated for the same project (3.9%), and is a consequence of the higher costs that are now expected and have been assumed in this analysis. Table 4 highlights that investment companies seeking a real IRR of 15 percent will get a negative net present value (NPV). Even assuming optimistic outcomes for all the estimated variables, a real IRR of 10.21 percent is calculated, with a negative NPV resulting (-\$973/ha) using a real discount rate of 15 percent.

Table 4: Discounted cash flows for an investment company investing in eucalypt sawlogs, assuming expected variables.

	Year												
	-1	0	1	2	3	4	5	6	7	8	20	
1. Planning and Management													
Planning	-3												
Management	-400												
2. Establishment costs													
Fencing & rabbit control	-75												
Ripping and mounding	-120												
Weed control		-65											
1050 seedlings @ \$0.3each		-315											
Planting @ 1000 stems/ha (5x2)		-105											
Fertiliser		-80											
Pest control		-80											
3. Operating Costs													
Infill Planting			-40										
Parrot control			-50	-50	-50	-50							
Post plant weed control			-60										
Culling						-280		-75					
Pruning						-210	-225	-270					
Coppice control						-60		-50					
Heaping debris						-5		-15					
Annual management			-40	-40	-40	-40	-40	-40	-40	-40			
Annual maintenance			-35	-35	-35	-35	-35	-35	-35	-35			
Land Rental	-120	-120	-120	-120	-120	-120	-120	-120	-120	-120			
Total Costs	-718	-765	-345	-245	-245	-800	-420	-605	-195	-195			-195
Harvesting Revenue													10800
Tax paid or Tax benefit (30%)	215.4	229.5	103.5	73.5	73.5	240	126	181.5	58.5	58.5			3182
Net cashflows	-502.6	-535.5	-241.5	-171.5	-171.5	-560	-294	-423.5	-136.5	-136.5			7423.5
Discounted cashflows @ 9%	-578	-536	-210	-130	-113	-320	-146	-183	-51	-45			454
NPV	-2091												
Real IRR	3.32%												

Table 5 identifies the variables causing the most impact on NPV. The performance (MAI) and stumpage price received from the eucalypt plantations is relatively unknown and are the two main variables influencing the profitability (NPV) of farm forestry for eucalypts in the medium rainfall zone. The uncertainty surrounding the stumpage price and MAI will alter the NPV of the project by between \$462 and \$257 respectively at a 15 percent real discount rate, therefore posing a significant risk. Herbohn and Harrison (1999) also concluded that a lack of published information available about the growth rates and prices as well as harvest ages for Australian eucalypt species were the main problems facing the industry. It is recommended that management examines these estimates of these variables more thoroughly, or collect more data in an effort to reduce errors in forecasting.

Table 5: NPV's for private investor investing in eucalypt sawlogs, assuming no carbon credits and \$120/ha lease annuity at 15 percent discount rate.

	Pessimistic NPV	Optimistic NPV	Range	Rank
Stumpage price (first harvest) - \$/m ³	-2322	-1860	462	1
Mean Annual Increment - (m ³ /ha/yr)	-2245	-1989	257	2
Establishment costs \$/ha (all year 0)				
Management	-2212	-2051	161	4
Fencing & rabbit control	-2152	-2071	81	7
Ripping and mounding	-2115	-2059	56	9
Weed control	-2098	-2074	25	14
Planting @ 1000 stems/ha (5x2)	-2091	-2077	14	19
Fertiliser	-2119	-2070	49	10
Insect control	-2105	-2063	42	12
Operational costs \$/ha				
Parrot control (years, 0,1,2,3,4)	-2141	-2031	110	5
Post plant weed control (year 1)	-2097	-2079	18	18
Infill Planting (year 1)	-2097	-2073	24	13
Culling 700spha (year 4)	-2107	-2063	44	8
Culling 120spha (year 6)	-2099	-2090	9	20
Pruning 300spha (year 4)	-2103	-2067	36	11
Pruning 180spha (year 5)	-2107	-2069	38	10
Pruning 180spha (year 6)	-2102	-2086	16	15
Coppice control (year 4)	-2099	-2083	16	17
Coppice control (year 6)	-2094	-2088	6	21
Heaping debris (year 4)	-2109	-2089	20	14
Heaping debris (year 6)	-2102	-2087	15	16
Annual management (years 1-21)	-2245	-2069	175	3
Annual maintenance (years 1-21)	-2135	-2069	66	6

The risk associated with the stumpage price is compounded by the final harvest being the only cash inflow throughout the life of the project. The risks associated with the long time period to harvest would likely therefore pose a constraint on investment. On the other hand, no value has been attributed to carbon credits (this is investigated later in the report) and the by-products from the venture, and it is here that further economic potential may exist. To date there are no markets for thinning, but further research would be recommended. In addition there has been no analysis of value-adding the timber. This would require the timber to be dried and dressed and it would be recommended that further analysis is done to investigate the potential profits from doing this.

Investment assuming no carbon credits

Internal rate of return (IRR)

Stumpage price has been highlighted as an important variable in the profitability of the project. For the project to return a real IRR of 15 percent using the most likely estimates, the stumpage price needs to return \$329/m³, or more than six times the most likely estimated price. Figure 5 provides the stumpage price required to return a real IRR of between 5 and 15 percent. The highest real IRR that lies within the stumpage prices estimated is 6 percent. To achieve this, the stumpage price required is \$87/m³.

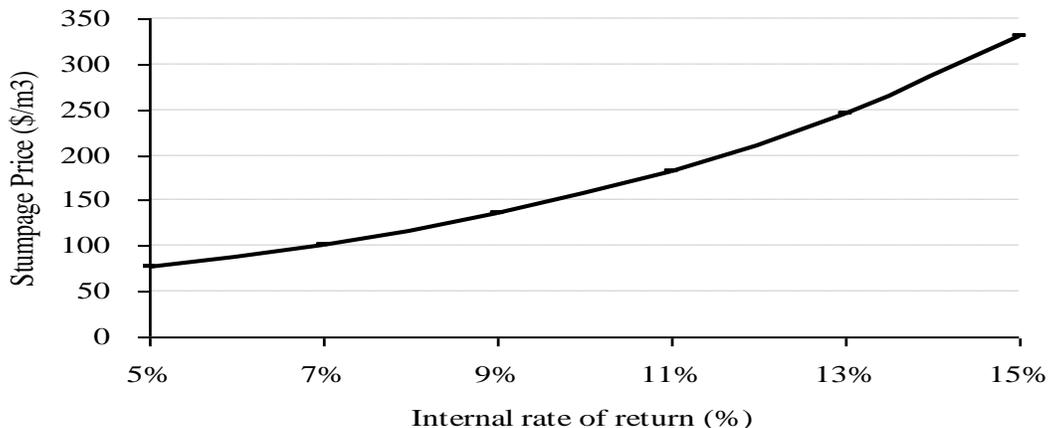


Figure 5: Stumpage price (\$/m³) required to provide a real internal rate of return of between 5 and 15 percent, based on the most likely estimates.

The annuity paid to farmers by investment companies is likely to reflect how much they are able to pay while still returning a rate of return that is satisfactory to them. Assuming all estimates of the most likely variables, to achieve a real IRR of 3 percent an investor would be able to pay a lease annuity of \$135/hectare (Figure 6). Paying an annuity higher than \$135/ha would lead to a negative NPV at this discount rate. Likewise, to achieve a real IRR of 6 percent an investor would be able to pay a lease annuity of \$5/hectare. An investor would not be able to achieve a real IRR any higher than 6.12 percent, as to achieve a return beyond this value, the farmer would

be required to pay the investment company money for his land. Obviously, the investment company will only be able to achieve these real IRR's if farmers are willing to lease their land for the given annuity. For example, it is likely that farmer's will not be willing to lease their land for an annuity of less than \$100/ha, considering the land that is required is referred to as their "better country". Therefore, it is likely that an investor would not be able to return a real IRR higher than 3.75 percent based on the most likely values. Given the risk associated with the project and the required real rate of return (15%), it seems unlikely from this analysis that investors would be interested in investing in such a project.

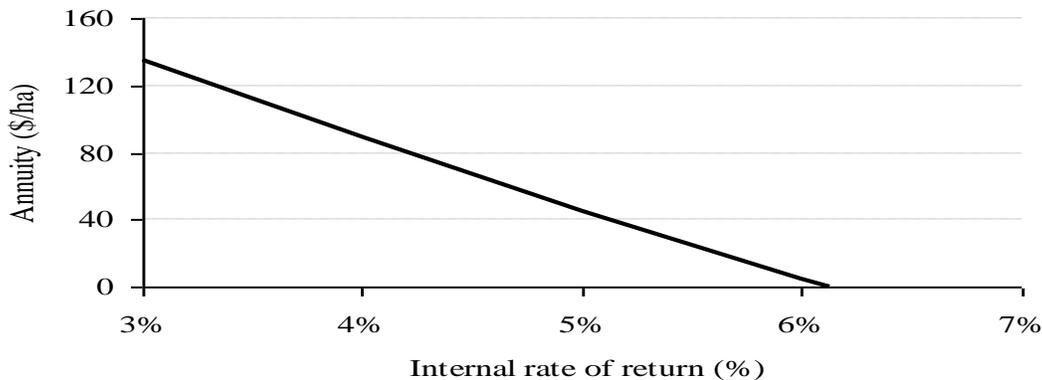


Figure 6: Lease annuity (\$/ha) that provides the investor with a specified real IRR, assuming most likely variables.

Often for government participation in farm forestry, a lower real rate of return than what private investors require is justified. This is because government will be interested in the management of trees for the non-wood benefits as well as for the timber, and also because governments are able to receive much lower interest rates due to their AAA credit rating. It is sometimes argued therefore, that indirect allowance can be made for multiple use of forestry by downward adjustment of the discount rate when governments are investing in such projects. Therefore for governments a real rate of return of 3 or 4 percent might be justified, and the project may therefore be feasible (Dayanandra et al. 2002). This would be consistent with NSW State Forests and Queensland State forest departments, which aim for a return between 5 and 7 percent, which equates to a real rate of return of approximately 2.6 and 4.6 percent.

Investment risk in evaluation of forestry investments

The cumulative distribution curve provides information about the likely financial performance of the project. Figure 7 shows that there is a zero probability that the project will return a payoff greater than \$0/ha NPV using a discount rate of 15 percent. The median payoff is approximately -\$2285/ha. The non-symmetrical shape of the CDC results in the median value calculated by using the expected values (-\$2091/ha) being greater than the mean payoff calculated using the CDC. This is a reflection of the downward risk associated with the range of possible estimated variables.

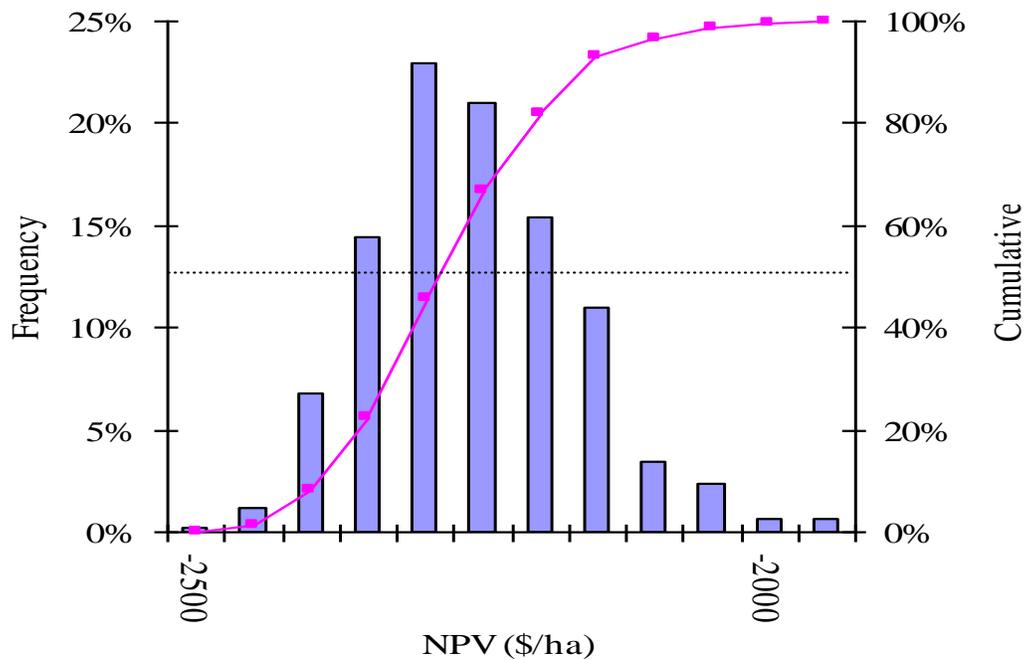


Figure 7: Histogram and cumulative distribution curve for a eucalypt plantation investment, with land lease annuity of \$120/ha, at 15 percent discount rate.

The likely performance of the project is however heavily dependent on the discount rate used. The sensitivity of the likely financial performance of the project to the discount rate is summarised in Table 5. This shows that the investor has a 35 and 3 percent chance to return a positive NPV at a 3 and 5 percent real discount rate respectively. Previously it was shown that using the most likely variables, that an investment company could return a 3.32 percent IRR whilst paying the farmer a lease annuity of \$120/ha/year. However, factoring in for downward and upward risk, using a 3.32 percent real discount rate and a lease annuity of \$120/ha/year, the risk associated with the project is still very high (69% probability of returning a negative NPV), reinforcing the downward risk of the estimated variables. Table 6 summarises the expected, median, minimum and maximum NPV's at five real discount rates, and the percent probability of returning a \$0 expected NPV and highlights that the investment in planting eucalypts for sawlogs is likely to be too risky for investment companies to be involved with.

Table 6: Summary of expected, median, minimum and maximum NPV's at five discount rates, and the percent probability of returning a \$0 expected NPV, assuming annuity of \$120/ha.

Discount rate	Expected NPV (Mean)	Median NPV	Prob. of NPV>\$0	Min NPV	Max NPV	Std dev
3%	-172	-281	35%	-1397	2453	735
5%	-1058	-1143	3%	-2040	814	517
7%	-1612	-1694	0%	-2222	-499	381
9%	-1935	-1963	0%	-2422	-1149	253
11%	-2128	-2150	0%	-2443.	-1574	172

Buying versus leasing the land

The investor may choose to purchase the land outright instead of leasing the land from the farmer. If the investor purchases the land outright, it has been assumed to sell the land for the same price they purchased it for, they are required to put the land back to the same state it was prior to planting trees (de-stumping and levelling). If the investor decides to purchase the land outright, they are able to pay the farmer a higher price for their land than a lease annuity if they are willing to achieve a real IRR less than 4.75 percent. It is not possible for investment companies to receive a real IRR greater than 6.12 percent, as to do achieve this, the farmer is required to pay the investment company money (Figure 8).

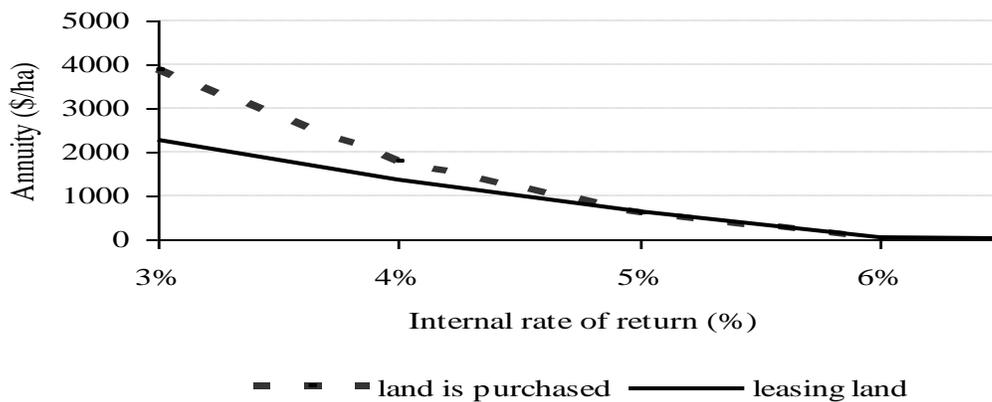


Figure 8: Comparison of the upfront payment of purchasing the land with the equivalent upfront payment from leasing the land to generate a real IRR of between 3 and 6 percent.

Comparing different length projects

Growing the trees for a longer period of time has the potential to result in greater profits. However this analysis shows that growing trees for an additional five years (20 years to 25 years) results in less profits at all discount rates assuming additional linear growth, whilst assuming the same prices as our expected estimates (Figure 9).

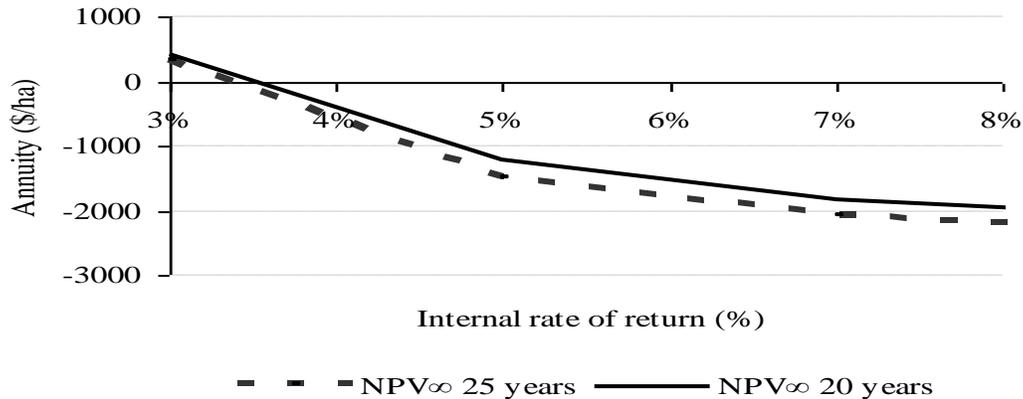


Figure 9: Comparison of NPV ∞ at different discount rates of a 20 and 25 year eucalypt rotation assuming most likely values.

If a higher stumpage price can be received for growing the trees an additional 5 years, then it has the potential to be more profitable than growing the trees for 20 years. If we assume that by growing trees for an additional 5 years the stumpage will be worth more, the stumpage needs to increase by \$28/m³ (\$60 to \$88) for the additional five years growth to equate to profits from growing the trees for 20 years, assuming the most likely variables. However the project would still return a negative NPV.

It was mentioned previously that to return a positive NPV at 15 percent discount rate, a stumpage price of \$329 would be required, assuming all other variables are kept at our expected estimates. Growing trees for an additional five years (20 years to 25 years) would be equally profitable if stumpage price received for the additional five years increased to \$535/m³. Obviously these prices are well above what could even be realistically received for the timber.

At lower real discount rates, the income from growing the trees the additional five years is reduced. For example, at a real discount rate of 9 percent, and stumpage price of \$60/m³, the additional 5 years growth needs to profit an additional stumpage of \$12/m³ to breakeven with growing the trees for 20 years, compared with \$28/m³ at a 15 percent real discount rate, but to result in a positive NPV the stumpage would need to increase to \$173/m³.

Investment assuming carbon credits

So far in this report, we have dismissed any potential inflows from carbon credits. The amount of carbon stored by trees and the value of carbon is extremely uncertain, however we have assumed in this analysis that the most likely value for carbon credits to be \$72/ha/year.

Internal rate of return (IRR)

Assuming the most likely variables, to achieve a real IRR between 3 percent and 8 percent an investor would be able to pay an additional \$65/hectare lease annuity than without carbon credits. For example without carbon credits, the investor would be able to pay an annuity of \$5/hectare to receive a 6 percent real IRR, but with carbon credits, would be able to pay \$69/hectare (Figure 10). An investor would not be able to achieve a real IRR any higher than 8 percent. A real IRR of 4.75 percent may be achieved, with farmers being paid a lease annuity of \$120/hectare (figure 10).

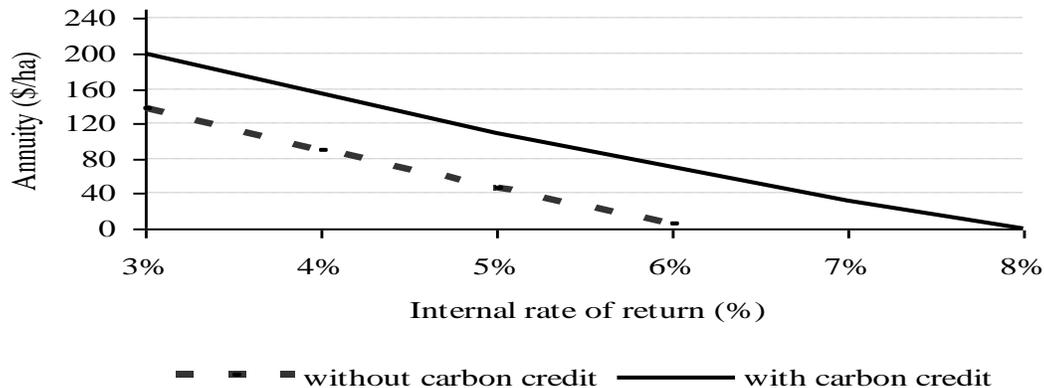


Figure 10: Annuity (\$/ha) that gives a specified real internal rate of return with and without carbon credits.

Investment risk in evaluation of forestry investments with carbon credits

Including carbon credits into the cash flows improved the likely performance of growing eucalypts in comparison to growing eucalypts without carbon credits. The cumulative distribution curves for the likely financial performance of the project with carbon credits at five discount rates (3,5,7,9 and 11%), with a lease annuity of \$120/hectare to the farmer for their land is shown in Table 6, and shown graphically in Appendix C. There is a probability of approximately 77 percent that the project will return a payoff greater than \$0/hectare NPV using a real discount rate of 3 percent (table 7). Thus carbon credits have the potential to significantly increase profits from growing eucalypts for sawlogs, although still do not result in a real IRR that investment companies are likely to be wanting to achieve, but are certainly an important aspect in the project’s potential viability.

Table 7: Summary of expected, median, minimum and maximum NPV's at five discount rates, and the percent probability of returning a \$0 expected NPV, assuming annuity of \$120/ha and carbon credits.

Discount rate	Expected NPV (Mean)	Median NPV	Prob. of NPV>\$0	Min NPV	Max NPV	Std dev
3%	716	626	77%	-973	4141	863
5%	-396	-443	24%	-1604	1119	532
7%	-1037	-1071	1%	-1809	270	382
9%	-1466	-1495	0%	-1994	-609	279
11%	-1680	-1701	0%	-2119	-1053	198

How to get private investors on board

From the analysis outlined above, it seems highly unlikely that private timber investors will want to be involved with growing eucalypts for sawlogs, and therefore will not be the main factor driving this industry in the short term. Discussions with representatives from Great Southern Plantations, Timbercorp and Integrated Tree Cropping (ITC), highlighted that the private timber companies need to be able to provide faster returns to their shareholders, thus short rotations are required. To be involved with any new tree species, they require trials to have been completed that provide them with reliable growth rates. This is particularly important, as many of the blue gum establishments, fell short of growth expectations. There have only been limited small-scale plantings (3-4 ha) on these eucalypt species, and further work needs to be done to establish reliable growth rates. This is particularly difficult however, when these trees are required to be grown for 20–25 years!

This then raises the issue of what government can do to make this industry attractive for private timber investment to occur. One solution may be that the government intervenes in the short term to establish the new industry and sells its equity to the private sector once the overall level of risk has been reduced.

The establishment costs together with the culling, pruning, coppice control and heaping debris costs are completed by year six. For the remaining fourteen years, there are no costs associated with the trees, apart from ongoing maintenance, management and lease annuity. Therefore most of the risk has been removed by this stage, as management should have a much better idea of final harvest and potential markets and prices. Consequently the rate of return that private investors would demand from the project will be much less than that required if investors were establishing the trees from the commencement of the project. Assuming that the most likely values for growth and price remains after six years of growth, Figure 11 shows the percentage of the costs that are incurred by the government (outlined above), discounted at 5 percent real, that investor groups could pay the government to result in a real IRR of between 9 and 15 percent. It has been assumed that the government would discount the costs at 5 percent real, due to the reasons outlined earlier in the report (non-wood benefits and AAA credit rating). If private investment companies require a 7 percent real IRR, then they could pay the government for 100 percent of the costs incurred in the years -1 to year 6. Similarly if they require a 15 percent real IRR then they could pay the government 21 percent of the incurred costs.

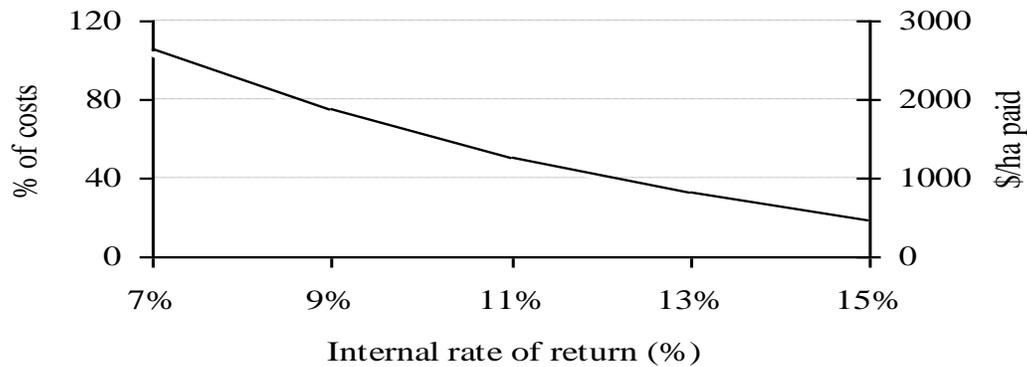


Figure 11: Percent of costs incurred from year -1 to year 6 at a real discount rate of 5 percent, and the corresponding actual cost (\$/ha) that private investment companies could pay the government in year 7 to return a real IRR of between 7 and 15 percent.

A second, and maybe more easily foreseeable situation, is that companies be involved with planting trees to offset their greenhouse gas emissions. As noted earlier, despite a present emissions trading system, several companies including BP, Royal Dutch/Shell Group and Alcoa, have already internally set up goals to reduce greenhouse gas emissions, exceeding goals put forth in Kyoto. FPC already plants *Pinus pinaster* on behalf of BP, primarily for this purpose. These speculative investments are in anticipation of carbon trading in the future, which will provide them with an offset against future greenhouse liabilities. Thus if the Kyoto protocol is ratified, companies are either going to have to become more efficient in using fossil fuels, or find alternative green solutions such as wind power, wave power and solar power to produce goods and services as renewable energy sources.

In participating in such ventures, companies simultaneously provide a positive image to their customers. If companies provide these types of benefits, they also allow themselves to take advantage of 'green funds', which are becoming increasingly larger, as more people are beginning to want to invest in ethical companies, which are giving something, back something to society. Discussions with FPC, indicate that BP would be willing to plant eucalypts in the medium rainfall zone. Their main reason for growing the trees is to get carbon credits, and to date the best data comes from maritime pine (*Pinus pinaster*). It is likely that BP would be want to be involved with this planting these new eucalypt species, as it is targeting water recovery catchments which would give them an image of working with communities to provide a positive result. Therefore it is recommended that work is done to quantify how much carbon is being stored by the eucalypt species that are being planted in this new scheme to take advantage of this market.

THE GROWER PERSPECTIVE

Adoption

There are many factors that are likely to constrain the development and adoption of large-scale farm forestry. High establishment costs coupled with a long wait till any financial return creates cash flow problems for farmers, especially where no thinning markets exist. Other factors that reduce adoption of farm forestry include long investment periods (minimum 10 years); uncertain long-term market demands, the risk of insect and parrot control, and the profitability of alternative enterprises.

In addition to these factors, in the low to medium rainfall zone uncertainty is increased, further inhibiting adoption of farm forestry. The slower growth rate due to lower rainfall creates longer investment periods (minimum 20 years) as well as greater uncertainty to the likely demand and price. In addition there has been little research into suitable species in the low to medium rainfall zone, and therefore there is a lack of information on growth rates and harvest ages, as well as inexperience and lack of knowledge about growing trees (Washusen 1999). Another factor which farm forestry in the low to medium rainfall zone must contend with is the threat of trees dying due to a series of poor seasons or loss by fire. Therefore there is a high degree of uncertainty surrounding farm forestry in the low to medium rainfall zone, which is caused by a multitude of reasons when compared to other zones.

In areas that receive more than 700mm annual rainfall, blue gums for pulpwood is the most attractive forestry option currently available to farmers. Where forestry is more commercially/economically attractive than current alternative land uses (e.g. wool) then it has been shown that landholders are likely to invest in medium to large-scale farm forestry. This has been shown in the south-west of WA, where blue gum plantations were considered to provide greater economic security by its guaranteed source of income via an annuity compared to wool production, and consequently development was as woodlots and small plantations. Any new agro-forestry industry must offer the farmer both a commercial or economic value greater or equal to existing practices.

When species are considered less commercially attractive than current or alternative land uses (e.g. crops and wool), then it has been shown that landholders are likely to integrate small areas (<5ha) of trees as timber belts and planting on marginal areas for agricultural, environmental or conservation benefits, with few investments in medium to large scale farm forestry (>10ha) (Curtis and Race, 1998). This is currently the case in the medium to low rainfall areas of WA.

In the medium to low rainfall areas of WA, faster growing species such as Blue gums (*Eucalyptus globulus*) are often inappropriate. In the 700-400mm annual rainfall zone, Maritime pine (*Pinus pinaster*) is currently an option in the WA wheat belt. Trees are grown for approximately 30 to 35 years for high quality sawlogs. Maritime pine can be a popular option for farmers due to its ability to grow on deep sands and deep sandy gravels that are the less productive cropping and pasture soils. Oil mallees are currently being developed as an alternative species for the WA wheat belt and are repeatedly harvested on a 2 to 3 year cycle. In areas that receive more than 600mm annual rainfall, radiata pine (*Pinus radiata*) is also an option. They grow on deep, well-drained soils with high water holding capacity, similar to the requirements for the eucalypts being planted in the new eucalypt sawlog scheme.

Producing a product (e.g. timber or oil) from growing trees is important, however it is also important to be aware that many farmers in the low to medium rainfall zone may only plant small areas to trees and the value they place on the non-timber qualities of trees will influence their overall decision as to whether to integrate trees into the farm. In the short term, trees on farms can provide a multitude of benefits including increasing the production of other agricultural enterprises. For example by reducing wind speeds, soil erosion is minimised and therefore can be an important strategy for soil conservation, which can positively affect pasture and crop growth. Trees can also provide shelter for livestock, which can be associated with increased live weight gain, an increase in milk and wool production, and reduced stock mortality rates.

On the downside, trees compete with neighbouring plants for light, water and nutrients. However strategic placement of trees can reduce waterlogging problems and therefore improve productivity. Planting trees on high recharge land is one strategy to reduce the area and effects of waterlogging and salinity. Other short-term benefits include stream bank stabilisation, improvements in water quality and farm beautification (Herbohn and Harrison 1999).

In a feasibility study, VCG Australia Pty Ltd (1999) identified five direct benefits and one penalty associated with the integration of woody perennials into farming systems:

Benefits:

- 1 Revenues from sale of products such as timber, biomass and oil
- 2 Trees confer benefits such as shelter and reduced erosion to nearby crops and livestock enterprises resulting in improved yields or stock carrying capacity due to reduction in wind speed and protection from inclement weather
- 3 Reduction in wind and water erosion, periodic inundation and water-logging and rate of water recharge into soil profile
- 4 Carbon sequestration credits if and when available
- 5 Increase in biodiversity

Penalties:

- 1 In alley farming configuration crop and pasture production are likely to decline close to the shelter zone as a result of competition for moisture and nutrients and lack of light penetration

A National Agricultural Survey during 1998 by the Kondinin Group showed that the main benefits that farmers were seeking from farm forestry included as windbreaks and shelter, and in controlling salinity and erosion. Other benefits included diversification and improvements in crop yield; pasture growth and animal production (Kondinin Group 1999).

One of the important benefits that trees can provide in the longer term is as a risk management tool. Due to the long-term nature of growing trees, and the ability to delay harvesting; income from trees can be delayed to years where wool or crop prices are low, and thus be used as a financial risk management tool. They therefore can be particularly attractive to low and/or volatile commodity prices and can provide an increase in both income and financial certainty. Farmers who grow trees which have a commercial harvest after 20 to 30 years, will however not be able to use trees for this purpose, as many farmers will not be there to receive this income, thus for long term schemes, trees may be better treated as money for retirement planning and transferring wealth between generations (Stewart 2000; Herbohn and Harrison 1999). Over the longer term other benefits that farmers may receive may come from carbon credits.

Apart from risk uncertainty, perception of positive or negative environmental effects of trees and financial considerations, Mattinson, Morrison and Eckersley (1989) highlighted three other considerations affecting whether or not a farmer will adopt tree farming, these were:

- 1) The farmer's level of knowledge of tree farming and his or her attitude to learning about it.
- 2) The availability of labour and how this matches the demands of tree farming
- 3) The farmer's preference for the traditional farming lifestyle and his or her attitude to change.

Similar to new technology, people are usually reluctant to adopt something they have little knowledge about. By holding agro forestry workshops, farmers in the Warren/Tone learnt what was involved with growing tees. As a consequence, many of the farmers who attended were synonymous with the farmers who are now involved with agro forestry (Coffey pers com).

Labour can be a constraining factor limiting a farmer's ability to be involved with agro forestry. There are currently many enterprises available for farmers to be involved with, all of which require time in the form of labour. It could be argued that growing trees requires less time over the life span than traditional cropping and grazing enterprises. However depending on whether a farmer wishes to contract the work out or not, it still requires a lot of preparation in the establishment year, and ongoing labour in the forthcoming six or so years, when pruning and other practices are required to provide good tree form and establishment. Good tree form is far more important for growing eucalypts for sawlogs in comparison to growing blue-gums for woodchips, and thus requires more labour.

Lastly, the farmer's preference for the traditional farming lifestyle and his attitude to change is an important factor in the rate of adoption. There is always resistance to change, and growing trees requires a change in farming practice, from growing an annual crop to growing a tree crop which spans a number of years (8 – 50 years). It is likely that many farmers will be reluctant to plant large areas of trees, due to the associated change in lifestyle.

Co-operatives

Co-operatives allow small-scale growers to join together and attract better prices. It has been reported that co-operatives in Tasmania have been able to increase returns for small-scale growers by as much as \$20/m³ (Curtis and Race, 1998). It has also been suggested that a viable co-operative requires an annual budget of \$150,000-\$200,000. At a levy rate of 10 percent, a co-operative would require an annual throughput of timber to the value of \$1.5-2 million stumpage (Curtis and Race, 1998). Assuming eucalypts grown for sawlogs are worth \$60 stumpage, this would equate to 33,333m³ of hardwood (about 185 ha/year).

Joint Ventures

Joint ventures are 'legal contracts between two or more parties combining land, capital, management, and market opportunities to provide a commercial tree crop' (Curtis and Race, 1998). Common joint ventures include lease, crop share and marketing joint ventures. In WA, lease joint ventures comprise 70 percent of the joint venture arrangements with the part-lease part-crop share schemes comprising 20 percent and the full-crop share joint ventures being the least popular joint venture arrangement (10%) (Curtis and Race, 1998).

Lease joint ventures

'Lease' joint ventures provide the landholder with a stream of regular payments over the life of the contract. Often these payments are indexed to the consumer price index (CPI). Trees are established and managed by investors, with the landholder contributing the land and maintaining the site (e.g. fire breaks and weeds).

Of the joint ventures that are currently available, 'lease' joint ventures are the most popular to both farmers and investors throughout Australia (Curtis and Race, 1998). Joint ventures provide investors with control of establishment and silvicultural practices that ensures timber quality at harvest (Curtis and Race, 1998). For farmers it overcomes the cash flow problem associated with growing trees by providing a regular stream of income, and eliminates much of the risk associated with the quality of harvest and price received for the product.

It has been shown in Australia that if the rent is greater than net return the farmer gets from their current use of the land, leasing out the land can be an attractive proposition for the farmer. Many of the farmers that were interviewed in the Timbercorp study last year engaged in agro forestry to help stabilise their farm income (Mazzarol, Sneddon and Soutar 2001). Integrated planting on annuity-lease contracts offered them regular income streams that helped to smooth out the farm's otherwise volatile cash flows. The environmental benefits of the planting were perceived as an added bonus. Such farmers tended to be the younger (e.g. aged under 45 years) and more strategic thinking ones. Similarly, many of the older farmers that leased their land to investors in the southwest of WA were thinking of retiring in the near future, or had separate farm blocks. Leasing their land provided them with significant retirement funds.

Table 8 presents a range of 'lease' joint ventures that were available during 2000. The annuities that timber companies payed to landowners for growing trees, differed between companies, regions and species. Growing hardwood in the southwest of WA received the highest annuities (up to \$300/ha), followed by Tasmania. The differences in annuities shown for companies competing in the same regions and for the same product can be explained by factors such as the minimum rainfall requirements (affects growth and quality at harvest) and the minimum land required (the greater the area planted the lower the cost to the company). The differences also reflect the influences of site characteristics, which affect quality of harvest. Many of the companies have site requirements such as State Forests of New South Wales, which specifies a requirement for well drained soils to at least 500mm depth and plantings to be on less than 18 degrees slope. Another important factor is the ease of harvesting and distance to the export mill or processing plant, with some companies specifying minimum distances to port of between 20km to 150km. The cost of transport is a significant cost, and based on costs of freight cost for NSW, Tasmania and WA during 1999, this cost is approximately \$0.115/ km/tonne to mill/wharf (figure 12). Additionally different companies have different costs of inputs and different required rates of return, which affect the price of annuities offered.

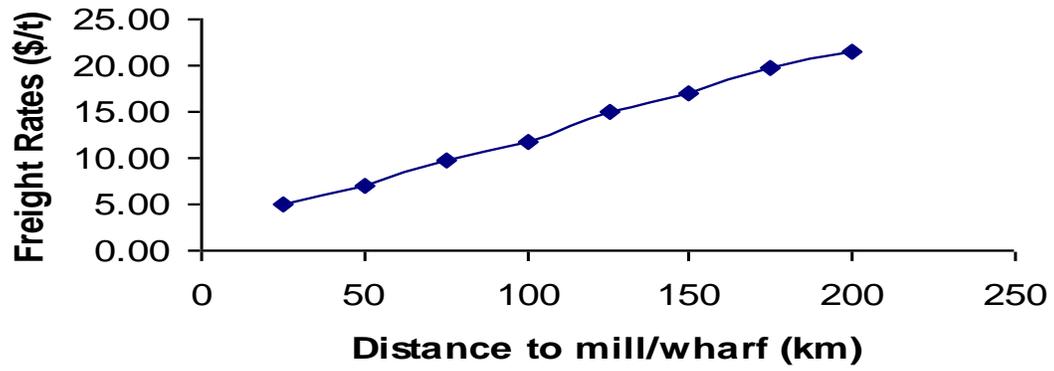


Figure 12: Cost of freight rate (\$/t) with increasing distance to mill/wharf (km).

Source: adapted from ANU Forestry 1999.

Table 8: A range of lease ventures that were available during 2000 by various companies.

Company	State	Timber	Max Period (Years)	Min. average annual rainfall (mm)	Min area (ha)	Rent paid	Annual rent (\$/ha)
Forestry Tasmania Tree Farms	Tasmania	Hardwood Softwood	31	800	20	Quarterly in advance, CPI indexed	\$110 - \$250
Gunns Plantations LTd	Tasmania	Hardwood Softwood	25	900	20	Quarterly in advance, CPI indexed, capped at 5%	\$150 - \$250
Integrated Tree Cropping Ltd	South-west WA Green Triangle	Hardwood	24	650	100	Quarterly in advance, CPI indexed, capped at 7%	\$75 - \$300
North Forest Products	Tasmania	Hardwood	23	700	20	Quarterly in advance, CPI indexed, capped at 5%	\$130 - \$240
Sotico	South-west WA	Hardwood	24	700	20	Quarterly in advance, CPI indexed	\$150 - \$260
State Forests of New South Wales	New South Wales	Softwood	35	700	40	Quarterly in advance, CPI indexed, capped at 6%	\$30 - \$90
		Hardwood	35	1000	50		\$80 - \$150
Trecorp Pty Ltd	Victoria	Softwood	16-24	600	20	-	\$140 - \$190
	South Australia	Hardwood	25-30				

Source: Adapted from ANU (2000)

Crop share joint venture

With a 'crop share' joint venture the landholder and the investor proportionally share the cost of the inputs and the returns throughout the projects life. Historically crop share joint ventures have attracted marginal, under-utilised agricultural land (Curtis and Race, 1998).

This was the case for the State Forests NSW crop share joint venture that is working with landholders to produce hardwood sawlogs. The type of land offered tended to be of marginal to low quality, and land which is difficult to manage with the scheme not particularly competitive for land which is producing an 'annual cash flow' (Curtis and Race, 1998). Farmers are probably reluctant to give away their better land, due to the long wait till harvest, thus they require their better land to maintain cash flows. It is also likely to be due to farmers taking on a greater proportion of the risk associated with the uncertainties surrounding trees, in comparison to a lease joint venture where the majority of the risk is taken aboard by the investment company.

Market joint venture

Market joint ventures are the least popular of the three joint ventures outlined. They provide the grower a guaranteed sale, which is usually based on market prices at the time of harvest. The grower has the opportunity to sell to another purchaser if a better price can be attained, but the industry partner has the first option of purchase. This type of contract holds very high risks for the farmer, and may be one reason to explain why they have not been a common contract with the blue gum industry.

Economics

The feasibility of farmers growing trees in WA has been looked at in a number of studies. Regional Analyses in WA by Eckersley et al. (1993) and Burange (1996) indicate that the blue gum pulpwood and softwood industries in the high rainfall zones can be more profitable than current grazing enterprises with IRR's ranging between 7 percent and 18 percent. Similarly, analyses by Mattinson, Morrison and Eckersley (1989), examined the profitability of tree farming as an alternative land use in the southwest of WA (>600mm average rainfall) and found that it was better than current enterprises (beef). Using a real discount rate of 8 percent over a time period of 31 years, a NPV for pines for sawlogs and blue gums for pulpwood of \$1,362 and \$3,672 respectively was calculated. It is important to note that these studies were done in a period when wool was depressed, and thus tree farming would look more attractive in comparison.

The Kondinin Group (1999) analysed the profitability of growing eucalypts for 38 years in the 600mm rainfall zone for clear log. A NPV of \$521 was calculated using a 5 percent discount rate. This was based on an expected mean annual increment growth rate for the eucalypt plantation of 11.5m³/ha/year. Total establishment costs were about \$1200/ha and further management costs were \$1900/ha. Commercial thinning during the 38 years included firewood, posts and sawlog.

More recently, in the medium rainfall zone (550mm/yr), Moore (2002) assessed the profitability of growing *E. saligna* for sawlogs over a 20 year time period. The assessment included grazing returns during the first 10 years and showed a NPV of \$521/ha. This was assuming that stumpage was \$45/m³, total costs were \$1,290/ha and the discount rate was 7 percent.

It is important to remember that the viability of growing trees will be sensitive to the discount rate used in the financial analyses. The analyses above all use differing discount rates when accessing the feasibility of the project, and thus should be carefully compared.

Socio-economic impacts of farm forestry

Observed socio-economic impacts in the high rainfall zone

In many of Australia's higher rainfall regions, a growing number of farmers have begun to diversify their operations by adopting extensive farm plantation forestry as an alternative farm enterprise. This has been particularly apparent in the southwest of WA, the Green Triangle and Tasmania, where extensive blue gum plantations have been planted and are beginning to be harvested. However, the development of these industries has not been without their problems. Since the emergence of these industries in the 1980s, this sector has attracted criticism from a range of economic, social and environmental perspectives. Some of the common concerns by farmers documented in papers by AGO 2001b; Tonts, Campbell and Black (2001), Mazzarol, Sneddon and Soutar (2001); Schirmer (2000) and Kelly and Lymon (2000) include:

- Reduction in farm families and employees
- Depopulation
- Withdrawal of services
- Decrease in levels of social interaction
- Concern that good farming land is going to trees
- Increase in pasture grazing wildlife e.g. kangaroos, vermin animals (rabbits and foxes) and invasive weed species
- Detrimental effect of aerial spraying on pasture and crops as well as water courses water supplies, and public health
- Increased fire risk
- Increasing land values
- Impact on landscape amenity, which can impact local property markets
- Driven by tax incentives for investors, rather than proven market demand
- Impact on local road infrastructure
- Soil erosion following harvest

The effect that farm forestry has on a local shire can vary tremendously. An example of this was reported by Tonts, Campbell and Black (2001), which highlights the contrasting effect that farm forestry had on the Shire of Boyup Brook with that of Bridgetown-Greenbushes. Within the shire of Boyup Brook trees covered approximately 9.4 percent of the Shire's agricultural land by the year 2000, with a similar area of approximately 11 percent for the Shire of Bridgetown-Greenbushes. Key farm enterprises in Boyup Brook however included sheep and cattle grazing integrated with cropping, where as the Shire of Bridgetown-Greenbushes was much more diversified in its enterprises and had many hobby farms, and tourism was also important.

In the survey that was carried out by Tonts, Campbell and Black (2001), 60 percent of farmers in Boyup Brook perceived farm plantation forestry to have a negative impact on local employment, in contrast to 55 percent of farmers in the Bridgetown-Greenbushes shire who perceived farm plantation forestry to have a positive impact on local employment. This difference can be largely attributed to the decision of some timber companies to base operations locally within the shire thus creating employment.

The impact of farm forestry on population levels also differed between these two shires. Between 1986 and 1996 the population of Boyup Brook fell from 1,747 to 1,604 (decrease of 8.2 percent), in contrast to Bridgetown-Greenbushes, which experienced steady population growth during this period. The decrease in Boyup Brook is attributed to the abandonment of farms by their owners who either sell out to the tree farming companies or relocate to coastal town and cities while their properties are under lease. Bridgetown-Greenbushes continued growth is likely to be due to the positive effect that farm forestry had on local employment, and maybe also due to hobby farms being increasingly popular in this area.

Therefore the contrasting attitudes to farm forestry is likely to be attributed to farm forestry being one of many land uses and economic activities within the Bridgetown-Greenbushes shire, which therefore resulted in less reliance being placed on traditional agriculture.

Potential socio-economic impacts in the low to medium rainfall zone

There is a belief that whole farm plantation forestry is unlikely to develop in the medium to low rainfall areas in the near future. This is partly due to investment driven plantation companies, being focused on species that yield a return on investment within a relatively short timeframe (Tonts, Campbell and Black 2001). Currently, this is only available in the high rainfall zone.

However private companies may get involved in the near future if carbon credit trading becomes a reality. This will make growing trees much more appealing for investment companies wanting to offset their carbon emissions. In the 550 – 650mm rainfall zone in Victoria, two private investment companies have been seriously looking into investing in large-scale sugar gum plantations (L. Hamilton pers. comm.). One of these companies is looking at growing sugar gum for sawlogs and the other for firewood. Both companies are interested for their potential carbon and salinity credits that may arise in the future.

It is likely that the outcome of carbon trading will determine whether in the low to medium rainfall zone commercial trees will be integrated with existing farm enterprises to combine positive economic and environmental outcomes or whether large blocks of land will be planted to trees. Integration is already being seen in the low to medium rainfall zone of WA, where trees such as *Pinus pinaster*, eucalypts and oil mallees are being integrated into existing farming practices to provide both a commercial return and to control environmental problems such as waterlogging, soil salinity and erosion.

If integration of trees occurs, then it is unlikely to have the same negative impacts on economic and employment as has occurred in some of the high rainfall zones (Tonts, Campbell and Black 2001). Similarly, land values are unlikely to increase rapidly as has occurred with farm forestry in the high rainfall zone (Tonts, Campbell and Black 2001). However problems associated with local roads, effects of chemical spraying, weed invasions, and pest control are likely to be similar to those for higher rainfall areas (Tonts, Campbell and Black 2001).

FARMER CASE STUDIES IN THE UPPER KENT CATCHMENT

Introduction

The methodology for this phase of the research involved a multiple case study design comprising six farmers in the Upper Kent catchment area. This area was selected because it offered access to a range of different farmer types. As noted earlier in this report, there had been no participants in the agro forestry scheme from among the Collie catchment farmers. As a result this area was not targeted for case studies.

Yin (1994: 13) defines a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real life context; especially when the boundaries between phenomenon and context are not clearly evident.” Its value as a research tool is its ability to measure and record behaviour at close range, thereby enabling the researcher and participants to interpret the reality of their experience, and develop a grounded understanding of how that behaviour has taken place (Chetty, 1996). Case study method is considered a more appropriate strategy where the research is seeking to answer questions associated with the ‘how’ and ‘why’, and where control over events is not possible or essential.

Case study method employs a ‘replication logic’ rather than a ‘sampling logic’ and as such each case needs to be viewed as an independent study with the researcher seeking to identify patterns across the cases that reveal new theory or support existing theory (Yin, 1989). The method allows similarities and differences to be examined across a group of cases with subtle discrimination between these groups possible (Chetty, 1996). Multiple case study designs of between 6 and 8 cases are considered to provide a good basis for comparison.

The purpose of these case studies was to reveal attitudes and concerns towards agro forestry and to get an insight into how farmers perceived the current scheme. A range of farmers was selected. This included farmers that were (i) only involved with the pilot program, (ii) only involved with the scheme, (iii) involved with both the pilot program and scheme and, (iv) not involved with either program. A range of farmers of various ages was also selected.



Figure 13: Will Owen in a stand of one-year-old eucalypts on his farm at Kojonup.

Environmental benefits

In relation to agro forestry, the farmers saw the environmental impacts as more than or equally as important as the financial rewards. This is consistent with Tonts, Campbell and Black (2001) who viewed that agro forestry in the low to medium rainfall zone would likely be largely driven by environmental reasons. Participants held a range of environmental benefits that they hoped to achieve through agro forestry. The most common environmental benefit was to prevent waterlogging or to lower the water table (Table 9). It was also hoped that agro forestry could protect the asset to prevent or reverse land degradation, provide shelter for stock and crops, and to control salinity. Scott (1988) and Schirmer (1999) found similar objectives for the establishment trees. This highlights the importance of trying to value the non-timber aspects when analysing the financial rewards of growing trees to farmers.

Table 9: Environmental factors that would be or were hoped to be achieved through agroforestry.

	1st factor	Other
Salinity management	1	1
Aesthetically pleasing		3
Shelter	2	3
Erosion		1
Stop waterlogging/lower water table	5	
Protecting asset	2	

Socio-economic impact of agro forestry

Studies have revealed that there are many social and economic concerns surrounding tree farming. These concerns have largely come about by block plantations (farm forestry) of blue gums in the south west of WA, green triangle and Tasmania. This is likely to be due to nearby large plantings of blue gums in the lower Kent catchment and the problems that have been experienced by farmers in this region. This highlights the need to look at the experience of the blue gum industry as a guide to this new agro forestry sector. The commercial practices of the blue gum industry have been driven by a purely economic rationale with insufficient attention given to environmental and social impacts. It seems that many of the timber ‘investor’ companies are now realising this, but the past decades have done their damage.

Responses to socio-economic impacts of agro forestry

Aerial spraying of tree plantations with insecticides and herbicides was viewed as only a problem in relation to insecticides. Most of the case study farmers saw insecticides as a major personal health risk, with serious concerns relating to the possible harmful effects that insecticides can have on your nervous system. There were concerns that drift from aerial spraying could not only physically get in contact with you, but also a risk of drift contaminating sheds where water runs off. These negative attitudes are likely to stem from recent allegations that people in the nearby Porongurup’s where blue gum plantations have been established on a large scale are becoming sick due to these insecticides. Only one farmer perceived aerial spraying as a risk to pastures, with no farmers seeing insecticides or herbicides as detrimental to their crops. There was also a feeling that similar rules of spraying should apply to both traditional farming as to agro forestry.

An increase in pasture grazing wildlife, vermin animals and invasive weed species from agroforestry was not perceived as a large problem. Generally respondents felt that this was a problem associated with large block plantings, but not with small areas. On nearby large blocks of blue gum plantations, farmers raised that they were concerned that no one was taking responsibility for controlling these problems. Similarly, all farmers viewed the fire risks associated with agro forestry to be equivalent to traditional farming.

Transporting harvested logs has the potential to cause serious damage to underdeveloped public roads that have private access to farms/plantations. This raises the question of who should bear

the cost of upgrading and maintaining roads that will serve the plantation industry. Most farmers were concerned about the impact of agro forestry on local roads. However differing opinions were voiced in relation to who should be responsible for upgrading and maintaining the roads. It was evident that many farmers had thought about this, but were still unsure as to whether the cost should be passed on to the plantation owners, or paid through the shire rates.

Historically land prices throughout Australia have risen due to farm forestry (Tonts, Cambell and Black 2001). No farmers interviewed were concerned about land prices increasing as a consequence of agro forestry. Many thought that this would not occur, and those that saw it could possibly arise, saw it as a positive result. In the lower Kent, land prices rose as a result of timber companies buying and leasing land to plant blue gums. This land however was predominantly grazing country and at the time the timber companies bought and leased the land, the wool industry was experiencing economic difficulties. The depressed wool prices meant that grazing land was also undervalued during this period and the new thriving and competitive blue gum industry increased these land prices. In comparison to the lower Kent, the upper Kent is regarded, as better cropping country and most farmers are not dependent on sheep as their main source of income. This may partly explain why farmers felt that land prices would not increase due to agro forestry in the future. This supports Tonts, Cambell and Black (2001) view that land values are not likely to increase rapidly as has occurred with farm forestry in the high rainfall zone.

Respondents raised a range of possible effects that agro forestry might have on the local community. Common responses included population decline, loss of families, closure of schools, reduced bus routes and less people to fight fires. These concerns are likely to stem from the recent effects on a nearby town – Rocky Gully. According to many of the farmers, this town now resembles a ‘ghost town’. The local school has declined from 100 to 12 kids within a short period of time, and the local school bus no longer services this route. On the other hand, Frankland, another close by town has been affected positively by the blue gum industry. This town is much more diversified and includes enterprises such as vineyards and hobby farms. The detriment of one town to another has been shown by the study by Tonts, Campbell and Black (2001). This study showed that the town of Bridgetown-Greenbushes, which had diversified enterprises including hobby farms, was positively affected by the blue gum industry, where as the shire of Boyup Brook which was largely involved with sheep and cattle grazing integrated with cropping was affected adversely, similar to Rocky Gully. It is important to realise the implications that trees planted on large scales can have on local communities. However the majority of respondents felt that you couldn’t interfere with the effects that agro forestry may have on changing community structures.

This was apparent by their response to their view of ‘good farming land going to trees’, where the majority of respondents expressed that it was no ones right to regulate what an individual decides to do with their land. This is consistent with feedback from the farmers that were interviewed by Mazzarol, Sneddon and Soutar (2001), who reflected similar views. It seems that many farmers in WA are resistant to anyone telling them what they can or cannot do with their land. This is in contrast however to farmers in Tasmania, where many landowners believed commercial farm forestry should only be established on land which was marginal for their other agricultural enterprises, although these feelings were not as strongly held in north-east Tasmania (Schirmer 1999). The acceptance to farm forestry could be a reflection of differing views of whether farm forestry is thought as another agricultural crop, as opposed to a non-agricultural crop, or could be due to an increased awareness and knowledge of trees.

Similarly most farmers from the Kent catchment felt that no limit should be imposed on the total area within a shire that can be planted to trees. There were a few respondents who were concerned that there would be a shortage of quality land to grow fat lambs and beef if land continually was planted to trees, and one respondent felt a limit should be imposed to prevent a declining population in the shire from occurring.

One farmer also raised concern that blue gum plantations in the Plantagenet shire were interfering with views of the Porongurup ranges and this would be detrimental to tourism and thus the community. The impact of plantations on visual amenity has also been raised in past studies, such as in Bridgetown-Greenbushes. In this shire, one of the key attractions for new residents was the 'rolling green hills'. There was some concern plantation forestry might degrade the visual amenity of the area, and thereby reduce the prospects for future population growth (Tonts, Campbell and Black 2001).

There were some farmers who felt that positive effects on the community could result from agro forestry. This was by creating employment in different industries as agro forestry grows.

Future planning

Once the timber has been harvested, and if the lease has expired, farmers will need to renegotiate contracts with plantation companies. If the company does not decide to renew the lease, and no other leasor can be found, the landholder may have significant costs with returning the land to a condition suitable for crop and livestock production. Most farmers however had not given much thought in regards to what they would do with the stumps that would be left once the trees were harvested. Removing the stumps from the ground can be an extremely costly exercise, and one that is currently not part of the FPC contract. According to one contractor, removing the stumps and levelling the land can cost approximately \$700/ha. All farmers did not perceive this as a large problem, and many were content to wait till a later time to think about how they would deal with these stumps. The lack of concern seemed to also stem from the wide spacing of these plantations, with a few respondents feeling that after thinning, the 150 stumps/ha would not propose a large problem, and many thought that one option could be to leave them to degrade. Some also viewed that the land that they had planted to trees as land always to remain in trees, and therefore stumps would not be a problem that would need to be overcome. This lack of concern is probably also accountable to the small scale of these plantings, but would likely to become more important if plantings were on a larger scale.

Similarly, most of the farmers that had planted trees in the scheme or pilot program had not considered what they would do with the land once the trees were harvested. Similar to the stumps, some viewed this land always remaining in trees. Other farmers, particularly those that were aged over 30, held the view that in 25 years they would be retired and this would no longer be a problem that they would have to resolve. Another common response was that they would deal with the problem closer to the time. The responses to what they would do with the stumps and the land once harvesting was done reflects the lack of long term strategic thinking inherent in farmers generally.

Factors important to farmers in adoption of agro forestry

A common thread throughout the cases was that farmers were there primarily to use their land for traditional farming. The farmer's preference for the traditional farming lifestyle and his attitude to change was cited by Mattinson, Morrison and Eckersley (1989) as an important consideration

affecting whether or not a farmer will adopt tree farming. It was evident that farmers were worried that they would have little to do if they planted large areas of trees. In many cases, they were reluctant to plant trees due to their sons who were running the cropping enterprise having 'big plans' for this land. The land that is required to grow quality eucalypt sawlogs is also referred to as the farmer's better cropping country, thus the ability to integrate the planting to allow farmers to continue operating the property may be extremely important in the uptake of the project.

For farmers who had not got involved in either the pilot program or the scheme, another factor that inhibited them was the long-term nature of the enterprise. This was a factor inhibiting farmers from being involved with farm forestry in the studies by Curtis and Race (1989) and Schirmer (1999). In the survey by Curtis and Race (1989) 43 percent of the farmers were at a stage in life where farm forestry was too long term. The eucalypt sawlog scheme entails farmers waiting twice as long as growing blue gums before any commercial product is harvested, however the upfront payment allows the farmer to receive the majority of the benefit immediately, therefore it is interesting that the long-term nature is prohibiting farmers being involved. It may be due to an unwillingness to lock the land up for such a long period of time.

This finding is consistent with research undertaken by Mazzarol (1995) that found significant differences between older and younger farmers (e.g. aged under or over 45 years). The older farmers were more likely to be concerned with short-term financial benefits, particularly payments leading to retirement incomes. Younger farmers were more likely to be concerned over the impact agro forestry might have on their capacity to make use of the land for other purposes. These findings have a potential impact on how contracts are structured. A contract of 25-years needs to be designed with farmer needs in mind, particularly inter-generational change within the farming family unit.

Some of the farmers interviewed were involved with the pilot program, but not with the eucalypt scheme this year. Reasons for not being involved included:

- Plantings in the pilot program were undertaken in areas that they were already intending to plant to trees for land care issues, and they were not really interested in agro forestry,
- Felt that 10 ha were too large an area.

A number of the farmers had blue gums surrounding one or more borders of their property. There were mixed responses from these farmers in relation to whether this had a positive or negative impact on their farm and subsequently the uptake of agro forestry. Some perceived this as advantageous, as their neighbour/s were reducing the water table, and reducing their waterlogged areas. Therefore these farmers were receiving external benefits that they were not paying for. They gained a feeling of protection from rising water tables which allowed them to continue traditional farming, which was their preferred enterprise without feeling that they needed to plant trees. In contrast, one farmer viewed having blue gum plantations on their boundaries as having a negative impact due to an increase in vermin and a loss of views.

Farmer views on the current eucalypt sawlog scheme

FPC has put out strict guidelines as to the soil type that they will grow the eucalypt sawlogs on. They have specified higher quality land in comparison to the maritime pines that can be grown on similar rainfall, but on sandier less productive soils. The soil types that were required for the eucalypt sawlog scheme comprised between 30 percent and 75 percent of the farmers land, and

having suitable land was therefore not a limiting factor in their decision as to whether or not they could grow trees. The interviewees did however highly value this land and referred to it as their 'better cropping country', and many were reluctant to see this land go into trees, and would prefer if trees could be grown on waterlogged and less productive areas.

This raises a potential problem for the implementation of the agro forestry scheme. Farmers that wish to maintain flexibility in the use of their land may be reluctant to commit to tree farming for the reasons outlined above. As efficiency of land use improves with greater use of precision farming techniques, farmers may be more unwilling to lock up good land to trees, particularly if these trees offer dubious long-term financial returns.

The current eucalypt scheme pushes for block plantings of 10 ha or greater (minimum width 8 rows or approximately 40 metres). Most farmers were happy with the current design, and felt that the minimum width was appropriate. Alley farming was one design that a few farmers would be interested in having as an option to incorporate trees into their farm.

The upfront payment was viewed by many as favourable to an annuity which had a perceived higher risk associated with it due to the potential for future payments not to be received. This reflects the high uncertainty towards agro forestry, and is not surprising due to many private tree investment companies collapsing recently. Some considered an annuity that was CPI indexed as equally or in some cases a more attractive proposition as an upfront payment. There were two reasons for this. Firstly if you sold the property part way through the eucalypt cycle, the land put to trees was perceived to be worth very little because the buyer had an obligation to keep the trees locked up until harvest, and the value of the clear fell is very questionable. Secondly an upfront payment required you to invest the money wisely. With farmers who were interested in an annuity that was CPI indexed, there were differing opinions on a balloon payment at the end of the harvest. Some farmers again were concerned about receiving the payment, and others saw this as an attractive form of superannuation.

The clear fell price (15% of the value of the clear fell) was generally not influential in farmer's decision to be involved with the scheme. The price that the timber is valued at will be influenced on many factors such as the management of the trees and the marketability of the wood. Therefore this price holds a high proportion of risk. There was a concern by some, that the program may fail, and that anything they receive from the clear fell would be regarded as a bonus. Due to the long-term nature of the scheme there were also some farmers who felt that there would be a good chance that they may not be around at the end to collect the 15 percent clear fell, and therefore was not a major consideration. Some farmers suggested that they would be happier with more money upfront in exchange for less of the clear fell value. This supports the work undertaken by Mazzarol, Sneddon and Soutar (2001), who in their discussions with accountants, lawyers and farm advisors found that there was a strong view held that the best outcome for farmers was to take all the money up front by simply selling the land to the investment company and not worry about long-term contracts. This was due to the uncertainty over future yields and price.

In general the farmers were content with the scheme that had been offered. However there was evidence that farmers have differing needs. As found by Mazzarol (1995) there is likely to be differences depending on certain characteristics of the farmer. For example older farmers may be more likely to want up front cash while younger farmers may want greater flexibility in terms of farm management. The structure of tree farming contracts is likely to be a critical factor in the adoption rate among farmers, as well as their long-term satisfaction with the scheme. Careful

consideration will need to be given to contract structure to ensure the interests of both the farmer (grower) and investor are protected.

The majority of the farmers were happy to have the government as the major partner that they would be involved with in relation to agro forestry. This was generally due to the long term nature of the scheme and therefore the perception that it would be better to be involved with a stable group who would be there in the long term. Private investors on the other hand were not perceived to have the best track record and to be less solid and therefore a higher risk.

Other potential incentives for farmer uptake

Co-operatives allow small-scale growers to join together and attract better prices. There were mixed responses in regards to whether they would be interested in being involved with a grower co-operative. On the one hand, there was the view that within grower co-operatives there were too many people making decisions that led to disagreements, and on the other they could be a marketing advantage and enable a sharing of expertise and resources. However most of the respondents who were interested in a grower-co-operative were farmers who had been involved with the pilot program, and so would need to find a market for their timber in the future.

Becoming a joint venture investor in the future commercialisation of the industry would require farmers to forgo money in the short term, but in the long term provide the farmers with ownership of the industry that would hopefully see their investment grow much like a superannuation fund. When asked if they would be interested in such a scheme, no farmers were showed any interest. Reasons for why they would not be interested were varied and included:

- They saw better alternative investment opportunities, which would return a larger financial gain;
- They were more inclined to use the money to plant trees, than to invest in the program;
- There was a perceived risk of venture falling over;
- They were busy enough without being involved with something else.

Conclusion

It seems that the most important factors influencing the case study farmers in terms of their decision to be involved with planting eucalypts on their farms was financial security, and to allow continued operation of the property for other purposes. These findings are consistent with research undertaken within the blue gum industry during the mid-1990s (Mazzarol 1995).

The other two important factors that Mazzarol (1995) identified as influencing farmers in southwest WA decision to be involved with planting blue gums on their farms were:

- 1) **Long-term benefits** – ability of the farmer to share a proportion of the crop after harvest, obtaining cash bonuses or balloon payments upon harvest
- 2) **Contractual issues** – initial preparation to the property prior to planting, as well as harvesting (e.g. stump removal), plus on-going plantation management over the course of the contract.

These two factors were not important factors in the interviews. The farmers did not place emphasis on long-term benefits of the eucalypts, maybe due to the longer time horizon of the project, and thus the probability of receiving these benefits. For example, while the blue gum

Eucalypt sawlog project

industry was concerned with a crop cycle of between eight and twelve years, this new eucalypt crop cycle is up to 25 years. Initial preparation to the property prior to planting was not discussed, but it was evident that stump removal was not a concern.

FINANCIAL ANALYSIS OF FARMERS INVESTING IN EUCAYLPT SAWLOGS

There is growing recognition that for adoption of farm forestry to occur at the scale required to have a significant impact on land degradation it must have a commercial basis to it that can return a profit. It is well established that landholders base their decision as much as possible on the actual profitability and cash flow consequences of an innovation (Abadi Ghadim and Pannell, 1999; Trapnell, 2001), and one way to evaluate this is through financial modelling.

The most common assessment of farm forestry in the view of farmers has been historically based on the economics of timber revenue compared to existing agricultural enterprises. The farmer's decision to undertake farm forestry or to grow a crop/pasture is mutually exclusive. That is, the decision to accept farm forestry on an area of land will result in crop/pasture income from that land to completely disappear. In this situation, the farmer will rank the projects in order of acceptability. This type of comparison uses discounted cash flow analysis (as has been undertaken for investor's investing in eucalypts), however the non-timber values rarely feature in such analysis. In any economic evaluation of farm forestry it is important to recognise the non-wood benefits that may result. This supports both the literature and the farmer surveys that we conducted in the Upper Kent catchments, which highlighted that in many cases, these other benefits of forestry are considered by landholders to be more important than timber production, and thus can be particularly important in a farmers overall decision as to whether or not to adopt agro forestry.

It is difficult to assign economic value to indirect benefits such as increased biodiversity and environmental impacts; however it is possible to obtain an estimate of other non-woody benefits. Shelter and reduced erosion to nearby crops and livestock enterprises for example can be estimated by the resultant improved yields or stock carrying capacity. A reduction in wind and water erosion, periodic inundation and water logging, and the rate of water recharge into soil profile can all help to improve neighbouring yields. An increased competition for moisture and nutrients and lack of light penetration close to the shelter zone however is detrimental to yields. These temporal and spatial interactions will be important, as tree/crop combinations will only be profitable if the value of tree products and any additional benefits exceed the value of displaced crops and decline in crop yield through competition.

Therefore, for adoption to take place, perceptions of profitability need to be supported by sound data and appropriate financial analysis. Therefore the objective of the following analysis was to compare the relative profitability of the existing eucalyptus agroforestry system with conventional crop and pasture production in the Warren/Tone catchment, and attempt to quantify the yield reductions required for eucalypts to be incorporated into the agricultural system. To do this we used the tool *Imagine*.

IMAGINE modelling

To compare a eucalyptus forestry project with crop/pasture rotations, a bio-economic model (*Imagine*) has been employed. *Imagine* is a business analytical tool that was developed by Don Cooper at CALM and Amir Abadi at Department of Agriculture Western Australian, with joint funding from NHT project. The design of *Imagine* allows it to be used for any annual crop and pasture species as well as any agro forestry or agricultural farming system. By specifying different management strategies for a block of land, it is possible to see how trees may benefit the

farmer, not only in terms of the commercial profits derived from the trees, but also how trees may interact with neighbouring crops and pastures in terms of competition and shelter benefits.

Imagine allows different management strategies for a block of land to be analysed. It is possible to allocate land to any sequence of trees, cropping or livestock enterprises, as well as enabling the alternative land uses to be arranged in alley or block plantation configurations. The project life (evaluation period) can vary from one year to a sequence lasting as long as 50 years.

Analysis

It is assumed that most landholders establishing trees will strategically plant trees to try and achieve agricultural benefits (i.e. to provide shelter for livestock and crops) and to arrest land and water degradation (i.e. reduce soil erosion, reduce salinity and improve water quality).

The following farmer analysis was based on the Warren/Tone catchment, and inputs for the pasture and crops were sourced from John Young, a local farmer and agricultural financial analyst in the area. It was assumed that a farmer has a paddock situated on a slope. Up slope the land has soil characteristics synonymous with those required for growing eucalypt sawlogs that FPC have outlined. It is assumed that the current rotation that is being undertaken upslope consists of five years pasture, followed by canola and wheat (5PCW). Down slope the land is used for grazing (pasture). The upslope and down slope paddocks are also assumed to be equal sizes.

The first part of the analysis investigates the relative profitability of establishing eucalypts compared to receiving a lease annuity and a share of the final harvest. The assumptions made for farmers establishing the eucalypts are identical to those assumed for the most likely values used in the investor analysis (section 4), except the management fee and the annual management costs are not incurred.

The second part of the analysis compares the relative profitability of growing trees versus growing the pasture crop rotation (5PCW) upslope. The analysis then investigates the potential benefits that may arise from planting the eucalypt trees upslope, and the effect that these benefits may have on the decision to adopt agro forestry. This is investigated by assuming that if you continue the present rotation (5PCW) that land down slope over time will become less productive due to salinity, waterlogging, erosion etc., thus over time will slowly hold a lower stocking rate. It is assumed that if a eucalypt plantation is established upslope, the productivity of the land down slope is maintained. The rate at which the land become less productive over time, is investigated by calculating the reduction in yield per year down slope (DSE/ha) that is required for the eucalypt/pasture split paddock (trees upslope and pasture down slope) to be as equally profitable as the 5PCW rotation upslope and pasture down slope. The two scenarios are illustrated in figure 14.

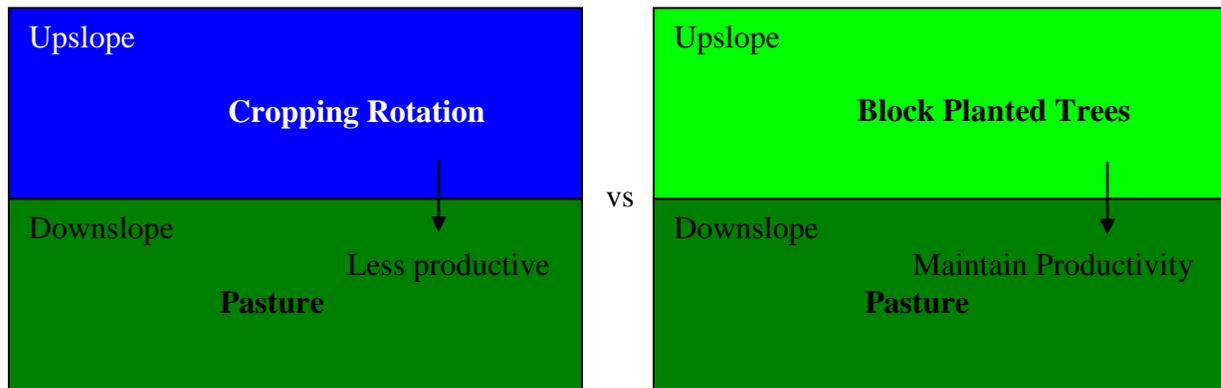


Figure 14: The two scenarios used in assessing profitability of cropping or block planted eucalypt plantations, illustrating their effect on productivity of down slope pasture.

Sensitivity analysis was used to assess the robustness of the findings to the assumptions made. This was tested by a sensitivity of results to a range of wool prices, eucalypt yields and stumpage prices. Wool prices were altered 30 percent above and below the expected price (\$5.50/kg), to give a wool price ranging from \$3.80/kg to \$7.00/kg. Eucalypt sawlog growth rates and stumpage prices were also altered to reflect the pessimistic and optimistic estimated values that were used in section 4 (financial analysis of investors investing in the eucalypt sawlog industry).

Assumptions made in the analysis

Inputs, Yields and Prices

Eucalyptus plantations

For farmers establishing the eucalyptus plantation, establishment costs, yields ($\text{m}^3/\text{ha}/\text{yr}$) and stumpage prices ($\$/\text{m}^3$) used were identical to the most likely values used in section 4 (financial analysis of investors investing in the eucalypt sawlog industry). Carbon credits were assumed to be worth \$72/hectare. For farmers involved in a lease joint venture, it is assumed that they receive an annuity of \$120/hectare/year and a 15 percent share of the final harvest, based on the most likely growth rate and stumpage price, as described in section 4.

Pasture

Pasture inputs were sourced from John Young. The pasture is assumed to be predominantly sub clover, with some volunteer annual grasses and capeweed also being present. The income per DSE (Dry sheep equivalent) is assumed to be \$24/DSE, at a stocking rate of 11DSE/ha (calculations are shown in [Appendix](#)).

Crops

Crop inputs, yields and prices for canola and what were sourced from John Young and are shown in detail in [Appendix](#).

Project Life

The following analysis assumes a time period of 21 years (minimum time required for one rotation of eucalypt trees).

Discount Rate

A real discount rate of 7 percent was used in the analysis.

Results

Based on the estimates collected for establishing, maintaining and harvesting eucalypts, and using a real discount rate of 7 percent, farmers would be financially better off, taking an annuity of \$120/hectare/year (equivalent to an upfront payment of \$1100/ha) in comparison to establishing the eucalypts themselves in all situations except if optimistic growth rates and prices result (table 10). If optimistic growth rates and prices result, then farmers could potentially earn 24 and 63 percent more (depending if carbon credits are included or not), in comparison to receiving the current \$120/hectare annuity. Establishing the eucalypts at most likely estimates gives a real IRR of 8.1 percent and 10.45 percent when carbon credits are included. These are much higher than for the investor scenario, due to a management fee, annual management costs and annual lease payments not being incurred.

The NPV calculated in this report is significantly less than a previous analysis done by Moore (2002) who concluded that growing *E. saligna* in the medium rainfall zone for sawlogs (no carbon credits) over a 20-year time period would provide a NPV of \$521/hectare at a 7 percent discount rate (presumably a real discount rate). However this difference can largely be explained by Moore's (2002) total costs being \$925/hectare less than the present study, and the incorporation of grazing revenues during the first 10 years.

Table 10: Comparison of the net present value received at pessimistic, most likely and optimistic growth rates and prices, using a real discount rate of 7 percent assuming, (i) the farmer receives an annuity and percentage of the cropshare, (ii) the farmer establishes the eucalypt plantation and receives no carbon credits and (iii) the farmer establishes the eucalypt plantation and receives carbon credits.

	Eucalypt growth and price		
	Pessimistic	Most Likely	Optimistic
Lease annuity	138	163	194
No annuity	-126	37	241
No annuity plus carbon credit	-52	112	316

The present analysis assumed a real discount rate of 7 percent for both scenarios, and a much higher discount rate should be assumed for the scenario when farmers are establishing the eucalypts themselves, as they are taking on a much higher risk in comparison to receiving a lease annuity. Therefore, the \$47/hectare profit at optimistic growth rates and stumpage prices, without carbon credits, from establishing the eucalypts would most likely be eliminated once this is accounted for.

The annuity in effect is subsidising the farmers to plant trees at most likely and pessimistic values. At these growth rates and prices, by assuming that the farmers can receive \$120/hectare/year, the government in effect is giving a subsidy, which makes it more profitable for farmers to take the annuity than establish the trees themselves.

Even if establishing the eucalypts were to be more profitable than receiving a lease annuity, adoption may still be hindered due to farmers preferring a regular income to a lump sum in a future date. As shown in figure 15, even when the project delivers a substantial NPV, the farmer needs to be able to survive without this income till harvest occurs. Commonly projects that do have higher profitability than conventional agricultural practices are rejected on the basis of unsustainably high peak debt. Often, there are also projects whose payback period is further than what a farmer (investor) can bear. Farmers generally look for land management practices that return moderate profits with short payback periods (Trapnell, 2001). Therefore, it would be recommended that research be undertaken into potential thinning markets to reduce this payback period to a more acceptable length of time.

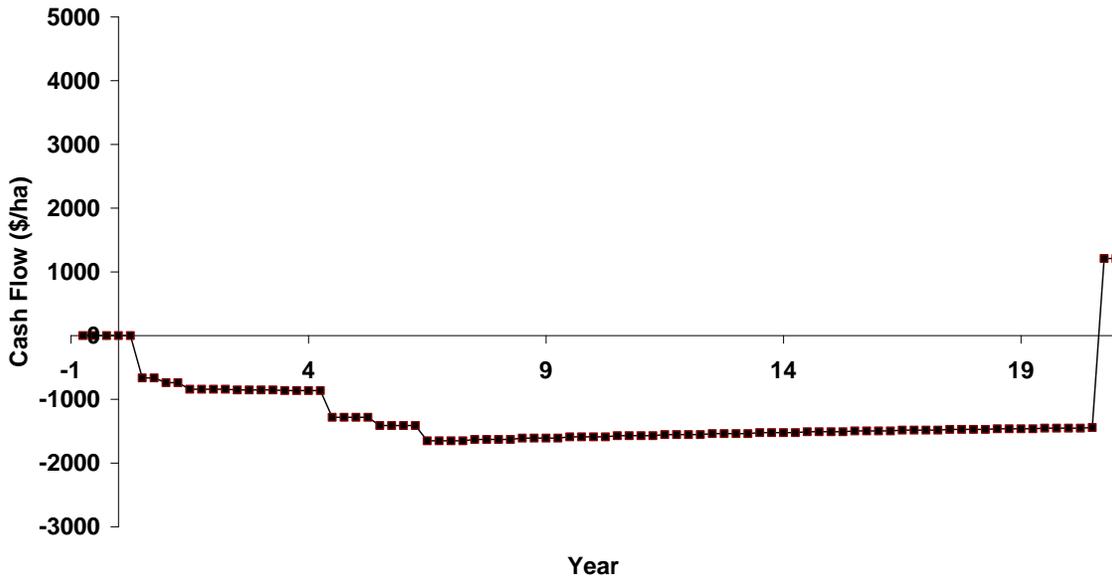


Figure 15: Discounted cash flows for a farmer establishing trees on 100 ha, assuming optimistic values, with carbon credits.

Analysis based on comparison of growing a eucalyptus plantation with a pasture/crop rotation, shows that in all situations the pasture/crop rotation is more profitable than receiving an annuity and a share of the harvest of the eucalyptus plantation (Table 11). Wool prices would need to drop such that the profit from each DSE is approximately \$17 for Eucalyptus plantations to be equally profitable at optimistic growth rates and prices. In addition, no cost has been factored in for returning the land back to a state that could be used for cropping (de-stumping and levelling costs), and this would further add significant costs. Therefore, analysis based exclusively on comparison of growing eucalypts with a pasture/crop rotation, shows it is unlikely that farmers would switch from the current land use into agro forestry.

Table 11: Comparison of a pasture/crop rotation (PPPPCW) net present value at three wool prices, and eucalyptus plantation gross margin at pessimistic, most likely and optimistic growth rates and stumpage prices.

Net Present value (\$/ha)	Wool Price		
	Low wool price (\$18/DSE)	Medium wool price (\$25/DSE)	High wool price (\$31.50/DSE)
	208	267	321

Net Present value (\$/ha)	Eucalypt growth and price		
	Pessimistic	Most Likely	Optimistic
	138	163	194

The potential for eucalyptus plantations to be incorporated into the farming system is much more attractive if additional benefits from growing trees are included in the analysis. If we were to assume that no decline in productivity would result down slope, then in no circumstance outlined in Table 12, is receiving an annuity to grow eucalypts upslope and pasture down slope more profitable than growing the pasture/crop rotation upslope and pasture down slope.

However it is assumed that by growing the current rotation upslope that land degradation down slope would occur in the future, leading to reduced pasture productivity. Table 12 shows the decrease in pasture productivity down slope per year (the percent shown in brackets) that would be required to occur over the next 21 years, for the eucalypt plantation to be as profitable as the 5PCW rotation.

Table 12a: Net present value (\$/ha) for a split paddock comprising of a eucalyptus plantation upslope, and pasture down slope. Eucalyptus plantation growth rates and stumpage prices are at pessimistic, most likely and optimistic values, and pasture is at three wool prices, discounted at 7 percent real. Numbers in brackets indicate the percent in pasture yield reduction down slope required for the eucalypt/pasture split paddock to be equally profitable as the net present value (\$/ha) for a split paddock comprising of a pasture/crop rotation (PPPPCW) upslope and pasture downslope (12b).

Eucalypt growth and price	Wool Price		
	Low wool price (\$18/DSE)	Medium wool price (\$25/DSE)	High wool price (\$31.50/DSE)
Pessimistic	\$152/ha (5%)	\$192/ha (8%)	\$223/ha (11%)
Most Likely	\$164/ha (3%)	\$204/ha (6%)	\$241/ha (8%)
Optimistic	\$179/ha (0.5%)	\$219/ha (3.5%)	\$256/ha (6%)

Table 12b: Net Present value (\$/ha) for a split paddock comprising of a pasture/crop rotation (PPPPCW) upslope and pasture downslope at three wool prices discounted at 7 percent real.

Wool Price		
Low wool price	Medium wool price	High wool price
\$182/ha	\$250/ha	\$313/ha

If medium or high wool prices occur over the next 21 years, then productivity down slope needs to reduce by between 3.5 and 11 percent (depending on the assumed yield and price of eucalypts) for their to be any financial benefit to the farmer. However if wool prices are low over the next 21 years, then productivity down slope needs only to reduce by between 0.5 and 5 percent for the eucalyptus plantation to be equally profitable to growing a pasture/crop rotation upslope. This assessment has not included grazing returns that could be attained from grazing between the eucalypts, and this could add significant value, and thus reduce the land productivity required to make a farmer grow eucalypts.

CONCLUSION AND RECOMMENDATIONS

While market demand for hardwood sawlog and veneer timber is difficult to forecast over the time horizon of 30 years set for this project, existing estimates suggest that the industry has a future. The establishment of a new agro forestry industry located in the medium rainfall zones of Western Australia offers significant economic, environmental and social benefits to the state. Cultivation of hardwood eucalypt plantations within the wheat belt has the potential to enhance the management of salinity, control erosion and offer additional benefits to stock husbandry. Such an industry also offers farmers an opportunity to diversify their income and smooth out their cash flows. Over the long term this industry would offer WA a chance to further widen its economic base and create additional employment opportunities in regional and rural areas.

Despite the positive benefits accruing from this new industry its potential to develop is likely to hinge on decisions made within the State Government in relation to how the industry is financed. The financial modelling undertaken in this study suggests that the industry is unlikely to be attractive to private sector investors. Unlike the blue gum industry in the higher rainfall zones of the state, the long growing cycle of the new hardwood species, and the risks associated with establishing the plantations and managing them through the first six years make the rates of return unviable. Greenhouse gas credits may enhance this proposition for certain types of investor, but the uncertainty over Australia's decision to sign the Kyoto Protocol is likely to reduce the number of such investors in the medium term.

Critical decisions for the Government

It has been the stated aim of the government to develop this new industry on an economically self-sustaining basis by attracting private sector investment. As discussed above, in its current configuration this industry does not appear to offer attractive returns for such investors. The State Government may need to consider absorbing the establishment costs for this industry over the first perhaps six years so as to make the deal more acceptable to the private investor. This is likely to be a fundamental decision for the government. Although the cost to the public purse will be high in the short term, this must be weighted against the longer-term environmental, social and economic benefits.

- **Recommendation – that consideration be given to the government carrying the establishment costs of the new industry and subsequently transferring title to private investors through deal structures that provide attractive investment opportunities**

Farmers are likely to derive both economic and environmental benefits from engaging in agro forestry, however the establishment and growth this industry will be contingent on the speed within which farmers adopt the new crop. Although the majority of farmers are likely to appreciate the benefits of agro forestry it is far from certain that sufficient numbers will be willing to participate in the industry. The history of the blue gum industry in WA shows that farmers are likely to respond to agro forestry in different ways depending on their circumstances. When faced with low returns for other crops or perhaps pasture for wool production the offer of upfront cash payments or regular annuities will be attractive. However, the long-term growth cycle of this hardwood eucalypt crop is likely to raise particular issues about how much land is put under plantation, and the security of the partner financing the deal. The structure of agro forestry contracts and the assurance provided by the government to the viability of the scheme are likely

to be crucial factors in securing farmer participation. For the more strategic farmer the capacity to retain flexibility in their farm asset and switch land use to take advantage of different commodity prices over the 25 years of the growing cycle is also likely to be a key consideration.

- **Recommendation – that further attention be given to the design of contracts to determine the most appropriate deal structures for farmers**

As identified in this study, farmers are likely to be reassured of engaging in this industry if government supports the management infrastructure. The experience of the blue gum industry over the past decade has provided examples of the difficulties that can beset agro forestry, with social, environmental and financial problems emerging in varying degrees. There is little reason to believe that this new industry would not face similar challenges. However, the advantages it has is that it can learn from the mistakes of others and seek to avoid repeating such actions through careful planning.

On a strategic level the planning horizon for this industry is essentially 50 years. This assumes a 20-30 year growing cycle for the first crop rotation, and a further 20-25 years for a second crop rotation. This length of planning horizon will require the establishment of an industry management infrastructure that is sufficiently stable that it can remain secure from three-year political cycles and subsequent changes in public policy. Even if the government is required to carry the establishment costs of this industry it must develop an exit strategy that enables it to sell down its equity in the industry to private investors. Consideration will need to be given to the formation of appropriate managerial structures with the capacity to undertake commercial risk projects, and deal with the complex issues associated with establishing and maintaining long-term contracts with both farmer/growers and subsequently private sector investors.

- **Recommendation – that consideration be given to determining the most appropriate management structure for the new industry, including:**
 - **The establishment of a new entity with the capacity to undertake commercial risk and**
 - **To remain stable for a period of approximate 50 years**

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2 APPENDICES

2.1 Appendix A – Beta coefficients

Company Name	Beta
Gunns limited	1.02
Auspine limited	0.85
Timbercorp	3.98
Great southern plantations	3.51
Evergreen forests	-0.1
Forest enterprises	2.63
Average	1.98

Source: AGSM 2002.

2.2 Appendix B – Differences in most likely Eucalypt estimates

Most Likely estimates for inputs used in this analysis compared to BIS Shrapnel analysis

	Current	BIS Shrapnell	Difference
Stumpage price (first harvest) - \$/m ³	60	60	0
Mean Annual Increment - (m ³ /ha/yr)	9	9	0
Establishment costs \$/ha (all year 0)			
Fencing & rabbit control	75	18	-57
Ripping and mounding	120	105	-15
Weed control	65	44	-21
Seedlings	315	195	-120
Planting @ 1000 stems/ha (5x2)	105	80	-25
Fertiliser	80	83.5	3.5
Insect control	80	50	-30
Operational costs \$/ha			
Parrot control (years, 0,1,2,3,4)	50	20	-30
Post plant weed control (year 1)	60	96.5	36.5
Infill Planting (year 1)	40	0	-40
Culling 700spha (year 4)	280	140	-140
Culling 120spha (year 6)	75	75	0
Pruning 300spha (year 4)	210	180	-30
Pruning 180spha (year 5)	225	165	-60
Pruning 180spha (year 6)	270	270	0
Coppice control (year 4)	60	25	-35
Coppice control (year 6)	40	20	-20
Heaping debris (year 4)	5	5	0
Heaping debris (year 6)	15	15	0
Annual management (every year after year 0)	40	75	35
Annual maintenance (every year after year 0)	35	41	6

Note: BIS Shrapnel's estimates were based on a planting of 625 stems/ha. This can help explain differences in seedling and planting establishment costs, as well as pruning, coppice and culling cost differences.

2.3 Appendix ? - Crop inputs, yields and prices

Canola sowing and harvesting costs (\$/ha)

	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Insect control + application		36.19		
Weed control + application		39.63		
Fertiliser		83.16		
Cost of seed (including dressing/cleaning/etc.		12		
Inoculum		0		
Insurance	4.85			
Seeding machinery costs		20.99		
Labour		11.25		
Finance		7		
Testing		2		
Swathing				18.5
Harvest Machinery costs				42.5

Products

	Price	Yield
Grain	\$350 t/ha	1.4t/ha
Stubble	\$15t/ha	3t/ha

Time	Expected
Yield change/yr	0.05%
Price change/yr	-0.01%
Cost change/yr	0.02%

Wheat sowing and harvesting costs (\$/ha)

	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
Insect control + application		4.11		
Weed control + application		29		
Fertiliser		110		
Cost of seed (including dressing/cleaning/etc.)		12.11		
Inoculum		0		
Insurance	4.64			
Seeding machinery costs		28.78		
Labour		11.25		
Finance		7		
Testing		2		
Harvest Machinery costs				16.74

Products

	Price	Yield
Grain	\$175 t/ha	3.25t/ha
Stubble	\$15t/ha	4t/ha

Time	Expected
Yield change/yr	0.05%
Price change/yr	-0.01%
Cost change/yr	0.02%

2.4 Appendix ? – Pasture inputs, yields and prices

Husbandry				Husbandry Programme Summary					
				Ewes	Lambs	Hgts	Wethers	Ram Hgts	Rams MA
Shearing		3.20	/hd	1		1	1	2	2
Crutching	contract	0.65	/hd	1		1	1	1	1
Drenching	Ivomec/Comb	0.0045	/kg	65	60	65	70	65	90
Vacc	3 in 1	0.128	/hd	1	2	1	1	1	1
Tag		0.22	/hd		1				
Mules		0.65	/hd		1				
Dip		0.50	/hd	0.33	0.33	0.33	0.33	0.33	0.33
Interest		9.00	%						
Labour		20.00	/hr					0	
Grain		0.20	/kg	15	10	15	8	30	60
Cost				7.44	3.56	7.44	6.06	18.21	19.75
Lambing month		8							

	DSE/hd	S.R. hd/ha	Lamb %	Death rate	CFA Cull %	Husbandry Programme	cost	Ram %
Ewe Lamb				5%		2	3.56	
Ewe Hgt	1.0	11.0		5%		3	7.44	
Ewe 2yo	1.5	7.3	70%	5%	10%	1	7.44	2.50%
Ewe 3yo	1.5	7.3	90%	5%	10%	1	7.44	1.50%
Ewe 4yo	1.5	7.3	90%	5%	15%	1	7.44	1.50%
Ewe 5yo	1.5	7.3	90%	5%	50%	1	7.44	1.50%
Ewe 6yo	1.5	7.3	90%	7%	100%	1	7.44	1.50%
Weth Lamb		0.0		5%		2	3.56	
Weth Hgt	1.0	11.0		5%	100%	3	7.44	
Weth 2yo	1.0	11.0		3%		4	6.06	
Weth 3yo	1.0	11.0		3%		4	6.06	
Weth 4yo	1.0	11.0		3%		4	6.06	
Weth 5yo	1.0	11.0		3%		4	6.06	
Weth 6yo	1.0	11.0		5%		4	6.06	
Ram Lamb		0.0		5%		2	3.56	
Ram Hgt	1.2	9.2		5%		5	18.21	
Ram MA	2.0	5.5		5%	33%	6	19.75	

Eucalypt sawlog project

	Shear Month	Months growth	Wool cut Greasy	FD	\$/kg	Wool value \$	\$/hd	Sale price	Purchase price Ram
Ewe Lamb		0.00					0.00		
Ewe Hgt	10	14.0	4.8	18.5	6.88	6.88	33.00	35.00	
Ewe 2yo	12	14	5.7	20.0	5.63	5.63	32.06	32.00	
Ewe 3yo	1	13	5.2	21.2	5.00	5.00	26.00	32.00	
Ewe 4yo	1	12	5.0	21.2	5.00	5.00	25.00	32.00	
Ewe 5yo	1	12	5.0	21.2	5.00	5.00	25.00	32.00	
Ewe 6yo	1	12	5.0	21.2	5.00	5.00	25.00	30.00	
Weth Lamb		0.00					0.00		
Weth Hgt	10	14.0	5.1	18.5	6.88	6.88	35.06	35.00	
Weth 2yo	12	14	6.0	20.0	5.63	5.63	33.75	35.00	
Weth 3yo	1	13	5.5	21.2	5.00	5.00	27.50	35.00	
Weth 4yo	1	12	5.3	21.2	5.00	5.00	26.50	35.00	
Weth 5yo	1	12	5.3	21.2	5.00	5.00	26.50	35.00	
Weth 6yo	1	12	5.3	21.2	5.00	5.00	26.50	35.00	
Ram Lamb	12	4.00	1.1		5.00	5.00	5.50	30%	
Ram Hgt	10	10.0	3.7	18.0	7.08	7.08	26.18	400.00	156.67
Ram MA	10	12	6.5	22.0	4.75	4.75	30.88	35.00	400

Eucalypt sawlog project

	Start Number	Births	Deaths	Sales	Purchases	End Number	DSE	Wool Value	Sale Income	Husbandry	Purchases	G.M.	G.M./DSE
Ewe Lamb		1456	73	0		1383	0	0	0	4926	0	-4926	
Ewe Hgt	1383		69	314		1000	1383	43349	10976	9770	0	44556	
Ewe 2yo	1000		50	95		855	1500	30459	3040	7065	0	26434	
Ewe 3yo	855		43	81		731	1283	21119	2599	6041	0	17677	
Ewe 4yo	731		37	104		590	1097	17362	3333	5165	0	15530	
Ewe 5yo	590		30	280		280	885	14020	8973	4171	0	18822	
Ewe 6yo	280		20	261		0	421	6519	7823	1939	0	12403	
Weth Lamb		1456	73	0		1383	0	0	0	4926	0	-4926	
Weth Hgt	1383		69	1314		0	1383	46058	45976	9770	0	82265	
Weth 2yo	0		0	0		0	0	0	0	0	0	0	
Weth 3yo	0		0	0		0	0	0	0	0	0	0	
Weth 4yo	0		0	0		0	0	0	0	0	0	0	
Weth 5yo	0		0	0		0	0	0	0	0	0	0	
Weth 6yo	0		0	0		0	0	0	0	0	0	0	
Ram Lamb			0	0		0	0	0	0	0	0	0	
Ram Hgt	0		0	0		0	0	0	0	0	0	0	
Ram MA	62		3	19	22	62	124	2508	679	1604	8993	-7411	
Total	6284						8074	181395	83400	55377	8993	200424	\$ 24.82
Area							734	\$ 247.12	\$ 113.62	\$ 75.44	\$ 12.25	\$ 273.05	
MA Ewes	3457												

Appendix ??: Spatial Interactions

Yield interactions		
W-H Competition width (tree heights)	1	1 tree height
W-H Competition factor	0.5	Multiplier to yield for that zone (yield reduced by 50% of open paddock)
W-H Shelter width	2	2 tree heights
W-H Shelter factor	0.03	Multiplier to yield for that zone (yield increased by 3% of open paddock)

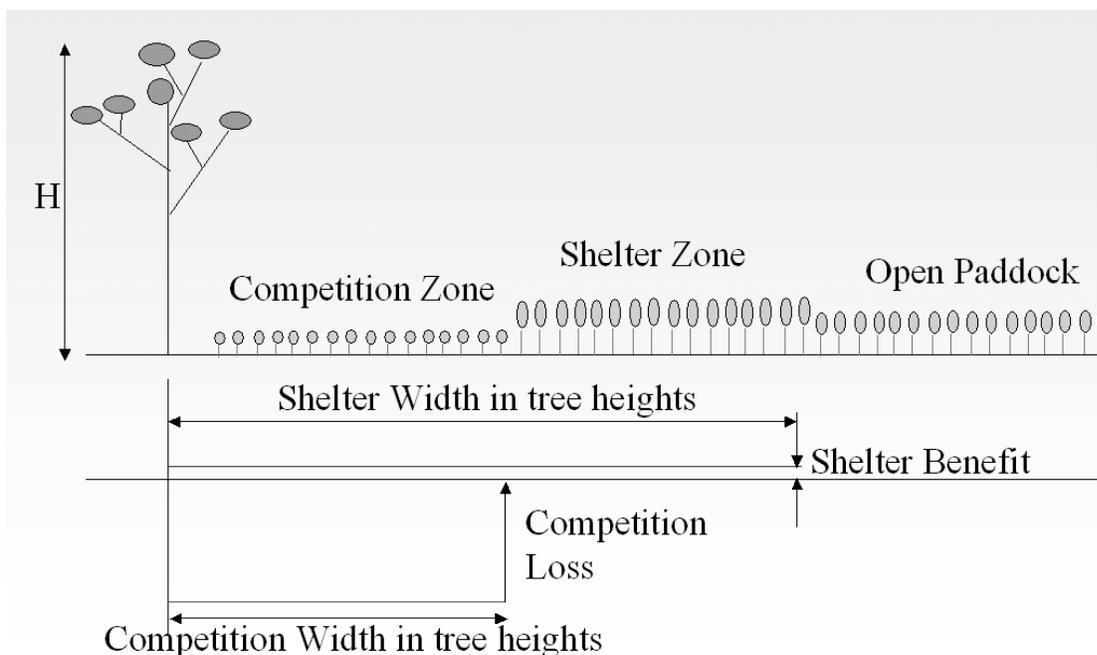


Figure ?. Shelter and competition effect of trees on crops and pastures as modelled in *Imagine*.

