Trees: an investment for the future

Proceedings of

A seminar on
commercial tree growing
in the
Albany and Mount Barker area

Friday 5 July 1991
Dymesbury Lodge, Albany

Department of Conservation and Land Management
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The paper *'CALM AND COMMERCIAL TREE GROWING'* presented by Dr Syd Shea at this seminar is not represented in these Proceedings. It is a separate publication, *Plantation Forestry in Western Australia: Achievements and Prospects,* available from the Dept of Conservation and Land Management.

WHY TREES ?

Alex Campbell, The WA Farmers Federation

Australia is a young country. We have only just completed our development phase, taming a hostile environment, clearing the land and developing an infrastructure that befits a developed economy. It is a natural time in history to now look back at our development phase and take stock of our achievements and to rectify mistakes that have been made.

Australia in general, and agriculture in particular, are now entering what I term the "consolidation phase." The heady days of rapid expansion are over and all sectors of the community are coming to terms with the realities of being world-competitive, in order to maintain our living standards.

Agriculture is assessing both the economics of our traditional exports, as well as coming to terms with the problems of various types of land degradation that have arisen as a result of large scale clearing and use of annual crops and pastures.

For these reasons, the time is right for diversification into timber production.

Let us first look at the macro-economic situation. The Australian agricultural export production totals $16b, the major commodities of grains, meat and wool from broad acre production accounting for $11.5b. These products are competing on world markets that are under threat of over supply and suffering manipulation by the major trading powers of the European Economic Community, United States of America and Japan.

On the other hand, Australia is a net importer of timber products in the order of $2b. Nations in South America, Africa and even Portugal in Europe are exploiting our native eucalypts successfully on world markets, while we are still vast net importers of timber products.

An obvious first target is to be self-sufficient as a nation. A second target must be to achieve a net export status, so that our broad acre exports are further diversified and less reliant on annual crops and grazing pursuits.

The micro economic image reflects the above points, when looked at on a farm enterprise basis. The traditional farming practise in the 600 m and higher rainfall area is very largely grazing of sheep and cattle, with some cropping and some intensive horticultural production.

For example, the combined production from the Shires of Albany and Plantagenet (Mt Barker) in order of value are: wool $82m, meat (beef and sheep) $24m, and broadacre cropping $17m. These figures are for 88/89, the most recent Australian Bureau of Statistics' data available. Anticipated wool returns for calendar year 1990 will see the wool return at between 40 and $45m.

It can be seen that a sharp decline in wool, as occurred in 1990 and beef in the late 70s has a dramatic impact on a farm business.

Farmers are looking to diversify, but have capital constraints that influence their decisions.

The other imperatives influencing farm decisions are the environmental issues. Rising water tables with the associated problems of waterlogging and salinity, gully and sheet erosion, the need for shade and shelter as remnant vegetation declines, wind erosion and down stream eutrophication are points in question, and the subject of a further paper.

The CSIRO has shown in experimental work that farm production from traditional grazing and cropping actually increases as a farm is selectively planted to tress to an optimum ratio of about 15 to 20%. The Lynch family of Mt Barker, winners of the 1990 Land Manager of the Year Award, have demonstrated similar trends in this area. In other words, production from judicious timber planting in the order of 15 per cent to 20 per cent of a farm are of a bonus nature above normal production.

Total freehold land area in the two Shires of Albany and Mt Barker total 870 000 ha, of which 771 000 ha are cleared. This would indicate an immediate opportunity of between 3 000 and 7 500 ha of timber planting in these shires, assuming all uncleared land comprised viable remnant vegetation worthy of protection. Recent work would indicate that areas of remnant vegetation under 5 ha are non-viable in the long term. These areas comprise the typical shade and shelter belts on farms, and as they decline will need replacing with planted strips. The New Zealand experience demonstrates that shelter strips are a viable farm commercial timber resource, when planted on a rotational basis. This form of planting will add further to the immediate opportunity figures just quoted.

For farmers to then achieve a balanced diversification on the remaining 670 000 hectares of wool, meat and cropping production, it would indicate a further potential of some 160 000 hectares of timber planting.

You will note that all references have been based on an integrated farm system, as opposed to more traditional concepts of large scale forest plantings on block formations of boundary to boundary plantings.

Let us study the two alternatives.

The first, as I have described, addresses the macro needs of the nation, allows farmers to diversify, helps to reverse aspects of land degradation, whilst being an unobtrusive mosaic through the landscape. Local communities benefit in the establishment phase and in the production phase by job creation and business opportunities. The challenge of this concept is in the finance and management areas so that security of investment and production can be assured.

The other alternative is for farms to be bought up for the sole purpose of timber production, with concentrated mono-culture plantings.

The benefits are ease of management and security of tenure, while also addressing the macro needs of the nation. The down sides are the capital tied up in land ownership dedicated to a single form of production, risks of disease and fire relating to concentrated plantings, the invasive nature of these plantations to the environment and the lost opportunity of correcting district-based land degradation needs.

The challenge for this seminar will be to explore ways in which the first preferred option can be brought to fruition.

The farming community has the challenge of adopting a new system or concept of farming. It can be compared to the trace element and clover rotation revolution of the 1950s. When research work identified these new opportunities, some innovative farmers put the research into practise, the benefits became obvious and was then adopted on a massive and successful scale. On-farm timber production is now at the stage of being adopted by innovative farmers, the rest are looking on with interest. I predict farmers will also adopt this concept with the same vigour as they did with trace-elements and clover lay farming in the 1950s.

The business community has the challenge of creating investment packages that provide the capital to facilitate this development, while guaranteeing security and a profitable return to those institutions and individuals who will invest in this area.

Foresters and plantation managers will have the challenge of keeping pace with such a diversified development, and will need to work closely with other disciplines to ensure that maximum benefit is derived from areas planted to trees.

Government will need to be pro-active in encouraging this new development. Federal governments must guarantee open export licences for plantation chip and wood products derived from private land production. They must ensure that the tax system is at least neutral when comparing a long rotation crop to a series of annual crops. On-processing into pulp and manufactured products must be supported, rather than stifled.

State governments must address the transport and export needs of this new industry. Roads, rail and ports have to be progressively upgraded to cater for the new production. These issues will be taken up by other speakers during the day.

Why Trees ?

Because the time is right!

EXPECTED BENEFITS OF TREES AND TREE SHELTER IN AGRICULTURE

David Bicknell, Department of Agriculture, Esperance

* Reduction in mechanical damage to pasture and crop plants. This damage has not been extensively quantified (except in horticulture), but is thought to be common on exposed pastures and some crops. 'Bruising', splitting of stem and leaf material, and removal of the waxy cuticle have been documented.
Protection should lead to production increases, even where sandblasting does not occur.

* Reduced evaporative demand. Slowing windspeed reduces evaporation and leaves more soil moisture available for photosynthetic activity. Under some conditions this will lead to increased water usage, reflected in greater production.
Higher humidity in the canopy will also favour increased production.

* Livestock shelter. The effect of cold winds, with or without rain, has been extensively monitored and researched in Australia. The most obvious instances of gains from shelter are for off-shears sheep, and recently born lambs.
Other expected gains, more difficult to quantify in the field, are from modifying microclimatic effects on energy demands of livestock. Most of this work relates to the effect of cold. Changes in 'social' and grazing behaviour of sheep in relation to shelter has been observed and researched.

* Control of wind erosion. This is an obvious, but apparently poorly understood benefit from reducing windspeed with trees.
The design principles have been widely researched, but the field design is less well understood.
The benefits come from preventing sand blasting, preventing the loss of topsoil containing valuable nutrients, and the costs associated with soil accumulating where it isn't wanted and being removed from where it is wanted.

* Improved management conditions. Lower windspeeds will usually allow more days suitable for spraying, and improved operator conditions to work in. Stopping dust and grit entering the house is usually a high priority !

* Salinity, watertable control and waterlogging control. Trees in windbreaks and other configurations will use more water than the pastures they replace. This is particularly so near swamps and sumps, saline areas, drainage lines, and seeps. These discharge areas are often suited to growing trees, although tolerance to waterlogging and salt concentration must be considered.

On clearly defined 'intake' areas, trees are very suited to prevent recharge.

* Improvement of soil structure. In particular areas, the use of edible shrubs, deeper rooted crops, perennial pastures and trees, will allow easier water flow into the subsoil. They are also likely to increase soil organic matter, water table aggregates and macrofaunal populations.
  Alley farming with deep rooted shrub species has been suggested as one way of preventing soil structure decline. Trees in windbreaks or timber-belts are suited to this system in the higher rainfall areas. A few farmers in the agricultural region of WA are trying forms of this system, but not primarily for improvement of soil structure.

* Tree and shrub products. Secondary products can increase the value of farm tree plantings. The type of product will be determined by the environment and the management demands on the farmer.
  Examples of secondary products are:
  sawlogs;
  poles and posts;
  fuel wood;
  fodder;
  honey, oil, and flowers

* Nature conservation and its positive interaction with agriculture. There are many values in maintaining biological diversity that have not been expressed in dollar terms (yet!). Remnant vegetation can also have a direct value to agriculture by providing shelter, high water use *etc.*
  Revegetation on cleared agricultural land can protect, improve and help regenerate nature conservation values while making use of the remaining vegetation. The soils under remnant vegetation are a good indicator of the conditions before clearing, and can be used to gauge the success of land and soil conservation activities.

WHY TREES?

Proven track record

Trees for windbreaks and shelterbelts have been used and reported on for many decades. Most of the literature is from Europe, the United Kingdom, and the United States of America.

Farmer experience with windbreaks for livestock shelter, erosion control, horticultural protection and so on, is very extensive.

Historically, trees have been used for revegetating saline areas and lowering water-tables. Recent interest in Western Australia, and Australia generally, has been well documented.

Low running costs

After establishment, most tree systems do not require separate fertilizer, watering or protective spraying. In some cases, management of the trees for saleable products will increase the 'running' costs.

Low maintenance

Trees should be selected for their suitability to the conditions they are planted in. Selection based on soil, moisture and other conditions will give a hardy tree.

Multi-purpose

Trees can give shelter, use more water, reduce windspeed, and produce saleable products *at the same time.* There is usually a primary consideration for planting trees, but the secondary benefits should also be accounted for.

Long life

Most of the trees recommended for on-farm planting will have a useful life of greater than 20 years. For some uses, lives of greater than 40 years are possible. These life times equate with those expected of soil conservation earthworks, fencing, and, in many cases, the farmer's working life on a given property.

Work 'independently' of annual management decisions and weather changes

Because of their long life, trees will continue to do their job, independent of annual changes. For instance, windbreaks give their *best* result during drought years, conditions of strong wind, over-grazing and so-on. Management that depends on annual decisions may go wrong through no fault of the operator.

Reduction of erosion by stubble retention, reduced grazing pressure, and direct seeding of crops may work in most seasons. However, late breaks to the season, dry and strong winds at critical times, and very poor livestock prices, can lead to conditions causing erosion. Trees will be in place to safeguard against these circumstances.

INTEGRATING TREES INTO A FARM AND CATCHMENT PLAN

All tree planting on farms should be as part of a farm plan. Ideally, all farm plans should be part of a catchment or district plan.

The approach used for farm planning will also suit tree planting, that is:

* map physical and long-term, man-made features (drainage lines, rock outcrops, power lines, roads, etc.);
* map soil types/landforms and risk factors (internal drainage, slope, salt, watertable, erodibility, etc.);
* draw in management units with proposed land use (or rotational management units for more accuracy), and proposed fencing;
* determine optimal areas for tree planting: windbreaks, havens, saltland reclamation, intake areas, woodlots etc;
* develop a work program (an implementation program) with costs.

On most properties, trees in plantations will be a small proportion of the total. Also, plantations minimise the positive interaction possible between agriculture and trees.

For most farmers there will be more to be gained by protecting the agricultural base with trees, and choosing species of trees that can be harvested.

Specialist advice or input can be used at all stages of this program. The tree establishment and species selection will be especially important, because many farmers do not have experience of the alternatives.

LIVESTOCK RESPONSES TO TREE SHELTER

Post shearing losses of sheep from cold average about one per cent per year. This figure is conservative, and hides the fact that losses in some areas are consistently higher.

Losses from autumn shearing through to early spring are commonly observed, and have even been the focus of animal welfare activity in Victoria.

Lamb losses. On average, about 15 per cent of all lambs die of exposure soon after birth. Very high losses have been recorded under conditions of high windspeed and relatively light rainfall.

An indication of the regularity of such losses is found in the Esperance Shire statistics. Over the twenty years of data collected, there were four years of severe lamb loss. Individual farmers have admitted that lamb marking in 1981 was often around 10 to 20 per cent. The Shire average was reported to be 48 per cent for that year, and is higher than 70 per cent in a 'normal' year.

It is reasonable to expect that 50 per cent of lamb losses can be prevented with adequate shelter. Under severe conditions, lambing 'havens' give a much higher degree of protection. This form of shelter costs very little, and gives high economic benefits.

Energy requirements for maintenance and wool growth.

Most of the information available is from work in pens. If this information can be extrapolated to the field, quite small reductions in windspeed can reduce energy needs. An example is a reduction in windspeed from 3m/sec to 2m/sec can result in a 10 per cent saving in maintenance energy requirements.

Wool growth studies have shown marked increases in wool growth (31 per cent over a five-year period) and body weight using windbreaks at high stocking rates. The windbreaks in the quoted example were of corrugated iron, and the gains were largely due to pasture gains. Many other references are available, mostly relating to the effect of cold stress.

There are few trials reported using field studies with tree windbreaks. More extensive monitoring of existing tree windbreaks is needed.

Trees, as long lived perennials, develop complex interactions with their environment. The usually reported interaction is that of root competition with pastures and crops for moisture and nutrients.

PLANT RESPONSES TO TREE WINDBREAKS

This is the area that has been most widely reported in the overseas literature. There have been many reviews and 'rediscoveries' of the costs and benefits of windbreaks.

Unfortunately, this is the topic that is rarely taken to be relevant except where the work was done. This is often because not enough of the background data has been recorded. For instance lack of rainfall or soil description.

A table of "Past studies concerning shelterbelt effects on crop yields" is given by J Kort (1988). Most of the reported material relates to snow-trapping windbreaks. However, there are instances of Mediterranean and marine climatic areas, similar to southern Australia, with crop yield increases of up to 35 per cent.

Yield increases of pastures and crops, out to about 15 tree heights in the lee of shelterbelts, of about 20 per cent to 30 per cent are often quoted. However, the size and direction of a change in yield varies with crop, season, soil types, tree species, windbreak orientation and so on.

It is important to use data from well-constructed windbreaks with the correct management to show the potential gains from tree windbreaks.
Western Australian information on the value of tree windbreaks for crop production. There is very little properly measured information available in WA on this topic.

Most of the material available is farmer observation, sometimes with coarse estimates of production changes.

A measuring program was started in 1988 at Esperance to find the effects of young *Pinus radiata* windbreaks on lupin and oat yields by Bicknell and Vincent. This work was done near Gibson, in a 450 mm rainfall zone. The soil was between 2.5 and 4.5 metres deep fine, podsolised sand.

Pine windbreaks were established by the farmer, Garry English, in 1984 as part of a program to prevent soil erosion and allow cropping. The windbreaks are parallel, about 200 m apart and 2 000 m long, running approximately north-south.

The 'lands' have been cropped on a wheat-lupin rotation until 1988, then oats were introduced for an oat-lupin rotation. Lupins in 1988 and 1989 showed a distinct response to the windbreaks on the western and eastern sides. This was interpreted as a response to protection from the cold north-westerlies in early winter, and protection from the dry easterlies in spring.

Lupins are more susceptible to cold conditions than are the cereals. Also, lupin flowers are particularly susceptible to heat and drought stress.

The net yield increase between the windbreaks was about 27 per cent in 1988 and 30 per cent in 1989. After accounting for the area 'lost' to windbreaks, the over-all yield increase was 19 per cent in 1988 and 21 per cent in 1989. It is possible that the actual yield increase is greater than this, because the centre value is at less than 20 tree heights from the windbreaks, and there is likely to be some windbreak effect at this distance. Yields of lupins in 1990 were highly variable across the paddock, and showed no clear response to the windbreaks.

The return on costs of establishment in 1984 until the single benefit of 1988, was estimated at 28 per cent per annum. This is obviously an underestimate, because there has been a reduction in soil loss, and some yield increases in previous years.

Oats did not give a clear response in 1988, and gave about a 10 per cent yield gain in 1989. Wheat, grown in 1990 has shown a yield gain (not measured yet).

There are several problems interpreting this information. There is a complex interaction between the elements of the system; it should not be compared to a set of imposed treatments such as those in a crop variety trial.

The cropped area between windbreaks is 200 m by 2 000 m. The planting, fertilising and harvesting machines are not exactly the same width, and therefore there are lines of higher and lower yields along the long axis of the paddock. This effect in one crop year then affects the following crop in the rotation.

Weather that affects crop growth differs between years, and therefore gives widely differing responses to the windbreak.

Les Webster, farming east of Esperance, recorded a 47 per cent yield increase in the lee of a three-year-old windbreak. Three rows of *Pinus pinaster* were planted on the north-west side of a sand paddock. The wheat crop was sandblasted several times at the beginning of the season.

From the one year's results, it was estimated that investment in a windbreak gave an annual interest return of 40.6 per cent. The windbreak is now taller, and continuing to work *especially* in the worst seasons.

WIND EROSION AND WINDSPEED MEASUREMENT

Given the right (or wrong!) conditions, most of the soils in the Western Australian Agricultural region are susceptible to wind erosion. An estimate by the Department of Agriculture (Carder and Humphry 1983) was that about 25 per cent of the 16 million hectares of cleared agricultural land needed special attention to prevent wind erosion. Another 40 per cent was estimated to need some management to control wind and water erosion.

Sandy-surfaced soils, commonly called the 'Sandplain' (and characterised by 'Kwongan' vegetation), are particularly susceptible to wind erosion.

Wind erosion is known to be widespread in Western Australia, and particular risk factors are associated with erosion events. However, "there is little documented evidence of its occurrence, severity and cost" (Hamilton *et al* 1987).

An unpublished report in the Department of Agriculture estimated that, in 1986, 500 000 hectares was actually affected by wind erosion, and another 10 million hectares was susceptible (cited by Hamilton *et al* 1987).

Anecdotal information on dust erosion in the central wheatbelt is widespread, but documentation is not available. Instances of note in 1991 include severe wind erosion in the north-eastern, central and south-eastern wheatbelt of Western Australia. The south-eastern area, to the north of Esperance, was put at risk by the driest spring and summer on record. The central wheatbelt was affected by a decaying cyclonic low-pressure system in May 1991, at a period when many paddocks had been cultivated for crop establishment, and pastures were mostly bare.

An example of an area with some documentation is Jerramungup.

Jerramungup, cleared mostly since the 1950s, has had significant wind erosion in 1969/70/71/80/81/83/84/86 and instances since then. Wind erosion and the effects of sand movement were particularly bad around Jerramungup in 1980, 1981, 1983 and 1984.

About 44 000 ha in 1980 and more than 64 000 ha in 1981 were estimated to have been seriously affected by wind erosion (Goddard *et al*, no date). This was about 7.3 per cent of cleared land, and 18.3 per cent of the cropped area showing evidence of sand blasting. The report estimated that the direct, or cash costs, averaged $17 900 per farm for 1981 alone. Wind erosion caused an estimated loss of $1.5 million in the Shire of Jerramungup in 1981. This estimate does not include the effect on subsequent crop yields, depressed yields on areas not totally destroyed, the cost of clearing roadways and tracks, recovery of fences, and loss of vegetation due to sand abrasion and cover.

Conservation farming techniques to minimise wind erosion have been known for many years. 'Minimum tillage' and stubble management in cropping have been a major extension and research activity of the Western Australian Department of Agriculture for nearly a decade. This reliance on management of crops and annual pastures for wind erosion control could be adequate, if universally practised, in a 'normal' year.

Severe weather and/or economic factors, combined with less than perfect adoption of appropriate grazing and crop management systems, shows the weakness of relying completely on annual management decisions.

Tree windbreaks for prevention of wind erosion would overcome the reliance on short-term management decisions for protection during severe conditions. Combinations of tree and agronomic protection systems are likely to give higher returns over a range of risk conditions.

SALINITY, WATERTABLE AND WATERLOGGING CONTROL

Some discharge areas can be recovered easily with trees, or be planted profitably with salt-tolerant forage shrubs.

Preventing the rise of water tables and the spread of salt, though, usually relies on increased water use and surface water management throughout the catchment. Trees are only a part of the answer.

Successful examples of trees lowering 'watertables' in a restricted area are common in Western Australia. Their major advantage over other systems of water removal is that salt is leached down in the soil profile, and not transferred elsewhere.

Trees are of particular benefit along defined water-ways, around sumps, swamps and lakes, clearly defined recharge areas, and the margins of saltland. Shade and shelter benefits can usually be designed at the same time.

Placement of trees to use water effectively is critical. Planting onto sandplain seeps is very successful because the water is relatively fresh and close to the surface. Water use in this situation is likely to be more than 10 litres of water per day for each year of age. That is, a ten-year-old tree could be using more than 35 000 litres of water a year. From this sort of information, the number of trees needed to dry a particular area can be calculated.

On relatively flat saltland, trees need to be dispersed, rather than being planted in clumps. Wide-space lines have been used successfully at Boundain, east of Narrogin, to lower saline watertables.

Waterlogged areas can combine trees with perennial pastures to reduce the problem, at the same time producing useful feed and timber.

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ESTABLISHMENT TECHNOLOGY

By Simon Penfold,
Department of Conservation and Land Management, Western Australia

Forestry needs technology. It is the lifeblood of new innovations and the commercial applications capturing these developments.

This technology requires the co-ordinated interaction of foresters, tree physiologists, statisticians, economists and a plethora of other professional groups - a true multi-disciplinary task!

CALM has been, and continues to be, a major player in this arena. Since 1957, CALM's plantation silviculturists have scientifically refined establishment techniques. It is these techniques that the case studies have used as examples:

Section 1:	Mr R.R.A. Fremlin discusses the activities important for potential tree planters.
Section 2:	Dr. T. Butcher and Mr S. Penfold outline the volume gains available from CALM's advanced tree breeding program.
Section 3:	Mr G. Ellis outlines the major findings of the National Afforestation Program and it's implications for tree-planters.

Section 1: A Guide To Planting More Trees

Mr R.R.A. Fremlin,
Department of Conservation and Land Management, Western Australia

Trees are an essential part of our environment. They enhance the beauty of the landscape, provide shelter and conserve wildlife. Trees also help to control erosion, water-logging and salinity.

Tree establishment success depends on the right choice of tree, appropriate site selection, soil preparation, weed control and methods of planting.

Usually trees are propagated in individual containers (potted) or grown in open nursery beds (bare rooted). A seven-to-twelve-month- old seedling is ideal for establishing under natural rainfall or where infrequent watering is likely. Advanced trees need more care and, if grown in containers, are likely to have coiled roots. If the coiled roots are allowed to develop they can strangle the tree and make it prone to wind-throw.

Plant trees as early in the season as practicable, provided adequate soil moisture is available. This gives them sufficient time to establish a root system before the dry season. Waterlogged sites must be drained and moulded as young trees will die if planted in saturated soil. **The small details often make the difference between success or failure of trees.**

The way trees are transported from the nursery to the planting site has a significant effect on their growth potential. If the nursery supplying your trees is a long distance away, pick them up yourself. If they are to be consigned to you by road or rail, discuss the transport with the nursery manager and get an assurance that the trees will arrive in good condition. Do not accept any trees unless you have an assurance they are free of fungi.

Trees must travel in a completely enclosed compartment. Overnight transport is preferable as it avoids the possibility of a hot journey. Particular care should be taken with bare-rooted plants as they deteriorate rapidly in hot conditions. Make sure you are aware of the tree's arrival date to avoid unnecessary unattended periods. Let the nursery know the condition of your trees on arrival.

Keep your plants moist and away from wind and sun at all times while waiting to plant. Bare-rooted plants should be held no longer than three days before being planted. Bare-rooted plants should be "heeled" in a trench in moist soil and watered regularly.

Before planting, make sure the soil is adequately prepared and a weed control strategy is in place.

Section 2: Species Selection And Tree Breeding

Dr T. Butcher and Mr Simon Penfold
Department of Conservation and Land Management, Western Australia

As the world's population grows, so does the need for forest products. However, the land available for growing them has been shrinking because of agricultural demands, city expansion and road development. Thus there is a need to increase the productivity of our available forest land.

Today all large planting programs include some breeding research, and improved species of trees are being used.

In Western Australia, intensive tree improvement programs were begun in 1957 for *Pinus pinaster* and for *Pinus radiata* and more recently in *Eucalyptus globulus.*

These programs follow the path of : -

Table 1: Tree Improvement Strategy (attached). That pathway has generally followed the step-wise progression from Level 1 to Level 4 and 5. The key technical steps to approach forestry (Level 6) are being actively pursued.

The gains for each level of improvement are shown below in:

Table 2. These levels of volume gain are relative to the seed used from routine (unselected stands or seed orchards) collections. All levels are based on proven broadscale trials, analysed by conventional statistical techniques (refer Butcher 1988).

As is indicated in Table 2, volume gains at the current levels of the Super Tree Strategy will increase production per unit of land by 26 to 33 per cent, 40 per cent and 42 per cent for the major WA commercial plantation species of *P. radiata*, *P. pinaster* and *E. globulus*, respectively. These unit gains are considered to have major beneficial effects on the cost structure per unit of wood produced e.g. more wood for the same establishment costs.

Table 1
Super Tree Strategy

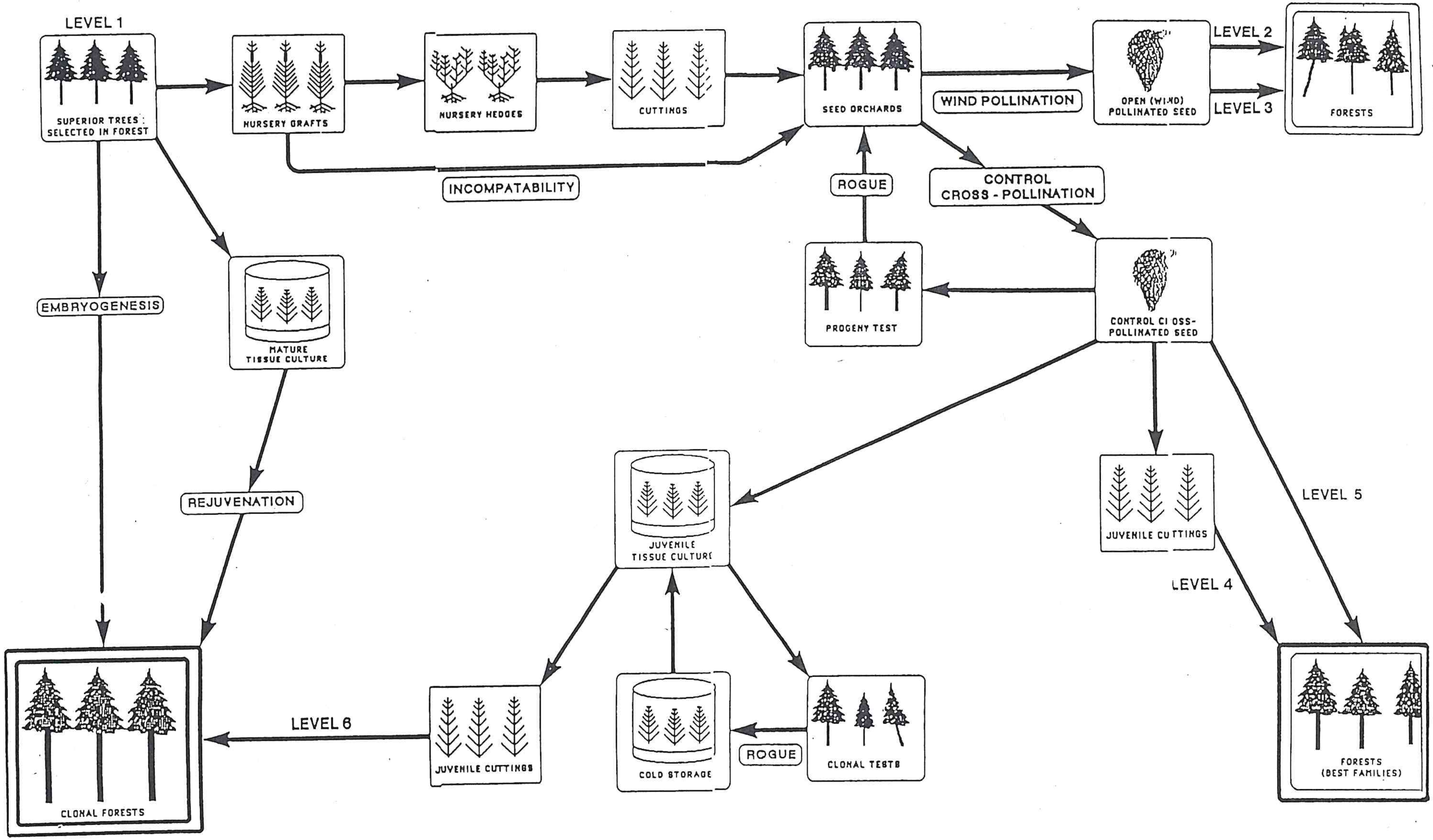


Table 2

Potential Gains from the Super Tree Strategy

Level of Improvement	Origin	Radiata	Pinaster	Globulus
Level 1 (Seedlings)	Seed from routine stands	0	0	0
Level 2 (Seedlings)	Seed from first generation seed orchards	+12%	+18%	+12%
Level 3 (Seedlings)	Seed from second generation open pollinated seed orchard	+21%*	+40%*	+42%*
Level 4 (Cuttings)	Correct controlled cross - pollinated breeding arboretum	+26-33%*	-	-
Level 5 (Seedlings)	Future controlled cross - pollinated seed orchard	+33-41%		
Level 6 (cutting)	Proven clones derived from controlled cross-pollinated seed.	in excess of 50%		

* Current Implementation Level

Section 3: The KeyTo Plantation Success

Gavin Ellis,
The Department of Conservation and Land Management, Western Austrlia

The following notes refer primarily to eucalyptus on farmland and are based on research into the establishment of *Eucalyptus globulus* plantations for pulpwood. However, the general message contained herewith probably relates to all tree establishment.

BIGGER TREES GROW FASTER

Therefore, aim to give trees the best start possible and then maintain growth through management (weed control, fertiliser, insect control, fire control, stock control).

Big healthy trees:

- appear to be less attractive to insect grazing compared to small, stressed trees;
- more able to resist insect grazing;
- have a corresponding large root system and therefore better capacity to survive summer droughting due to greater access to soil moisture;
- dominate the site and the weeds earlier, resulting in:
- less competition from weeds for moisture and nutrients and, in turn ...
- better growth.

To achieve the best start possible, two things need to be invested (assuming techniques for establishment are appropriate and operators have sufficient skills to apply them properly):

- time. Time for planning and organisation and sufficient lead time between operations.
- money. Don't compromise quality by trying to save a few dollars, as the extra investment to achieve success is far outweighed by the costs of failure or sub-optimum results.

  For example, an additional $100 per hectare spent in year zero to establish a pulp crop need only result in a 4% increase in production in a 20 MAI plantation to pay for itself - but unspent, may mean the difference between success or failure.

Six aspects of successful establishment of trees include the following:

1. **Site preparation - overcome water-logging, allow roots to penetrate beyond soil hardpans or into heavy clays (improve stability and access to water) and to maximise the exploitable soil volume for rapid root development.**

Mound and drain wet sites to alleviate water-logging - make use of levels to keep the water honest. Plough prior to mounding if the soil is heavy and soil clods are large.

Mound sands if erosion is not a potential problem.

At least rip all other sites (including sands), the deeper the better and preferably with a winged type to maximise fracture of the soil.

Use the appropriate gear and be prepared to pay for it.

2. **Weed Control - to reduce competition for available soil water and nutrition.**

Get the site preparation right and allow sufficient lead time for settling of rip-lines and mounds before application of herbicides.

Know your target weed species and anticipate potential invaders - develop an appropriate strategy.

Apply the right chemicals at the right rate in the right way under the right conditions with the right gear. For example, use Roundup (at 1 - 4 l/ha) as a broad spectrum knockdown, plus Brushoff (at 15 - 50 g/ha) for sorrel, dock and bracken control; aim to achieve lasting control of weeds into the first spring by using Simazine (at 10 l/ha) with the knockdown spray.

3. **Seedling condition - healthy plants, able to survive the elements and grow vigorously from day one.**

Ensure seedlings are healthy, strong and hardened off, capable of growing a well balanced root system as soon as possible after planting (coiled or root-bound root systems are bad news).
Transport and treat seedlings with respect and avoid damage to roots and shoots.

CALM's 64-cell, painted Kwikpot has performed as well as, or better than, pots of twice the soil volume on a range of sites tested over the past two years.

Bigger pots may result in marginally better survival and growth on harsh sites yet cost is excessive.

Choose the right species for the site.

4. Planting - to ensure seedlings have the best possible chance of survival and growth.

Plant as early in the season as practicable, especially high, dry sandy sites.

Allow 2-4 weeks and at least 50 mm of rainfall between herbicide application and planting.

Care for the seedling on site prior to planting by sheltering from wind and sun and maintain watering.

Ensure seedlings are planted deep (with the top of the root system at least 50 mm below soil surface) and are well-heeled or pressed in - avoid air pockets.

5. Fertiliser - to provide sufficient nutrition to cater for the early demands of the seedling to maximise early growth.

Applying 10 - 20 g of nitrogen and phosphorus per seedling results in optimum growth.

Fertilise well-drained sites 4 - 6 weeks after planting to maximise the potential of the seedling to access nutrients by allowing root development prior to the application of fertiliser.

On wet sandy sites where nutrients are readily leached, fertilise in Spring or fertilise with slow release fertiliser 4 - 6 weeks after planting.

6. Management (insect control, weed control, fertiliser).

After planting, monitor seedlings for insects and take appropriate action to control if necessary. Those impacting most on seedling survival include wingless grasshopper, plague locust, spring beetle, various weevils, budworm and cutworm and African black beetle.

Purchase a CALM Insect Manual (at $35 per copy) for further reference on insects and their control.

Weed control in the year after planting is most beneficial, especially for seedlings which did not get a good start in the first year. Trials have shown that growth rates of young trees can be doubled by second year weed control. Weed control can be achieved by careful application of Roundup around trees or by using selective herbicides such as Lontrel for broadleaf species and Fusilade, Assure or Sertin for grasses.

Post-establishment fertilisation of *Eucalyptus globulus* plantation has been carried out on the Bassendean sands on the Swan coastal Plain using 250 kg/ha diammonium phosphate and 125 kg/ha muriate of potash. It is thought that unless trees are suffering from nutritional deficiency, weed control rather than fertilisation (or in conjunction with fertilisation) is the way to go.

Research into second year weed control and post establishment fertilisation are current research priorities.

THE BENEFITS OF GETTING IT RIGHT THE FIRST TIME AROUND ARE LARGE - THE COSTS OF GETTING IT WRONG ARE HUGE.

SITE SELECTION FOR COMMERCIAL TREE GROWING IN SOUTH-WEST WESTERN AUSTRALIA

Gary Inions,Department of Conservation and Land Management, Western Australia

INTRODUCTION

Like any agricultural pursuit the owner of commercial timber crops needs to know:

(a) how well the crop is performing; and
(b) what the yield will be at the time of harvest.

There are a number of measures which give an indication of yield. The most common are cubic metres or tonnes of wood. These are the units in which the crop is usually sold. Another, more economically important measure is bone dry units (BDU) which is the amount of dry wood fibre produced. BDU is similar in principle to the farmer's dry sheep equivalent.

However, how does the manager of a tree crop measure cubic metres, tonnes or BDU halfway through the rotation? If it is possible, it is time-consuming and expensive.

As a result of these problems, foresters throughout the world use an index of productivity termed site index. The forester will say 'this patch of land has a site index of 15', in much the same way as a farmer will say 'that paddock is a 7 DSE or 20 bag paddock'.

Site index is the top height of a stand at a nominated reference age. Top height is the average height of the tallest 40 trees per hectare. Site index has gained its populality because:

(i) it is easy to measure;
(ii) it is independent of stand density; and
(iii) it is strongly related to the potential of the site to produce a resource whether measured in cubic metres, tonnes or BDU.

Examples of top height development and site index curves

Figure one is an example of top height development and site index curves for Tasmanian blue gum *(Eucalyptus globulus)* in south-west Western Australia. Each curve represents the top height development pattern of a stand. The site index is the height at age five years and is marked on the vertical line corresponding to age five. Once the site index is known the future development of the stand may be predicted from the graphs.

However, what good is top height? We don't sell top height. As previously mentioned, top height is strongly related to the potential of the site to produce a resource. Top height is usually converted to cubic metres, tonnes or BDU with formula-termed yield equations which usually look like:

$$\left.\begin{array}{l}\text{cubic metres}\\ \text{tonnes}\\ \text{BDU}\end{array}\right) = e^{-a}.H^{b}.D^{C}$$

where:

H	=	top height,
D	=	stand density or stems/hectare,
e	=	base to the natural logarithm
a,b,c	=	parameter to be estimated

What about site selection?

The difficulty arises when we need to know the site index of a piece of land before we plant it. We need such information in order to avoid unprofitable sites and decide whether it is worth applying some of the more expensive silvicultural techniques.

The usual approach to estimating a site index of a piece of land, prior to planting is to use "soil-site" studies. Such studies usually produce an equation such as:

site index = a + b. soil + c. climate

Over the last three years the Department of Conservation and Land Management has researched and developed such equations.

These equations form the bases of CALM's land evaluation system for *E. globulus* in south-western Western Australia.

To derive such equations, 60 plantations were surveyed for growth and yield data. One hundred and twenty environmental variables were also collected from these plantations. The resulting equations derived from this information perform with acceptable accuracy and precision and are therefore used operationally by CALM when selecting CALM planting areas.

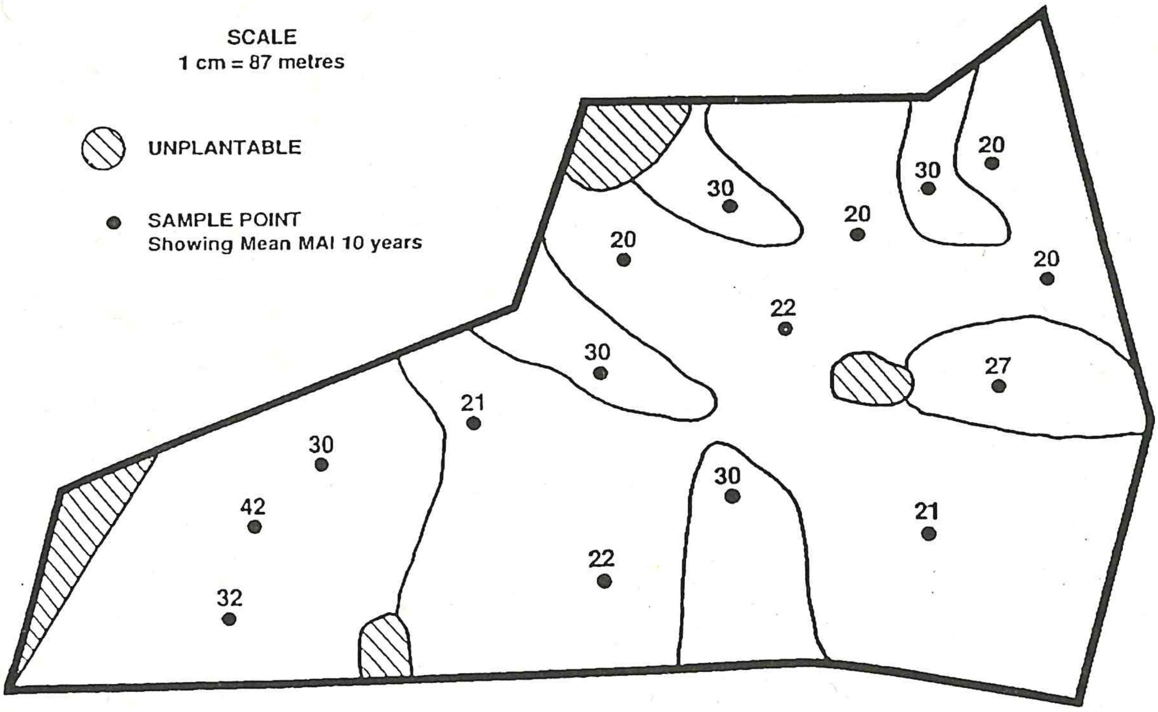
Operational procedures

When assessing a property for its suitability for *E. globulus* the first step is to collect this information with the use of a drilling rig which extracts soil cores. Soil samples are then sent to the soils laboratory where fertility and texture are assessed. These data are then plugged into the equations previously mentioned and site index is derived.

When the drilling rig is correctly operated, one core is extracted every five minutes. The sampling intensity is one sample per five hectares. The location of each sample is marked and maps of the subject area are produced such as that shown in figure two. With such information the land owner may select those sites which best suit the purposes of tree planting, and avoid unprofitable sites.

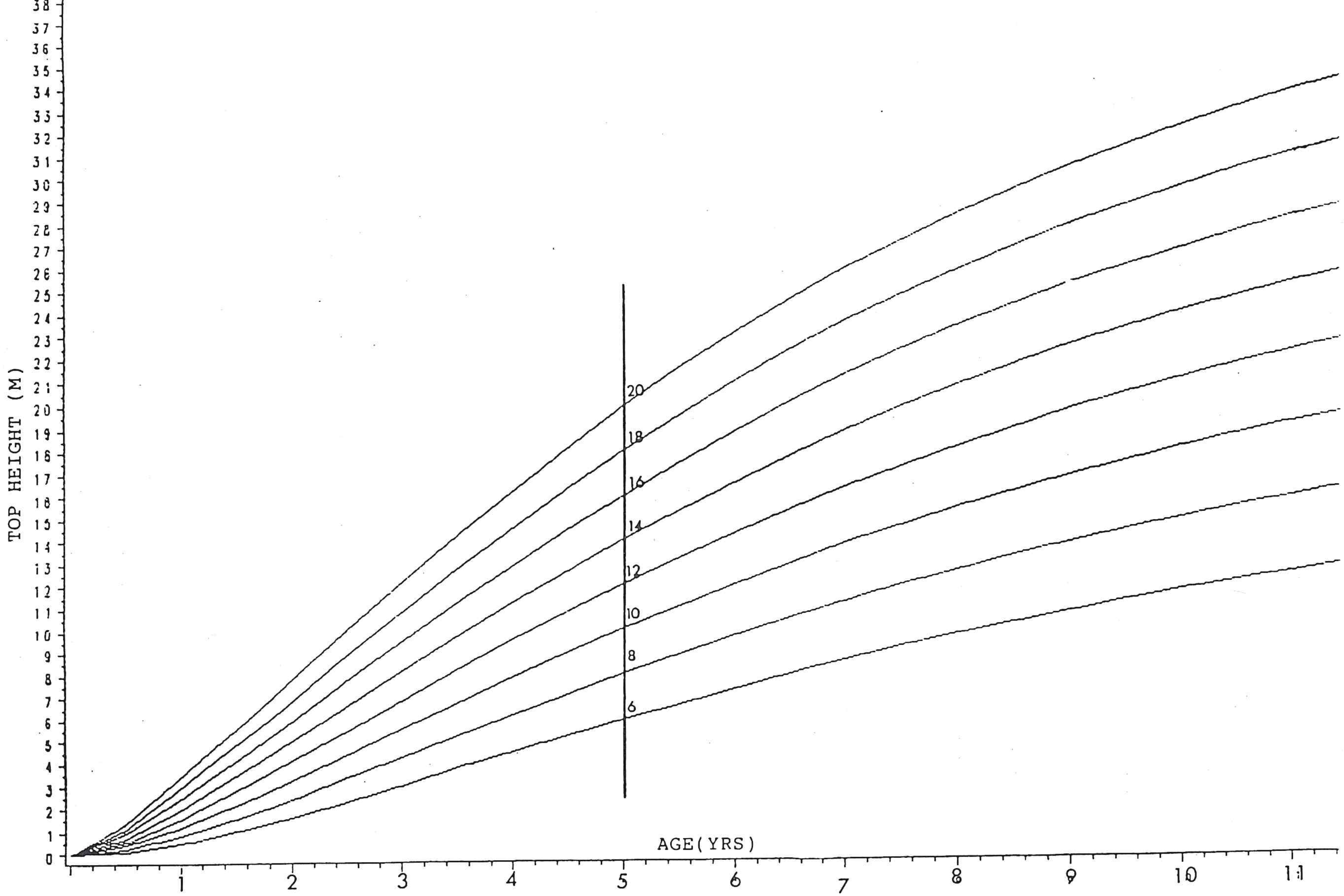
The importance of land evaluation

CALM estimates that there are some 450 000 ha of cleared agricultural land in the Albany region. Not all of it will be suitable for commercial tree growing. Correct silviculture, improved genetics and the best management possible is no guarantee of success unless the site is selected correctly.



E. globulus Site Productivity Assessment for a Typical Farm

Site Index and Top Height Development Curves for *E. globulus* in South West Western Australia



PORT FACILITIES AND WOODCHIP EXPORTING

Terry Enright, Albany Port Authority

Albany Port Authority's interest in woodchips began in 1980.

At that time an export licence was being sought by Gordon McLean and discussions took place with the Authority over the prospect of shipping through Albany, although it was recognised that initial tonnages would be shipped through Bunbury.

The Authority had ongoing discussions through the 80s on the prospect of shipping woodchips and/or silica sand.

In 1990 the Authority commissioned an Albany Port Development Study to determine Port development options. The study was carried out by Port and Harbour Consultants Pty Ltd.

Based on that study and the accumulated knowledge, I am able to outline today some options that would enable woodchips to be exported through the Port of Albany.

Basic Requirements:

1. access to Port area - both rail and road;
2. suitable area in size and proximity to wharves for stockpile;
3. a transfer system to get stock to ship loader;
4. suitable skilled workforce
5. suitable berthing facilities - the facilities will need to accommodate vessels of 45 000 DWT (deadweight tonnage) and 12-metre draft plus appropriate tug services.

ACCESS: to the Port area by road and rail is adequate to enable product to be transported for shipping and or stockpiling. As part of the Railway Redevelopment Steering Committee we have endeavoured to ensure that unimpeded access is maintained to the Port whilst the foreshore redevelopment takes place.

AREA
Approximately 15 ha of reclaimed land is available east of the land-backed wharf. This has been set aside by the Authority in anticipation of stockpiling bulk products. The area would be sufficient to stockpile woodchips.

The Authority does not believe the location of the chipping mill would be appropriate on this site.

TRANSFER SYSTEM: will depend on which berth is ultimately used for loading.

WORKFORCE: The Port of Albany, along with other Australian Ports, is in the midst of a review of employment on the waterfront as a consequence of the Inter-State Commission investigation into waterfront reform and the establishment of the Waterfront Industry Reform Authority.

It is the view of the Authority that the only way to achieve optimum workforce arrangements for the Port of Albany which will guarantee its future is to opt for a totally integrated port workforce involving in the first instance the existing Waterside Workers' Federation, the Foreman Stevedores and the Authority employees. Under this option the entire workforce would be available to stevedore the vessels in the port and, at times of no vessels, would undertake port maintenance and administrative functions.

Labour arrangements for loading woodchips would most probably be similar to that of grain.

FACILITIES: Albany Port Authority has, for some time, been exploring the options to accommodate woodchip exports.

OPTION 1

Cooperative Bulk Handling facilities: CBH has indicated that grain loading facilities could be used to load woodchips provided that suitable arrangements can be made to get the woodchips on to the belt or loading booms.

This is an engineering job and estimates of cost are $1 - $1.5m.

Recently a delegation for the OJI Paper Co visited the Port and further discussions between that company and CBH are continuing. CBH will insist that costs associated with this do not reflect in increased costs to the grain industry.

If two belts were utilised in the operation the loading rate would be approximately 800 tonne per hour as against grain loading at 1600 tph.
The draft and length of the No 3 berth and the upgraded fender system meet requirements for 45 000 DWT bulk carriers. However, a conflict of use may arise as it is the only grain loading berth. It is also currently used for phosphate unloading.

Suitability of grain loading booms in relation to woodchip carriers: It is important that the ship not be required to move during the loading operation.

OPTION 2

Upgrade No 2 berth plus part of No 1 berth. This would need associated dredging and removal of a rock outcrop opposite No 2. Ship handling simulations show some difficulties could be encountered when sailing from No 2 with No 3 occupied and the rock outcrop remaining.

The preliminary design of No 2 berth would require an expensive fender system to be installed to minimise reaction forces through the deck.

As the woodchip stockpile would have to be located in the reclaimed area east of the berths, this option would necessitate an additional length of conveyor system to transport material between that location and No 2 Berth and the building of a woodchip loader.

OPTION 3

The development of a new berth along the new alignment proposed in the plan.

This scenario results in the highest berth facility cost. However, with the costs of additional materials, handling facilities and maintenance costs which are associated with the upgrade of No 2 berth, the resulting cost difference would only be marginal. Therefore, provision of an entirely new berth of modern standard seems an attractive option for development of the Port.

Albany Port Authority must also take into account the possibility of the bulk cargoes which may eventuate. Specifically, silica sand and cayline clay.

Stockpiled silica sand would need to be covered. Loading via the new berth would require a loading gantry and ship loader.

The Authority was first approached in 1982 with regard to silica sand shipping. We have had discussions on this product from time to time ever since. While no firm proposal for shipping silica sand or clay is before us, future port development must endeavour to accommodate future products.

To illustrate some of the potential problems in handling of these diverse cargoes, the prime physical properties of the two materials are compared:

CARGO	DENSITY	ANGLE OF REPOSE
Woodchips	160-480 kg/m^3	greater than 45^0
Sands (Silica)	1440-1600kg/m^3	30^0 - 45^0

Thus loading rates for these two cargoes could have up to a ten-fold variation, if all other factors were to remain constant.

Handling Systems - Reclaimers
All parts of the bulk cargo handling system are influenced by the required loading rates per hour, the annual throughput envisaged, the shipment sizes and the intended life of the commodity export enterprise.

Port-located stockpile areas must be sized according to whether the full shipment needs to be on site before loading or whether it can be augmented by road or rail deliveries during shiploading. Clearly, a low density cargo such as woodchips requires a large stockpile area with at least on-shipment tonnage capacity.
Only when the first proposal for bulk shipments is before the Authority, can the future direction for materials-handling plant be determined with confidence.

While there exists the valid preference for common user facilities, it will be necessary for the Authority to assess expenditures against likely future revenues from both the first proponent and other subsequent users.

For the first cargo it may well be that the most favourable arrangement for the future benefit of the port will be a trade-off between the two parties - modifications to, or up-rating of, the proponents-supplied facilities to facilitate economic loading of other future cargo types, at the Authority's expense. Such expenditure would need to be at least notionally tied to future expected revenue gains from the subsequent cargoes.

Similarly, the decision on whether to locate the bulk outloading berth at the existing No 2 berth or at the location of the planned No 4 berth, may be dictated by the first proponent. Hence, the opportunity may arise for some development cost-splitting.

However, whereas the above scenario may imply private ownership of the mechanical handling facilities, it is clear that the Authority should retain total ownership of its berth structures.

Another aspect that should be considered is tug requirements.

Woodchip carriers, because of design are more difficult to handle than a similar DWT bulk carrier vessel. Irrespective of which berthing option is chosen, woodchip carriers berthing in Albany on an ongoing basis will necessitate the provision of a second tug. This is not a problem in itself but has implications regarding Port costs.

We are confident that if a woodchip industry requires shipping facilities at Albany the requirements can be met as part of a smooth transition to the Port's ultimate capacity whilst at the same time allowing flexibility for change with the trends which are evidenced in shipping trade and the cargo handling industries.

Keeping in mind the growth being experienced in merchant ship sizes and the distribution of sizes along with new Port construction particularly in developing countries, the selected future berth alignment and sizes should allow for accommodation of vessels up to 60 000 DWT.

Development of the Port will have a cost.

With the introduction of the State Government Financial Administration and Audit Act of 1985 and the subsequent amendments to the Authority's Act there is greater onus on accountability by the Authority. There is now a requirement to strive to achieve a pre-determined percentage return on capital invested (at current asset value) currently approximately 4.2 per cent and the future potential of the payment of a dividend to the State Government.

Current requirements which must be met with regard to major expenditure are:

1) the ability to service the capital;

2) provision for depreciation of the asset;

3) achievement of a rate of return on the asset.

If these critera cannot be met, the Government would be unlikely to approve the expenditure.

It is important that future development costs do not impact adversely on current Port users. In Albany, this principally means the grain industry.

Cross-subsidisation ultimately distorts real costs. All export industries face a very competitive market place and now demand transparent pricing policy.

Change in the product type and quantity have been part of Port of Albany history. Trade commodities previously shipped out of Albany include:

Tallow	Cattle
Meat	Whale Oil & Solubles
Sheep	Apples
Bagged Grain	Timber
Wool	General Cargo
LP Gas	

Change in world shipping trends and cargo paths and systems have been largely responsible. Albany Port Authority sees expanding the trade base as essential to long-term viability of the Port and is committed to assisting the development of a woodchip industry in the region.

On behalf of the Chairman of the Albany Port Authority John Plewright, I thank Conservation and Land Management and the Great Southern Development Authority for the opportunity to be involved in this important seminar.

WOOD FIBRE—A NEW EXPORT INDUSTRY FOR THE GREAT SOUTHERN

Mr B Ray, Consultant

A wood fibre export industry will be operating in the Great Southern early next century. This vision, soundly based on international market trends and environmental benefits, sees the following principal features:

a new central processing plant

a new shiploading facility

an enlarged transport sector for the region

a patchwork quilt of selected eucalypt plantings on a large number of farms

the value of annual fibre exports ranging from $30 million initially to $150 million as the development matures

This new industry will bring with it:

diversity of farm income

increased regional employment

financial returns to investors

economic multipliers to the region generally

improvements to land and water quality, improved farm amenities, meaning reduced soil erosion, shelter for stock, improved pasture production and improved aesthetics achieved through what has been termed "integrated farm planning" and discussed by others.

Underpinning the success of this new industry

A limited number of success factors will ensure the success of the development. These are:

the North Asian market for hardwood pulpwood

In Japan short-fibred hardwood is pulped for the local market for high quality writing, computer, fax and tissue paper. As living standards and domestic consumption rise in that country the rising trend in usage is expected to continue.

Overhead 1. (appendix 1.) shows the traditional role Australia's native eucalypt forests have played in wood-fibre trade with Japan which is by far the largest current market. This also highlights the rising consumption trend.

Overhead 2. (appendix 2.) shows Japan's pulpwood requirements for both hardwood and softwood from 1988 to 1998 and the balance between local supplies and imports. Note the decrease expected in local supply; it is expected that Japan will continue to be constrained in it's ability to supply hardwood pulpwood.

Overhead 3. (appendix 3.) highlights a review of regions worldwide with potential for competing for the Japanese deficit. **It is important to note there is a net deficit of 5.7 million m^3 with no identified likely suppliers. Is this the market window for the Great Southern** ? I believe it is.

This opportunity is reinforced by increasing conservation pressures on native forests which do have the potential to remove resource from productive use. An interesting example of this is the recent reservation of significant areas of Red Alder forest on the U.S. west coast where the habitat needs of the spotted owl have been recognised.

In addition it is reported South Korea has moved to increase hardwood pulp capacity which will further increase demand in the region possibly by as much 700,000 m3 by 1992-1993.

These positive signs will not represent eternal opportunity as other Australian regions and countries with land capability and proximity to north Asia will be drawn into the supply stream; already Thailand and Vietnam are reportedly starting to win a share of the trade.

the high quality and pulping advantages of plantation-grown *Eucalyptus globulus* ssp. *globulus*

E. globulus has excellent pulp and paper-making characteristics especially when grown in well-managed plantations. This is likely to give it a competitive edge over native forest wood and other hardwoods such as *E. camaldulensis* grown in plantations in warmer climates.

(Other species such as *E. grandis* are good pulpers and have demonstrated good plantation performance in favourable conditions. They should not be overlooked.)

land capability

While the above-mentioned species generally seem at home in the Great Southern in a competitive world it is vital to achieve peak performance from ~h~m.

Careful choice of site and rainfall zone are vital for low-cost production.

A general soil assessment suggests an adequate land base for a major project.

knowhow

Plantation management must focus on maximising the rate of development of pulp fibre in dry weight terms per unit of site area occupied. Site and species selection must be followed by optimum site preparation, planting technique, nutrition management, competition control, protection and growth monitoring.

Planting must be carried out with harvesting methods and costs in mind and integrate with overall farm and district objectives.

Tree-breeding is critical in ensuring long-term success through robust costs and quality.

Financial knowhow is important and this is reflected in a later section.

commitment by local community to plantation resource development

Here the local community means farmers, town residents, the representative councils they elect, port authority, road authority, business people, education authorities, media, investors; in short the whole community. It is important the development and its impacts are well understood and supported for the right reasons.

There is a local communication and leadership requirement leading to resource planning and establishment without the community tensions which have been generated by poorly understood plantation developments elsewhere

The subject is raised here because of the next listed factor viz: marketing.

It is very difficult to market a product (e.g., a plantation) which does not exist. It is not unusual in commerce to tie up markets prior to proceeding with a project such as an iron ore mine but there are many ventures which proceed on the basis that market share will be won pursuant to the project commencing and pursuant to future marketing.

Given good and favourable market research, good prospects of secondary returns from tree-planting

and significant tax breaks for expenditures consider the launching of a farm-based wood fibre industry one which can be attractive to its' participants without prior product purchase agreements being in place, although the risks are greater.

international marketing

The task of marketing the Great Southern eucalyptus wood fibre resource will be greatly facilitated by:

(a) its existence (even as an embryo);
(b) the commitment of its proponents to its on-going development;
(c) its minimum size;
(d) its uniformity and quality;
(e) its ease of access and reliable annual off-take;
(f) the existence or likely existence of processing facilities, shiploading prospects at a deepwater port and good transport facilities;
(g) the ability of its proponents to act as an entity and conduct meaningful negotiations with prospective buyers;
(h) the absence of intimidating government regulations and costs impeding the export of plantation grown woodchips and small logs;
(i) the perceived goodwill of the local community including local governments, industrial and environmental groups.

Given these conditions, the marketing of the development after its commencement is likely to result in better selling prices and conditions which is consistent with the higher risk.

flow of risk capital

It is vital to have a flow of risk capital to the project in order to fund initially the plantation programme and this leads us to the next section: "the economics of plantations". (infrastructure projects inc. log extraction, transport, processing and shiploading all need funding and represent opportunity for profitable investment this is presented later)

The economics of plantations and the influence of tax

Overhead 4 (appendix 4) shows an example of project cash-flow; typically there is relatively high initial outgoings and because of intensive management for wood production there is significant annual cost.
However, because of the high quality product resulting, the returns are capable of generating attractive Internal Rates of Return (IRR).

The selling price or stumpage used is $30 per m3, a relatively high figure by native forest standards, but justified on the grounds of quality, operating cost and the market condition. The growth rate chosen is 23 m3/ha/yr.

The example **highlights the tax deductibility of allowable expenditure against other income** which, while not affecting the IRR because tax applies equally to income and expenditure, **lowers outgoings and thus risk.**

The IRR after tax, real 1st rotation is 8.3%
2nd rotation is 16.8%
over 2 rotations is 9.9%.

Overhead 5 (appendix 5) shows the same plantation but in this case the **investor has no taxable income from which to deduct allowable expenditure in the year incurred.** The investor is permitted to carry forward losses and reduce the tax paid on plantation revenue.

The example illustrates reasonable real IRR but lower than the former example

The IRR after tax, real 1st rotation is 5.6%
2nd rotation is 12.0%
over 2 rotations is 7.1%.

These two examples **suggest the linking of high income-earning investors and lower-income earning farmers in correctly constructed tax-efficient schemes**

Obviously, it is most attractive to high income farmers especially if, as claimed by others, there may be no loss of agricultural income as a result (i.e., no opportunity cost).

There are many tax scenarios which impact on the IRR including **the extremely favourable situation for the provisional tax-payer**

Tax clearly has an important role in attracting investment and it should be noted **schemes should be constructed in a way so as to deem an investor a primary producer.** This is done quite regularly through a variety of financial mechanisms.

Capital Requirements

Overheads 4 & 5 showed the present value of 1st rotation costs of $3 030 per ha before tax. It is clear a large project will require a large injection of funds. (this cost per hectare has made some allowance for a farmer's opportunity cost and organisational overheads)

Establishing 4 000 ha per year, say, requires an overall commitment of the order of $12.00 million pa for nominally 10 years.(subsidised through tax)

After nine years, the capital value of logging, transport, processing, and port facilities will be of the order of $54.00 million and these represent further opportunities for profitable investment; see overhead 6 (appendix 6).

Local Impacts

Noting this development could generate as much as 1.0 million green tonnes of fibre per annum:-

Impacts on some roads will be significant but the preliminary costings indicate a reasonable road levy can be sustained to allow road authorities to address any above-normal wear and tear.

There will be very positive employment impacts creating demands for housing and all flow-on effects

Mechanisms for Implementation

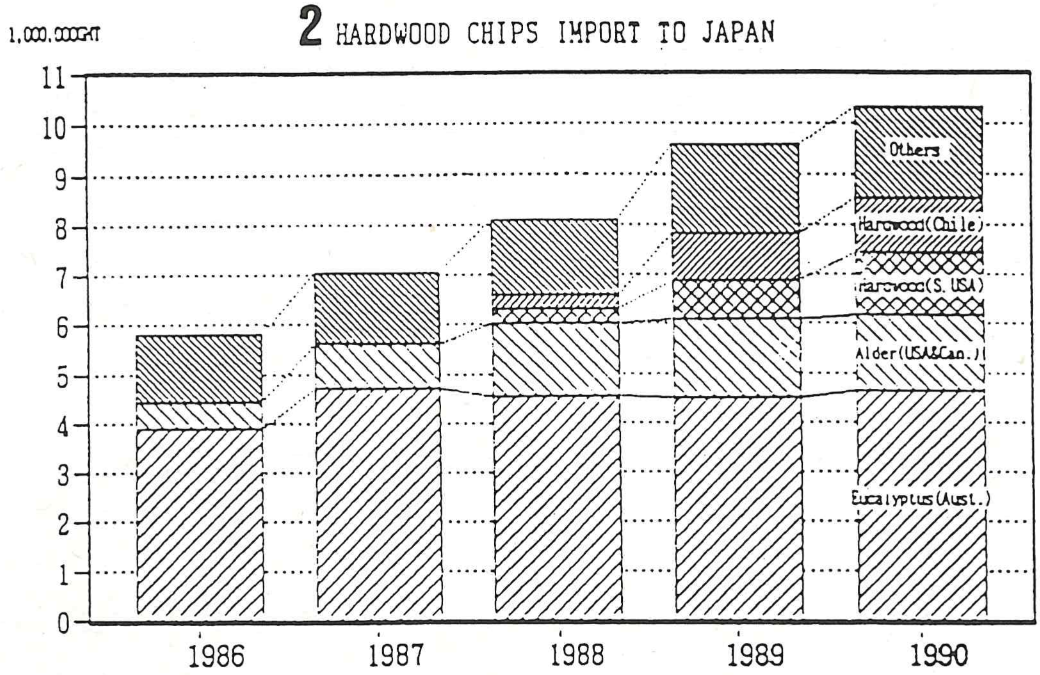
A local planning group is proposed to capitalise on the opportunity but it will need to adopt direction and create linkages across the above-listed **success factors.**

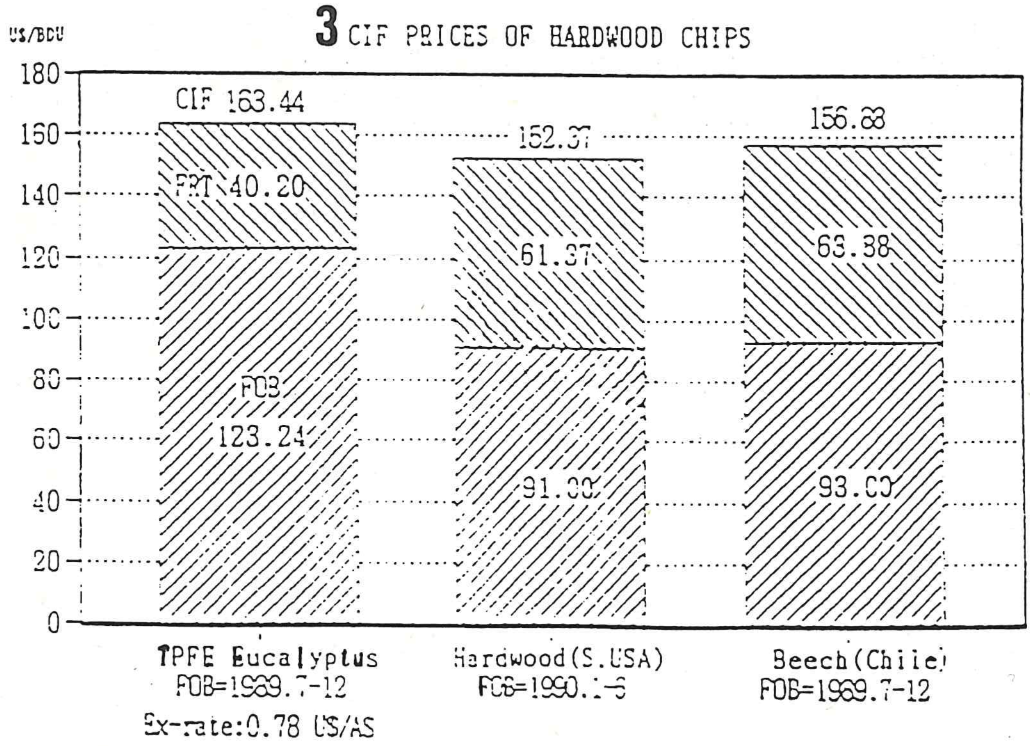
As a suggestion the local Land Conservation District Committees could be an initiating vehicle.

The initial mission would be to develop a business plan including feasibility study, resource development plan (featuring regular minimum annual areas of planting), marketing plan and finance plan.

This local step could link with the stimulating work being done by CALM and others and will immeasurably enhance prospects for a worthy, ecologically sustainable project.

APPENDIX 1


1,000,000GMT
2 HARDWOOD CHIPS IMPORT TO JAPAN
11
10
9
8
7
6
5
4
3
2
1
0
Others
Hardwood(Chile)
Hardwood(S. USA)
Alder(USA&Can.)
Eucalyptus(Aust.)
1986
1987
1988
1989
1990


US/BDU
3 CIF PRICES OF HARDWOOD CHIPS
180
160
140
120
100
80
60
40
20
0
CIF 163.44
FRT 40.20
FOB
123.24
152.37
61.37
91.00
156.68
63.38
93.00
TPFE Eucalyptus
FOB=1989.7-12
Ex-rate:0.78 US/AS
Hardwood(S.USA)
FOB=1990.1-6
Beech(Chile)
FOB=1989.7-12

APPENDIX 2

Japan: Forescast of Pulpwood Consumption & Supply Situation to Year 1998

YEAR		1988		1998
PULPWOOD CONSUMPTION				
Wood pulp production - mill. mt/year		**10.5**		**12.0** a)
b) Pulpwood consumption - mill. m³/year		**34.7**		**39.7**
PULPWOOD SUPPLY		- millions m³ -		
	(%)		(%)	
Domestic Hardwood	(27)	9.5	(21)	8.5
Imported hardwood	(24)	8.2	(31)	12.1
TOTAL HARDWOOD	(51)	17.7	(52)	20.6
TOTAL SOFTWOOD	(49)	16.9	(48)	19.1
PULPWOOD SUPPLY		**34.7**		**39.7**

a) Maximum growth for existing pulpmills. Further supplies to come from imported pulp and paper.

b) Based on ratio of 3.7 mt pulpwood per mt pulp.

APPENDIX 3

Japan: Country Summary: Sources of Supply of Hardwood Pulpwood

	1988		1998	
	Reliable /Low Freight Cost	Less Reliable /High Freight Cost	Reliable /Low Freight Cost	Less Reliable /High Freight Cost
		- millions m³ -		
Argentina		nil		?
Australia	4.7			3.0
Chile		0.3		1.0
Indonesia		0.3		nil
Malaysia	nil		0.5	
New Zealand		0.2		nil
North America				
- Pacific North West	1.4		1.4	
- Gulf States		0.4		?
Papua New Guinea	0.1		0.5	
South Africa		0.5		?
Others		0.3		
TOTALS	6.2	2.0	2.4	4.0
Deficit			5.7	
Pulpwood Supply	**8.2**		**12.1**	

APPENDIX 4

EXAMPLES OF PLANTATION CASH COSTS & BENEFITS - 1 HA OF PLANTATION, $ CONSTANT 1991 VALUES

FAST-GROWN EXPORT PULPWOOD REGIME,

MEAN ANNUAL INCREMENT (MAI) M3/HA	23
2 ROTATIONS OF 10 YEARS EACH	
TAX RATE	39.0%
INFLATION RATE	0.0%
INDICATIVE STUMPAGE $/M3, SAY	30

1. PLANTATION INVESTOR WITH TAXABLE INCOME FROM OTHER SOURCES

1.1 NO INFLATION
EXISTING TAX PROVISIONS

	YEAR																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Establishment & Charges	1316																				
Annual Costs		248	248	148	248	148	248	148	148	148	148	498	248	148	248	148	248	148	148	148	348
Insurance	9	10	11	13	14	15	41	41	50	55	60	10	11	13	14	15	41	41	50	55	60
Investor Plantation Costs	1325	258	259	161	262	163	289	189	198	203	208	508	259	161	262	163	289	189	198	203	408
Investor Revenue											6900										6900
Less Harvesting, Marketing Fee											690										690
Investor Cash Flow before Tax	-1325	-258	-259	-161	-262	-163	-289	-189	-198	-203	6002	-508	-259	-161	-262	-163	-289	-189	-198	-203	5802
Investor Tax	517	101	101	63	102	64	113	74	77	79	-2341	198	101	63	102	64	113	74	77	79	-2263
Investor Cash Flow after Tax	-808	-157	-158	-98	-160	-99	-176	-115	-121	-124	3661	-310	-158	-98	-160	-99	-176	-115	-121	-124	3539

Internal Rate of Return (IRR) after Tax, real	- 1st Rotation	8.3%
	- 2nd Rotation	16.8%
	- Average 20 years	9.9%

Net Present Value of 1st 10 years before-tax Costs @ 5% 3031

This has assumed the investor has taxable income every year from which to offset completely the plantation expense @ 39% and that the full plantation revenue is taxable @ 39%.
Costs indicative only as they depend on the site and nature of scheme.
Growth rate indicative only as this is site dependent and can vary greatly.

APPENDIX 5

EXAMPLES OF PLANTATION CASH COSTS & BENEFITS - 1 HA OF PLANTATION, $ CONSTANT 1991 VALUES

FAST-GROWN EXPORT PULPWOOD REGIME,

MEAN ANNUAL INCREMENT (MAI) M3/HA	23
2 ROTATIONS OF 10 YEARS EACH	
TAX RATE	39.0%
INFLATION RATE	0.0%
INDICATIVE STUMPAGE $/M3, SAY	30

2. PLANTATION INVESTOR WITH NO TAXABLE INCOME FROM OTHER SOURCES

2.1 NO INFLATION
EXISTING TAX PROVISIONS

YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Establishment & Charges	1316																				
Annual Costs		248	248	148	248	148	248	148	148	148	148	498	248	148	248	148	248	148	148	148	348
Insurance	9	10	11	13	14	15	41	41	50	55	60	10	11	13	14	15	41	41	50	55	60
Investor Plantation Costs	1325	258	259	161	262	163	289	189	198	203	208	508	259	161	262	163	289	189	198	203	408
Investor Revenue											6900										6900
Less Harvesting, Marketing Fee											690										690
Investor Cash Flow before Tax	-1325	-258	-259	-161	-262	-163	-289	-189	-198	-203	6002	-508	-259	-161	-262	-163	-289	-189	-198	-203	5802
Investor Tax											-1051										-1392
Investor Cash Flow after Tax	-1325	-258	-259	-161	-262	-163	-289	-189	-198	-203	4951	-508	-259	-161	-262	-163	-289	-189	-198	-203	4410

Internal Rate of Return (IRR) after Tax, real
- 1st Rotation 5.6%
- 2nd Rotation 12.0%
- Average 20 years 7.1%

Net Present Value of 1st 10 years before-tax Costs @ 5% 3031

This has assumed the investor has NO taxable income every year from which to offset completely the plantation expense @ 39% but the plantation revenue has previous years losses deducted before tax assessed @ 39%.
Costs indicative only as they depend on the site and nature of scheme.
Growth rate indicative only as this is site dependent and can vary greatly.

APPENDIX 6

Logging, Chipping and Port Facilities

Given that in one reasonably compact region with access to a port a viable plantation regime is established with long term continuity, the following processing and handling facilities will be required by say Year 10.

Facility	1990 cost for 600,000 GMT p.a. + $ mil. approximate
Logging equipment	12.0
Log transport equipment	4.0
Chip production facility including infrastructure and inventory	18.0
Chip transport equipment	3.5
Chip handling and ship loader including infrastructure and inventory	11.9
Shipping berth	5.5
Total	**54.0**

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