



# **Silviculture, management and infrastructure requirements for hardwood plantations in South East Queensland**

June 1999

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Views expressed in the report are those of the authors and not necessarily those of the Commonwealth Government. The Commonwealth does not accept responsibility for any advice or information in relation to this material.

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## Summary

This report brings together the results, key conclusions and recommendations of a study into the potential of the south east Queensland CRA region to support hardwood plantation development.

The study was based on the defined sawlog allocation zones in south east Queensland, and examined across a broad geographical range the

- Markets for plantation products;
- Potential plantation species and silviculture;
- General suitability of the land base for hardwood plantations;
- Infrastructure that may be required to support plantation development, including port facilities for pulpwood;
- Potential impediments to plantation development;
- Employment implications for plantation scenarios, including a case study of the northern NSW hardwood plantation industry, and;
- Competition for land from potential softwood plantation development, and likely implications for hardwood plantation development.

In order to attract investment for commercially viable hardwood plantations, plantation species and sites need to be reduced to a manageable number of options which have a reasonable prospect of producing outcomes. This resulted in recommendations for *E. cloeziana* and *E. pilularis* for sawlog plantations, and *E. grandis* for pulpwood plantations, with the proviso that hybrids of *E. grandis* are required to confer greater disease and insect resistance on the species. It is considered that there is substantial risk from pests and diseases for *E. grandis* grown for longer sawlog rotations.

Site selection for commercially successful plantations must be focussed on regions with the most favourable growing conditions and which are likely to result in a commercial timber crop within a reasonable time frame (refer Figure 2: Distribution of generally highly suitable land for hardwood plantations in the SEQ RFA region). These areas include the Land Management Areas (LMA's) of Moreton, Near North Coast and Coastal Burnett, relating to the supply zones Yarraman-Toowoomba, Gatton-Toogoolawah, Boonah-Warwick (part), Brisbane South East, Gympie, North Coast Zone, Kilcoy-Woodford, Builyan-Gladstone, Bundaberg and Maryborough. The Land Management Area is a broad sub-regional classification of land type and climatic characteristics.

Other LMA's in the study area have low rainfall and high evaporation combined with poorly productive soils. The supply zones to which these LMA's relate are the Eidsvold-Monto, Gayndah-Mundubbera, Murgon-Wondai and Boonah-Warwick zones (Stanthorpe-Rosenthal LMA).

There is the potential for softwood plantation development to increase competition for available land in the region. Drivers for softwood plantation development include predicted resource shortfalls from the current plantation estate and potential expansion of existing processing facilities. The zones that are likely to be affected by this competition include the Gympie, North Coast, Kilcoy-Woodford and Maryborough zones.

Employment in the region will be stimulated by an expansion of forest plantation activities. However, the actual numbers of individuals employed in the plantation industry are modest, running at around 50 full time employee equivalents/10,000 ha. Privately operated plantation enterprises are likely to employ fewer people than this.

Improving investor perception of the plantation forestry industry is critical in encouraging investment. This should include:

- Active promotion of the plantation industry and opportunities and analysis of developments in Australasia and the activities of international and national plantation owners;
- Debate on the need for private investment in the plantation industry and the potential for corporatisation and privatisation of state owned assets; and
- Recognition of the export potential of commodity and value added plantation fibre to the region, and the role of plantation forestry as a priority sustainable resource development for the future of Australia.

Activities on the finance side also serve to educate and lift the awareness of the investing public. These can include:

- Encouragement of State owned institutions (pension funds and banking) and local authorities to invest in plantation development as part of their long term investment strategies; and
- Providing investment incentives for the development of local processing and value adding facilities, and creating a demand for sustainable resource.

# 1. Introduction

Between December 1998 and June 1999, GRO undertook a study for BRS analysing the potential for establishing hardwood sawlog and pulpwood plantations in selected sawlog allocation zones of the south east Queensland CRA region. The study examined a series of factors relating to hardwood sawlog and pulpwood plantation development, and provided information for economic analysis to determine the suitability/viability of hardwood sawlog and pulpwood plantation development in the region. This Report provides the key information and conclusions from the study.

## 1.1 Short pulpwood and long sawnwood rotations

The rationale behind establishing hardwood plantations for pulpwood and sawlog is being driven by

- Supply constraints to existing native hardwood industries resulting from historical over-cutting of the available private property resource;
- Perceived and anticipated supply constraints from the outcomes of the RFA process itself;
- Increased pressure on the remaining native forest estate to be managed for a broader section of landuse than just production forestry;
- A genuine desire to diversify rural income through adopting alternative landuse, and,
- Good markets, infrastructure and growing conditions for the establishment of an economic hardwood plantation industry in the region.

## 1.2 Markets for hardwood plantation products

Markets for pulpwood will be based on the existing export woodchip market. However, with the current emphasis on utilisation of biomass as a renewable energy source, there is potential for this to provide an alternative market for hardwood pulpwood products.

Markets traditionally reliant on material grown in long-rotation hardwood crops from existing native forest are expected to be able to adapt to plantation grown products. There is a strong requirement to adopt an holistic approach to product and market development, and include markets such as post, poles and piles, sleepers and landscape timbers. It is this integrated approach which will assist in developing and ensuring efficient and economic utilisation of products grown in hardwood plantations.

## 2. Background information

The study covered the scope of the potential for development of a hardwood plantation industry in the south east Queensland CRA/RFA region and:

- Assessed players in, and the current status of, hardwood plantation development in the south east Queensland CRA region;
- Reviewed and made recommendations on species choice;
- Provided silvicultural regimes for sawlog and pulpwood plantations;
- Created synthetic yield curves for targeted hardwood species;
- Analysed product out-turn;
- Provided detailed plantation establishment costs;
- Provided plantation operational costs (roading, harvesting, haulage etc.);
- Analysed infrastructure in the region and commented on the adequacy of this to support plantation development where appropriate;
- Discussed potential impediments to plantation development and methods for identifying and resolving these;
- Analysed and presented land availability and cost for the sawlog allocation zones;
- Examined employment implications for plantation scenarios, including a case study of the northern NSW hardwood plantation industry, and;
- Examined the competition for land from potential softwood plantation development.

## 3. Hardwood plantation development in the region

Traditionally, there has been little hardwood plantation development in south east Queensland, both by comparison and in actual terms, when compared with exotic and native softwood. The critical factor in this situation has been market forces. That is, there has been no domestic or export demand for hardwood plantation timber given the historical usage patterns and markets for native hardwood timbers in the region.

Existing hardwood processing industries in the region have relied for supply on native forest sawlogs from both State Forest and private property in an approximate ratio 1:2. In addition, there has been no utilisation of hardwood residues, with the exception of

- CSR's hardboard plant at Ipswich;
- Sales of landscaping materials from those mills relatively close to the Brisbane market;
- Limited burning as fuel to supply power back into the grid, and;
- Small volumes (around 10 – 15,000 tpa) through the former Laminex Industries plant north of Gympie.

A number of proposals over the years, including pulp mills and eucalypt-based reconstituted board industries, have investigated the possibility to utilise residues from the region, however these have not progressed further. In addition, State Government legislation has been in place for a number of years prohibiting the felling of trees as pulpwood for conversion to woodchip.

The major market for Australian hardwood woodchip and residues is the Japanese paper industry. In relation to the region, there is concern over the uniformity and quality of any residue resource from the region as a source of raw material for paper production. As a result of low demand for this native forest product there has been no development of an export woodchip industry in the region or the State and, until very recently, no hardwood plantation establishment to meet a potential market. Note that there is a 300,000 tonne hardwood woodchip export licence currently in operation, but not utilised due to market and economic constraints.

In combination with the relatively small volumes of sawmill residues currently utilised by the industry, there is a significant surplus of hardwood residues in the region.

### **3.1 Products and markets**

Currently, there are two major focus areas in terms of hardwood plantation development. These are fast growing plantations for pulpwood, and plantations aimed at longer rotations producing a more diverse range of products. This section examines the more recent trial plantings and plantation establishment with a commercial focus.

#### **3.1.1 Short pulpwood rotations**

These are being grown on short rotations (10 years) for clearfall harvest and chip export.

### 3.1.2 Long sawnwood rotations

The rationale behind establishing hardwood plantations for sawnwood is being driven by

- Supply constraints to existing native hardwood industries resulting from historical over-cutting of the available private property resource;
- Perceived and anticipated supply constraints from the outcomes of the RFA process itself;
- A genuine desire to diversify rural income through adopting alternative landuse;
- Increased pressure on the remaining native forest estate to be managed for a broader section of landuse than just production forestry, and;
- Good markets, infrastructure and growing conditions for the establishment of an economic hardwood plantation industry in the region.

One of the key factors in the success of any marketing effort in this context is to ensure processing technology develops in concert with the plantations themselves. This technology should focus on the inherent characteristics of the available resource, and be directed by the market in terms of the outputs it is designed to produce.

## 3.2 Organisations/individuals currently establishing hardwood plantations

### 3.2.1 DPI Forestry

The Department of Primary Industries – Forestry (DPI Forestry) up until early 1999 were planting around 400 hectares per annum of long rotation hardwood plantation crops on farmland throughout the region in joint venture associations with land holders. This program is investigating the potential for site adaptability of a range of species, predominantly *Eucalyptus cloeziana*, *Corymbia citriodora* (Spotted Gum) and *E. argophloia* (Queensland Western White Gum). The program is funded in part through the Natural Heritage Trust to investigate the feasibility of establishing long rotation hardwood crops for sawlog.

DPI are looking to secure further funding through the Natural Heritage Trust to continue their joint venture plantation program. Currently the program has slowed significantly awaiting further funds. The total area of hardwood plantations established under this scheme since 1996 is around 1,500 hectares.

### **3.2.2 Queensland Commodity Exports Pty Ltd (QCE)**

Queensland Commodity Exports Pty Ltd (QCE) is a woodchip export and marketing joint venture between Japanese (Itochu) and Australian interests based at Fisherman's Wharf in Brisbane. Currently, QCE export around 300,000 tonnes of softwood woodchip per annum to Japan. The majority of this material is sourced from private property (former APM plantations in the local region) and from sawmill residue from the CSR Softwoods sawmill at Caboolture. It is anticipated this supply will last only until around 2004, when the last of the private property plantations are harvested on Bribie Island.

### **3.2.3 Oji Paper and East Cost Tree Farms Pty Ltd**

Oji Paper are setting up their Australian head office in Brisbane. Oji are currently purchasing softwood woodchips from QCE. Oji Paper own East Coast Hardwoods Pty Ltd, which is establishing *Eucalyptus grandis* plantations between Beaudesert and Kilcoy at a rate of around 1,300 hectares per annum (current estate size is around 3,000 hectares). Oji Paper also purchase woodchips (currently softwood but investigating hardwood) through their trading house Sumitomo Corporation. This seems to suggest that Oji is looking to expand significantly their hardwood pulpwood plantations in the region.

### **3.2.4 Canterwood Pty Ltd**

Hyne and Son Pty Ltd, based in Maryborough, have a joint venture company with Sumitomo Corporation of Japan, named Canterwood Pty Ltd. Canterwood exports around 300,000 tonnes of softwood woodchip per year through the port of Gladstone. The woodchip mill is located 25km south of Maryborough, and woodchips are loaded onto rail wagons for transport to Gladstone.

Canterwood's supply position is different to that of QCE, in that the vast majority their softwood log supply comes from state-owned forests managed by DPI Forestry. The wood supply comes from long-delayed thinning of softwood plantations due to the previous absence of a market for small diameter softwood. DPI have a stated intent to phase out thinning as a silvicultural tool in these forests and, as such, pulplog availability will decrease gradually over time. Canterwood's supply is anticipated to last until around 2006.

Canterwood have also established trials to investigate the potential of the region for hardwood plantations. Around 20 hectares of trials were established in the 1998 planting season over a range of sites investigating site adaptability and suitability of a range of species.

### **3.2.5 Plantation development for carbon capture**

Oil shale miner Southern Pacific Petroleum NL/Central Pacific Minerals NL has funded the establishment of around 150 hectares of hardwood plantation trials in the

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north of the region in the 1999 planting season. Any subsequent plantations based on the trials are aimed at capturing atmospheric carbon to offset emissions from SPP/CPM's core business activities.

### **3.2.6 Farm forestry/LandCare plantings**

While these do not yet fall into the commercial category, there have been significant monies allocated to be spent on farm forestry establishment in the region. Funds for these are generally administered federally. Examples include the Maryborough Farm Forestry group, which has been allocated several hundred thousand dollars to investigate the potential of the Maryborough region to grow long rotation hardwood crops.

### **3.2.7 Prospectus plantings**

In early 1999, two prospectuses have been issued for the growing of hardwoods in the region. The first, near Miriam Vale in the Builyan-Gladstone supply zone, is planned to grow commercial hardwood species. This prospectus is not a public document, and further information is not available.

The second prospectus is planning to grow "boutique eucalypt timbers" (high-value hardwoods on short rotations for specialty markets such as cabinet timbers) in the Stanthorpe area using intensive irrigation.

The total area that may be established under these arrangements in 1999-2000 is between 1,000 and 1,500 hectares.

## **4. Species choice**

### **4.1 Current knowledge**

Eucalypts have been planted in south east Queensland and north east NSW in relatively small areas, with low silvicultural inputs, and using techniques similar to those for enrichment plantings of natural stands. QFRI has established a range of hardwood trials which have shown, in small areas, the potential for hardwoods to be grown successfully in the region. Many of these trials are young and will produce excellent results in the coming years. Early experience has been gained in site preparation, response to fertiliser, weed control and stocking rates. Much of this experience has been based on knowledge gained from establishing extensive softwood plantations in the region.

Research and development (R&D) requirements to underpin a eucalypt plantation program in SE Queensland have been documented by Keenan et al (1998)<sup>1</sup>.

Requirements include:

- Land identification;
- Site and species testing;
- Silvicultural management for products;
- Management of pests and diseases;
- Wood and timber properties.

An expert panel and pool of available knowledge was used to define capability of land in SE Queensland for hardwood plantations (Queensland CRA/RFA steering committee 1998)<sup>2</sup>. The result of this study was to recommend a range of species and to determine that sufficient land exists which is capable of growing hardwood plantations; the suitability of this land in a socio-economic context remains to be determined.

## 4.2 Species selection – sawlog plantations

The species selected as most likely to be planted for hardwood sawnwood plantations in south east Queensland by the CRA/RFA Steering Committee<sup>3</sup> included:

*E. grandis* (Flooded gum)

*E. pilularis* (Blackbutt)

*E. cloeziana* (Gympie messmate)

*E. argophloia* (Queensland western white gum)

*Corymbia citriodora* (Spotted gum)

In addition, the Queensland Forest Research Institute<sup>4</sup> recommended that research was required on the following species for hardwood plantation development:

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<sup>1</sup> Keenan, R.J., Ivory, M., Lawson S., Lee, D., Leggate W., Lewty, M.J., Nikles D.G., Ryan, P., and Walker, S. 1998 Hardwood plantation research and development. Queensland Forestry Research Centre, May 1998.

<sup>2</sup> Queensland CRA/RFA steering committee 1998 SE 1.5 commercial plantation land capability analysis of south east Queensland. Revised draft report, September 1998.

<sup>3</sup> Queensland CRA/RFA Steering Committee September 1998 SE 1.5 commercial plantation land capability analysis of south east Queensland.

<i>Toona ciliata</i>	(Red cedar)
<i>E. camaldulensis</i>	(River red gum)
<i>E. cloeziana</i>	(Gympie messmate)
<i>Corymbia henryi</i>	(Spotted gum)
<i>Corymbia maculata</i>	(Spotted gum)
<i>E. micorcorys</i>	(Tallowwood)
<i>E. pellita</i>	(Red mahogany)
<i>E. tereticornis</i>	(Forest red gum or Queensland blue gum)

This list of species recommendations covers the biological growing conditions across the region, and some of these species may well turn out to be viable candidates for a plantation industry supporting timber markets. However, the main problem is that some immediate decisions need to be made about investment in hardwood plantations.

A list for immediate planting on highly suitable sites should be reduced to species which are known to have a market for their products, and are known to grow well and without major problems. This list should include *Eucalyptus pilularis* and *E. cloeziana* for sawlog plantations. The rationale for these priorities are:

- Established products and markets;
- Basic demonstration of performance in plantations;
- No major impediments to growth from pests and diseases;
- Growth, form and wood quality in native environments and soils;
- Overall performance in native range and suitability for coastal soils east of the Dividing Range.

Taking these considerations into account, exclusions from the list of most likely species proposed for sawlog plantation development by the Queensland CRA/RFA steering committee include the following:

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<sup>4</sup> Keenan, R.J., Ivory, M., Lawson S., Lee, D., Leggate W., Lewty, M.J., Nicles D.G., Ryan, P., and Walker, S. 1998 Hardwood plantation research and development. Queensland Forestry Research Centre, May 1998.

- *E. argophloia* was recommended in the CRA study, but has been excluded here because of currently insufficient understanding of wood and timber quality, and insufficient experience of growing conditions and yield.
- *Corymbia citriodora* (Spotted gum) is the highest priority species for drier sites, but current plantings in the region show widespread susceptibility to *Ramularia* leaf blight. This results in unacceptable tree growth, and precludes this species from further consideration until these problems may be overcome.

#### 4.2.1 Sawn products

The main question to be asked about hardwood plantations for sawlogs is “Can young vigorous hardwood trees supply wood of acceptable quality?”<sup>5</sup> The QFRI indicated the following problems and solutions required for conversion of plantation grown hardwood timber.

**Table 1: Issues to consider in processing young plantation eucalypts**

Issue	Problems	Solutions
Growth stresses	Distortion during sawing	Twin edging saws
	Brittle heart	Multiple blade saws
	End splitting	Radial sawing
	Low recovery	Wet storage
	Increased conversion costs	Increase log size through silviculture Reduce growth stresses through silviculture and site selection
Drying	Steep moisture gradients	Pre-drying technology
	Checking collapse	Solar kiln drying
	Long drying times	Radio frequency vacuum drying
		Production of thin wood and reconstituted boards
Defects	Insect borer holes	Remove need for whole board
	Knots	New products such as laminated veneer lumber (LVL)
	Rot	Veneer wrapped products
	Kino veins	Maximise market potential for feature wood highlighting imperfections

Developments in timber processing clearly indicate that there will be less reliance on sawn wood products in the future. It is expected that emphasis will shift to the production of reconstituted products from processed wood. The attraction of processing wood for products such as laminated veneer lumber (LVL), oriented strand board (OSB), and medium density fibreboard (MDF) include:

<sup>5</sup> Keenan, R.J., Ivory, M., Lawson S., Lee, D., Leggate W., Lewty, M.J., Nicles D.G., Ryan, P., and Walker, S. 1998 Hardwood plantation research and development. Queensland Forestry Research Centre, May 1998.

- Higher recoveries of useable wood from logs;
- Utilisation of smaller diameter logs;
- Reduced wood waste problems;
- Timber products produced to engineering specifications;
- Higher processing efficiencies through new equipment and processes; and
- Penetration of wood products into new markets.

These benefits are offset by the requirement to install world scale processing facilities for the new products. Such shifts in processing capacity will inevitably result in a rationalisation of the numbers and locations of wood processors.

**Table 2: Priority 1 species characteristics**

Priority 1 species	Common name	Growing conditions	Products	Markets	Plantation experience
<i>E. pilularis</i>	Blackbutt	Tall straight tree with dense crown. Recorded up to 70 m height and 3 m DBH in natural stands. Well watered (900-1750 mm/yr). Fertile and well drained coastal loams, clay loams and sandy loams.	Poles and sawn timber – quality flooring, kiln-dried structural, mouldings and components	Traditional and well established	Traditional and highly prized timber. Excellent yield expected in highly fertile well drained coastal sites. Substantial experience in enrichment planting and small areas of plantation in NSW and Queensland. Very little genetic selection but very great potential for improvement.  Successful plantation experience and products in Hawaii, Zimbabwe, Nigeria, Brazil.
<i>E. cloeziana</i>	Gympie messmate	Up to 55 m height and 2 m DBH in natural stands. Wide latitudinal range which overlaps <i>E. pilularis</i> . Rainfall 550-2300 mm/yr. Tolerates a wide range of soils and geologies. Best growth on loams and clay loams of volcanic origin.	Poles receive premium price. Sawn timber – flooring, decking, green sawn and kiln-dried structural.	Traditional and well established	Traditional and highly prized timber. Excellent yield expected in highly fertile coastal sites. Southern Queensland provenances better performance in plantations than northern provenances. Problems encountered in propagation from seed; highly variable germination. Poor rooting capability as vegetative cuttings; a major restriction for clonal propagation. Genetic selection and breeding can overcome these restrictions.  Excellent managed coppice plantations in South Africa. 17 year old plantation at Muguga research station in Kenya mean DBH 34 cm, mean ht 30m. Other successful plantations in Brazil, Congo, Madagascar, Nigeria, Sri Lanka, Zambia.

The rationale for selection of the two priority species is shown in Table 2. Sources of information contained in Table 2 and Table 3 are: Hillis and Brown (1978)<sup>6</sup>, FAO (1979)<sup>7</sup> Boland et al (1984)<sup>8</sup> and personal communications from Queensland Forestry Research Institute.

The species list has been added to in the RFA planning process (Queensland CRA/RFA steering committee 1998)<sup>9</sup> to include lower priority species (Table 3). New hybrids with *E. grandis* are also being tested and, based on overseas performance, some of these may prove to be highly suitable for the hardwood plantation industry. The expectation is that the growth performance characteristics of *E. grandis* will be incorporated together with hardiness for a wider range of sites in the new hybrids. It is most likely that new hybrids bred for their suitability for SE Queensland will receive a higher priority for planting than the traditional minor timber species. This is because of the potential to increase growth and yield through well targeted hybridisation.

Table 4 shows the species most likely to be successful in plantations have high standards of timber quality. The two main species selected as suitable for sawlog plantations have outstanding wood quality and have reliable markets based on these characteristics. This is based on wood samples taken from slowly grown trees from natural stands. It is generally well understood that the quality of timber from plantation grown trees will be different, and generally poorer in some respects. This is due to faster growth rates and growth stresses in the stem. Improvements in wood quality from plantation-grown timber can be achieved through a more uniform dimensioned product, and fewer defects because of silvicultural management such as pruning and management of fire and insects. Improvements in uniformity and predictability of the wood product are expected to far outweigh small decreases in wood quality and performance during drying.

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<sup>6</sup> Hillis W.E., and Brown, A.G. 1978 Eucalypts for wood production. CSIRO 1978.

<sup>7</sup> Eucalypts for planting. FAO Rome 1978.

<sup>8</sup> Boland, D.J., Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., and Turner, J.D. 1984 Forest trees of Australia. CSIRO 1984.

<sup>9</sup> Queensland CRA/RFA steering committee 1998 SE 1.5 commercial plantation land capability analysis of south east Queensland. Revised draft report, September 1998.

**Table 3: Priority 2 species characteristics**

Priority 2 and promising untested species and hybrids	Common name	Growing conditions	Products	Markets	Plantation experience
<i>Corymbia citriodora</i> (surrogate for previous wider species classification of <i>E. maculata</i> / <i>E. citriodora</i> and includes <i>C. henryi</i> / <i>C. variegata</i> )	Spotted gum	Wide latitudinal range extending into SE Queensland. Generally lower rainfall areas (750-1750 mm/yr). Occupies and tolerates shallower stony well drained soils on slopes.	Sawn timber – quality flooring, decking, green and kiln-dried structural, poles, handles. Can be turned easily. Produces straight poles suitable for treatment.	Traditional and well established	Species for lower rainfall and shallow soils: sites considered marginal for <i>E. pilularis</i> and <i>E. cloeziana</i> . Problems encountered with <i>Ramularia</i> shoot blight in trial plantations.  Plantations have been very successful in South Africa, Thailand, Hawaii, Brazil and Mediterranean countries. It tolerates hotter and drier conditions than <i>E. grandis</i> which could otherwise occupy the same sites. MAI of 16 m <sup>3</sup> /ha/yr achieved in Kwantong Province, China.
<i>E. grandis</i> x <i>E. camaldulensis</i>			<i>E. grandis</i> well established pulpwood species. Hybrid wood qualities not well known	Unknown	Excellent growth in Brazil and South Africa. Some clonal material imported into Australia and some small trial areas very recently planted in Queensland.
<i>E. grandis</i> x <i>E. urophylla</i>	Urograndis		As above	Unknown	Excellent growth in Brazil where it is used as a pulping species. Great potential for further selection and improvement.
<i>E. grandis</i> x <i>E. pellita</i>			As above	Unknown	Vigour of <i>E. grandis</i> with insect and disease resistance of <i>E. pellita</i> Excellent growth at sea level in South Kalimantan. Good growth in South Africa.
<i>E. grandis</i>	Flooded gum/Rose gum	Moderate geographical range from central coast NSW to N Queensland. Attains 45-55 m height and up to 2 m DBH in natural stands. Rainfall of 1000-3500 mm/yr. Quite restricted range of sites: occupies fertile well watered loamy soils on the margins of rainforests.	Poles, sawn timber (flooring, decking, structural, mouldings, components), excellent pulpwood species	Traditional and well established	Excellent early growth and good response to fertiliser enhancement. Shell trials in Queensland hit very hard by <i>Cylindrocladium</i> fungus, and later by insect defoliators. MAI of 15-16 m <sup>3</sup> /ha/yr in plantations established in NE NSW and SE Queensland and now up to 36 years old.  MAI in excess of 45 m <sup>3</sup> /ha/yr recorded in the Transvaal in South Africa.

Priority 2 and promising untested species and hybrids	Common name	Growing conditions	Products	Markets	Plantation experience
<i>E. resinifera</i>	Red mahogany	Wide latitudinal range in coastal Queensland. In natural stands attains 45 m height and 1-1.5 m DBH. Rainfall 800-2500 mm/yr. Occupies well watered and fertile coastal soils: loams and clay loams of volcanic origin.	Flooring, structural, green-sawn products	Established – minor forest species by comparison	
<i>E. microcorys</i>	Tallowwood	Wide coastal distribution from N NSW to Fraser Island. Rainfall 1000-2000 mm/yr. Occupies coastal range soils including clay loams and infertile but well watered sands.	Flooring, decking, marine use, piles, poles, girders. Highly sought after.	Traditional and well established	
<i>E. dunnii</i>	Dunn's white gum	Restricted natural occurrence on border of NSW/Queensland. IN natural stands attains 50 m height and up to 2.5 m DBH. Rainfall zone of 1000-1750 mm. Occupies a wide range of sites and soils in the coastal ranges on the margins of rainforests.	Non-preferred species for sawing and drying. Flooring, kiln dried structural.	Established – minor forest species by comparison	Good yield and favourable wood quality for pulping in Portugal.
<i>E. tereticornis</i>	Blue gum	Very wide latitudinal range from Victorian border to Cape York. Attains 20-50 m height and up to 2 m DBH in natural stands. Provenances cover rainfall zones from 600-3000 mm. Occupies fertile loams to well drained gravel soils.	Sleepers, poles, piles, rails, flooring, green and kiln-dried structural	Traditional and well established	A widespread species with very large differences in performance between provenances. Some excellent trees in SE Queensland. More selection and testing required
<i>E. acmenoides</i>	White mahogany/ Yellow stringybark	Wide coastal range from central coast NSW to N Queensland. Attains 60 m height and more than 1 m DBH in natural stands. Rainfall range 700-1700 mm/yr. Occupies shallow well drained soils on ridges of the coastal range.	Sleepers, piles, rails, some green sawn timber products	Established – minor forest species by comparison	

**Table 4: Ranking of mechanical properties of mature wood of eucalypts (1 low:10 high) (Hillis and Brown 1978)**

Species	Moisture condition	Density	Modus of rupture	Modus of elasticity	Compression strength	Shear strength	Hardness (side)	Toughness	Cleavage strength	Strength group	Shrinkage	Lyctus susceptibility	Description
<i>E. pilularis</i>	Green	8	7	8+	7+	7	7+	8	7+	S2	High	None	Grain straight, sometimes interlocked, Texture fine to medium, some kino veins may be present
	12%	9	9+	9+	9+	8+	8+	8	8+	SD2			
<i>E. cloeziana</i>	Green	9	7+	8	8	7+	8	8+	8+	S2	Medium	None	Grain straight. Texture even
	12%	9+	9	9	9+	9+	10	7	8+	SD3			
<i>E. maculata</i> (surrogate for <i>C. citriodora</i> )	Green	9	8	9	8	8	9	8+	8+	S2	Medium	Susceptible	Grain usually straight, occasionally wavy. Texture coarse. Kino pockets present. Slightly greasy
	12%	9+	9	9+	9+	9+	9+	9	9	SD2			
<i>E. grandis</i> (surrogate for <i>E. grandis</i> hybrids)	Green	7+	7	8	7	6+	6+	8	8	S3	Medium	None	Grain often interlocked. Texture fine to medium.
	12%	9	8+	9	9	8	8	7	9	SD4			

### 4.3 Species selection – pulpwood plantations

The main species suitable for pulpwood production in the study area is *Eucalyptus grandis*. However, this is seen as a moderately risky intermediate recommendation until more disease and insect resistant hybrids of *E. grandis* are developed. Young wood from other species such as *E. cloeziana* and *E. pilularis* may be suitable for pulping provided wood density does not get too high. However, there are few pulping tests for these species, and there are no current markets for pulpwood from these particular species grown in Australia.

*E. globulus* (Tasmanian blue gum) is a well recognised pulping species favoured by Japanese pulp and paper manufacturers, and is currently showing good early growth in the region in fertile krasnozems soils at altitude in the Yarraman district<sup>10</sup>. However, much more spatial testing is required to determine this species as a potential crop for south east Queensland; it is likely to be small in area if it is viable at all.

*E. grandis* and its hybrids with *E. urophylla* have achieved spectacular growth rates of between 44 and 84 m<sup>3</sup>/ha/yr in South Africa and Brazil<sup>11</sup>. Currently in Queensland, East Coast Tree Farms (ECTF) are projecting MAI of 25 m<sup>3</sup>/ha/yr at rotation age of 10 years for *E. grandis* grown for pulpwood<sup>12</sup>. This gives a total wood volume of 250 m<sup>3</sup>/ha at rotation age, planting at 1,250 stems/ha.

Shell established trials aimed at analysing the feasibility of establishment of pulpwood plantations in south east Queensland in 1987. Results from one of these trials<sup>13</sup> planting *E. grandis* on coastal podzolic soils showed optimum fertiliser treatment to increase wood production from 76 m<sup>3</sup>/ha to 145 m<sup>3</sup>/ha at age 5.6 years. This is a maximum growth rate of 26 m<sup>3</sup>/ha/yr. The most important finding from this trial was that as growth rates increased, wood basic density and pulp yield also increased, leading to an increase in the quantity of screened pulp per unit volume of wood (pulpwood productivity) by about 12% (from 194 to 217 kg pulp/m<sup>3</sup> wood). The nett effect of increased growth rate and wood density was a doubling of screened pulp from the plantation from 16t/ha/yr to 32 t/ha/yr.

This collected information is relatively scarce and locally focussed. However, it does indicate the potential for commercially viable growth rates of *E. grandis* hybrids for pulpwood production in the study area.

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<sup>10</sup> M Lewty Queensland Forest Research Institute pers. comm.

<sup>11</sup> Beadle C L and Inions G 1990 Limits to growth of Eucalypts and their biology of production. In: Prospects for Australian Plantations, J Dargavel and N Semple (eds) CRES Canberra 1990, 183-193.

<sup>12</sup> G Inions, East Coast Tree Farms pers. comm.

<sup>13</sup> Cromer R N, Balodis V, Cameron D, Garland C P, Rance S, and Ryan P 1998 *Eucalyptus grandis* fertiliser trials: growth, wood properties and kraft pulp yield. *Appita* 51 (1): 45-49.

#### 4.3.1 Pulping properties of eucalypts

Young *E. globulus* has been adopted as a benchmark for pulping properties of eucalypts. Moreover, the dramatic increase to more than 150,000 ha<sup>14</sup> of predominantly *E. globulus* in Western Australia, South Australia, Victoria and Tasmania will ensure that this will remain the standard for export of Australian plantation grown hardwood woodchips for pulp and paper making.

*Eucalyptus* pulps are used in widely varying proportions, together with softwood pulps, in the production of paper and packaging materials. Optimum wood density for eucalypts<sup>15</sup> would appear to be 460 kg/m<sup>3</sup>. At this level, paper tear strength is maximised. Higher wood densities produce bulkier, stiffer and more porous sheets. Lower density woods produce smoother, denser and higher tensile strength sheets.

Queensland DPI and CSIRO tested the pulping properties of young *E. cloeziana*, *E. pellita* and *E. urophylla* from northern Queensland<sup>16</sup>. The results (Figure 1) showed that the pulping properties, particularly tensile strength, were between those for mixed hardwood chips from Tasmania, and temperate grown *E. globulus*. The main problem with the wood from these species was the relatively high density, particularly for *E. cloeziana* (594 kg/m<sup>3</sup>) followed by *E. pellita* (534 kg/m<sup>3</sup>) and *E. urophylla* (488 kg/m<sup>3</sup>). Increases in wood density with age to greater than 600 kg/m<sup>3</sup> would make wood from these species completely unsuitable for pulping.

By comparison, *E. grandis* has a generally low wood density of around 440-450 kg/m<sup>3</sup> and it may be desirable to increase this wood density somewhat. For this reason, hybridisation of *E. grandis* with *E. camaldulensis* or *E. tereticornis* has been considered desirable.

Density requirements of *E. grandis* for pulping in South Africa<sup>17</sup> were found to be better towards the lower end of the range of between 670 and 344 kg/m<sup>3</sup>, and this may not be entirely inconsistent with an optimum density of around 460 kg/m<sup>3</sup>.

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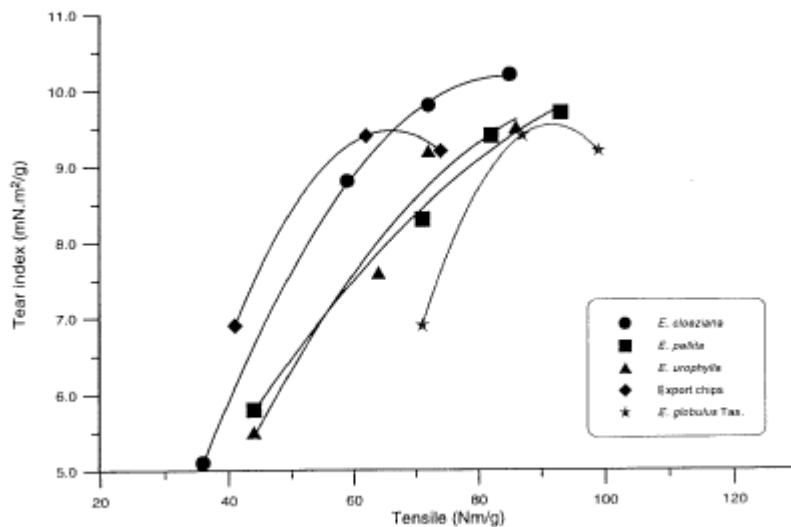
<sup>14</sup> ABARE 1998 Australian forest products statistics. December quarter 1998. pp 87.

<sup>15</sup> Arbuthnot A L 1991 The influence of basic wood density of eucalypts on pulp and paper properties. IUFRO Symposium Intensive Forestry: the role of eucalypts. 966-975.

<sup>16</sup> CSIRO 1996 The kraft pulping and paper making properties of 5 year old plantation-grown *Eucalyptus cloeziana*, *E. pellita* and *E. urophylla* from northern Queensland. CSIRO Division of Forestry and Forest Products Divisional Report No DFFP 523.

<sup>17</sup> DuPlooy A B J 1980 The relationship between wood and pulp properties of *E. grandis* (Hill ex-Maiden) grown in South Africa.

**Figure 1: Pulping properties of three Queensland hardwoods**



*E. grandis* is a suitable pulping species as demonstrated by its use in South Africa and the current plantings being established by East Coast Tree Farms Pty Ltd for pulpwood export to Japan. The hybrid between *E. grandis* and *E. urophylla* is currently used for pulpwood in Brazil.

The main problem with *E. grandis* still remains its susceptibility to insect attack (leaf eaters and stem borers) and leaf fungi. Pure plantings of *E. grandis* by Shell for pulpwood trials were severely damaged by insect attack<sup>18</sup>. Hybridisation of *E. grandis* with *E. urophylla* or *E. pellita* has the potential to confer better insect and disease resistance on *E. grandis*.

The current softwood plantation resource provides thinnings which are exported to Japan for pulpwood. Commonly, a mix of hardwood and softwood pulps are used to make many grades of paper and packaging materials with different proportions of pulp attributing strength and finish to the paper. A combined hardwood and softwood resource would be able to supply feedstock for products such as kraft liner board, corrugating medium, bond paper and copy paper for both domestic and export markets.

<sup>18</sup> Paul Ryan, Queensland Forest Research Institute pers. comm.

## 4.4 Performance in plantations

Hardwood plantations, particularly in south east Queensland and to a lesser extent north east NSW, have up until very recently been established in small areas. Establishment and silvicultural practices for these plantations have been similar to those used in enrichment planting for natural stands. Such practices included limited site preparation, direct seeding in some cases, and little use of fertiliser and weed control.

The yields from such plantations can be used only as a base level benchmark for the yield from plantations which can be established with:

- Genetically improved planting material;
- Appropriate soil cultivation;
- Pre-planting and post planting weed control;
- Tailored fertiliser treatments, and;
- Thinning and pruning to maximise yield and product out turn.

It is reasonable to expect that well managed plantations with genetically improved planting material could at least double yields compared to earlier plantations and enrichment plantings. Substantial experience in site management has been gained from planting *Pinus* species extensively in south east Queensland. Performance of these plantations can be used on a generalised level as a surrogate for the expected performance of well sited and well managed hardwood plantations.

Trials of hardwoods have been established only relatively recently. The Shell trials managed by Queensland DPI Forestry yielded some spectacular results for *E. grandis* grown under “superculture” conditions. These plantations, however, have suffered considerably from leaf fungi and insect browsers.

The oldest trials most commonly referred to are the hardwood trials at Pomona in SE Queensland. These trials were established in order to find ways of re-forestation degraded soldier settler small holdings in 1946. The plantations were established at a stocking of 1111 stems/ha and thinned back to 200 stems/ha at age 10 years, with the exception of *E. resinifera*, which was not thinned until age 25 years. The following table shows that *E. cloeziana* was by far the best performer. These trials were established with very low silvicultural inputs to yield an MAI of between 5.1 to 15.5 m<sup>3</sup>/ha/yr at age 40. Using current available knowledge about establishment and maintenance, it is realistic to expect that the volumes attained at age 40 years could be achieved at a rotation age of 25 years, leading to an MAI of between 8 and 25 m<sup>3</sup>/ha/yr.

**Table 5: Hardwood planting at Pomona at age 39.7 years (QFRI Experiment 253 Hardwoods)**

Species	Stocking (stems/ha)	Predominant height (m)	DHH/BA (cm)	Standing basal area (m <sup>2</sup> /ha)	Total production basal area (m <sup>2</sup> /ha)	Total standing volume (m <sup>3</sup> /ha)
<i>E. cloeziana</i>	208	40.1	52.1	44.4	52.9	620
<i>E. cloeziana</i>	178	38.4	47.6	31.7	34.2	423
<i>E. grandis</i>	168	40.2	49.4	32.2	35.3	228
<i>E. resinifera</i>	178	31.1	37.1	19.2	36.1	204

## 4.5 Limitations on growth

Planting any trees on sites to which they are not readily adapted causes stress in the tree. This is not a reason for excluding such sites if the stress can be overcome by silvicultural management such as cultivation to reduce root limitations, fertiliser to overcome nutrient stresses, and spacing to reduce competition for resources. When trees are under stress they are most often vulnerable to browsing by insects and attack by pathogens. This is most likely due to the increased palatability of the substrate (mostly leaves). Occupation and successful management of marginal sites is the main objective of foresters managing plantations since this is the land which most often is available for planting. Management of stress is then the main objective in establishing hardwood plantations in south east Queensland.

### 4.5.1 Leaf area

Growth of tree species is dependent upon received climatic parameters of effective rainfall (rainfall-evaporation), temperature, and solar radiation. Growth is also dependent upon received CO<sub>2</sub>, which is not limiting, but increased atmospheric CO<sub>2</sub> concentrations may increase growth rates. The physiology of the tree also determines the ability to which it can capitalise on water, CO<sub>2</sub> and sunlight, and this is determined in large part by leaf area display defined as leaf area index or LAI (m<sup>2</sup> of leaf/m<sup>2</sup> of ground). Studies on eucalypts in Tasmania and WA have shown the strong dependence of growth rate on light interception. Rapid growth rates can be attributed to species which carry high leaf areas in their early development, and *E. grandis* is one of these<sup>19</sup>. Good soils, good rainfall and good nutrition will result in expanded leaf area index and rapid growth of eucalypts.

<sup>19</sup> Beadle C L and Inions G 1990 Limits to growth of Eucalypts and their biology of production. In: Prospects for Australian Plantations, J Dargavel and N Semple (eds) CRES Canberra 1990, 183-193.

#### 4.5.2 Pests and diseases

The major problem in establishing indigenous species in monospecific plantations is that indigenous insects and pathogens attack the fresh display of food source. This is neither unique to *Eucalyptus* nor Australia. In Australia, insects and pathogens cause severe restrictions on the realisation of potential growth and yield of all eucalypts as shown in Table 6. The absence of many of these insects and pathogens overseas has underpinned the spectacular performance of *E. grandis* and *E. camaldulensis* in South America, South Africa and the Congo and the Mediterranean. Some eucalypts are more vulnerable than others, and *E. grandis* in particular is highly vulnerable to both leaf fungi, browsing insects and wood borers.

Pulpwood evaluation trials of *E. grandis* established by Shell in 1987 near Ingham, to the north of the south east Queensland study area, suffered from defoliation by the fungus *Cylindrocladium*. Defoliation resulted in the death of most trees. This event did not occur in the synchronously established Gympie trial sites, but it is a potential threat to *E. grandis* plantations in the study area.

Defoliation from *Cylindrocladium* will occur if there is an incidence of a prolonged period (several days) of high temperature, high humidity, no breeze and the presence of the fungal pathogen. The coincidence of these conditions is not common in the study area or further north, but attack from *Cylindrocladium* can occur on a frequency of around five to ten years. There are no supporting data for this meteorological incidence, but it may well be tied to weather patterns predictable from the southern oscillation index (SOI).

The Shell trials also suffered from attacks from wood borers. These included the wood moth *Xyleutes boisduvali*, and a long horn beetle *Tryphocaria solida*. Damage to stems from borers was widespread and was greatest in trees stressed from grass competition, and in trees in the “superculture” trial<sup>20</sup>.

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<sup>20</sup> P Ryan, Queensland Forest Research Institute, pers. comm.

**Table 6: Insects and pathogens that attack plantations in south east Queensland**

Insect/Pathogen	Common name	Activity and damage
<i>Anoplognathus</i>	Christmas beetle	Defoliation, particularly in ex-pasture sites where larvae live under the sward. Can lose current year's growth, and sometimes fatal.
<i>Epholcis</i>	Scarab beetle	Defoliation. Can lose current year's growth, and sometimes fatal.
<i>Monolepta australis</i>	Swarming leaf beetle	Defoliation. Can lose current year's growth, and sometimes fatal.
	Sap suckers	Reduced vigour
	Lerps	Reduced vigour
	Bugs	Reduced vigour
<i>Endoxyla cinerea</i>	Giant wood moth	Wood degrade and stem breakage in young plantations
<i>Phoracantha</i>	Longicorn beetle	Wood degrade and stem breakage in young plantations
<i>Ramularia</i>	Shoot blight	Defoliation. Reduced yield.
<i>Cylindrocladium</i>	Leaf blight	Defoliation. Often fatal.

#### 4.5.3 Potential for tree breeding and/or hybridisation

The potential growth rates of *E. grandis* are high due to its ability to increase leaf area under favourable conditions. However, such conditions appear to increase the risk of defoliation from leaf fungi and damage to stem wood production and tree health from wood boring insects. Both of these factors lead to the conclusion that successful pulpwood plantations relying on pulping properties of *E. grandis* must rely on hybrids with *E. grandis* and other species which can confer resistance to foliar fungi and wood borers without lowering pulping properties.

*Eucalyptus* hybridisation programs have been carried out most notably in South America and South Africa. The most notable hybrid has been *E. grandis* with *E. urophylla*, which has produced growth rates in the order of 80 m<sup>3</sup>/ha/yr in Brazil. Such rapid growth rates are a result of hybrid vigour as well as the lack of serious pests and disease of *Eucalyptus* in these countries.

Currently, several hybrids have been imported and established in trial plantings in Australia including hybrids of *E. grandis* with *E. camaldulensis*, *E. grandis* with *E. globulus* and *E. grandis* with *E. urophylla*. The hybrid material comes from a variety of sources ranging from well established and documented breeding programs with intellectual property agreements, to a few individual clones imported for testing on private arrangements. All imported clonal material has to be held in quarantine for a period of two years before release to ensure that pathogens are not introduced with the vegetative material. Whilst some clones, imported from locations with no insect or pathogen pressure, may be successful in some locations in Australia, this approach can be "hit and miss" when compared to a targeted breeding program designed to produce a wide range of clones for testing yield and resistance to insects and pathogens.

Breeding programs based on traditional tree breeding techniques coupled with widely available genetic mapping technologies can provide a strongly based range of elite hybrid clones. Whilst development and testing of such material is an on-going program, substantial gains can be realised in a matter of three to five years based on early selection criteria. This material results from a breeding program producing successive generations of elite clones from a strong and wide genetic base. Moreover, the control of hybridisation using genetic mapping and field testing will provide hybrids which are targeted specifically at carrying resistance to local pests and diseases.

*Corymbia* species in plantations suffer from *Ramularia* leaf blight. Its effect is to distort the tree's growth and to reduce wood volume production. There may be some genetic control of susceptibility to this leaf blight. Tree breeding is required to improve resistance of *Corymbia* to *Ramularia*.

## 5. Regional selection

The core assumption for determining allocation zones potentially suitable for establishment of hardwood sawlog and pulpwood plantations is that growth rates must be medium to high (i.e. greater than 20 m<sup>3</sup>/ha/year). The study was extended to include lower growth rates for sawlog. However, if a hardwood plantation resource is to be developed and/or funded by investors seeking an adequate return on their investment, it is more practical to consider only rainfall and soil conditions of high suitability, resulting in medium to high growth rates. Growth rate assumptions are based on SE1.5, and GRO's experience of the landscape, soils and climate in the region. Screening criteria for selection of suitable allocation zones for review include:

- Medium to high growth rates (although a low growth rate has been modelled for comparison);
- Growing conditions (soil type/geology, rainfall);
- Distance to proposed market; and
- Current plantation development activity.

## 5.1 Growing conditions and limits to growth

### 5.1.1 Growing conditions in the study area

The CRA/RFA Steering Committee<sup>21</sup> in their report SE1.5 highlighted the inadequacy of currently available soils information in relation to estimating potential plantation productivity. The findings of the study were also inconclusive about suitable area for plantations: the potential area for *E. argophloia* (western white gum) was 50% of the study area, and the potential area for *Corymbia* (spotted gum) was 72% of the study area for SE1.5. This uncertainty is compounded by the very meagre knowledge about growing conditions and markets for *E. argophloia*, and the high susceptibility of *Corymbia* to leaf blight. The study recommended further research using environmental domain modelling, but this in itself may not provide useful results because the experimental hardwood plantation base is so small. This is being remedied, but it will take many more years until useful and comprehensive growth and yield information is obtained for hardwood plantations in the study area.

A pragmatic approach has to be adopted in order to define the best growing conditions for tree species with respect to soils and climate, and to define species for which there are clear products and markets. For detailed species choice rationale refer to Section 4.

### 5.1.2 Climate and soils

The studies utilised the Land Management Reports for the study areas. Land Management Area mapping has been carried out by the Queensland Department of Primary Industry and the Department of Natural Resources. The mapping combines soils and climate information into land management classes predominantly for agricultural pursuits, and is a concise source of information for landholders, Departmental Extension Officers and groups or persons involved in farm planning (eg Land Care Groups and Property Management Groups).

The CRA/RFA Steering Committee set a limit of >800 mm mean annual rainfall for the suitability of sites for *Eucalyptus grandis*, *E. cloeziana*, and *E. pilularis*, and <800 mm for *E. argophloia* and *Corymbia* (Spotted Gum). The efficacy of these rainfall amounts was modified in the evaluation by soil suitability.

The basic premise was that the minimum rainfall for successful establishment and growth of commercial tree crops was >1,000 mm/year. This target was set in order to account for high year to year variation in mean annual rainfall, and high evaporation at these latitudes. In general across the study area, summer rainfall exceeds evaporation when rainfall is greater than 1,000 mm/year. As mean annual rainfall decreases, open pan evaporation exceeds rainfall at all times through the year.

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<sup>21</sup> Queensland CRA/RFA Steering Committee September 1998 SE 1.5 commercial plantation land capability analysis of south east Queensland.

This severely limits effective rainfall and makes the establishment and management of tree crops precarious. Growth rates of plantation crops are also slowed greatly under such conditions of water stress.

The conditions set effectively eliminate, for the time being, slow growing species such as *Corymbia* and species of unknown performance such as *E. argophloia*. These conditions also effectively eliminate from current consideration Land Management Areas of Stanthorpe-Rosenthal Region, and the Inland Burnett District.

Table 7 provides a broad overview of the Sawlog Allocation Zones for the study area and the Land Management Areas which cover them. The table also provides a qualitative ranking of overall suitability of the LMA for commercial hardwood plantations.

**Table 7: Overview of climate and soils for Sawlog Allocation Zones in the study area, and ranking of suitability for commercial hardwood plantations**

Sawlog Allocation Zone	Land Resource Area / Land Management Area	Climate characteristics	Dominant geological and soils characteristics	Overall suitability for commercial hardwood plantations
Eidsvold-Monto Gayndah-Mundubbera Murgon-Wondai	Inland Burnett	Mostly <800 mm mean annual rainfall.  Average evaporation rates exceed rainfall for each month of the year.	Highly dissected area with N-S drainage trend.  Largest land unit (706,500 ha) is upland sediments of sandstone, mudstone and conglomerate. Large areas also of granite hills (508,800 ha) and volcanic ranges (531,000).  Some highly suitable upland volcanic soils (462,100 ha) on gabbro and basalt.	Low
Builyan-Gladstone Bundaberg Maryborough	Coastal Burnett	Almost entire area >900 mm mean annual rainfall.  Rainfall exceeds evaporation in the south in Summer (Maryborough and Childers). Evaporation exceeds rainfall farther north (Bundaberg and Gladstone).	Landscape a mix of coastal lowlands and coastal hills and ranges. Soils are dominated by c. 700,000 ha of granitic and acid volcanic soils, and 434,000 ha of solodic soils and yellow earths on gently undulating coastal plains.	Moderate-High
Gympie Kilcoy-Woodford North Coast	Near North Coast [Study incomplete]	Steep rainfall gradient from coast (1,300 mm) to the west > 900 mm mean annual rainfall.  Rainfall exceeds evaporation in summer.	[From Sunshine Coast Land Resource Area]  East-west drained landscape flowing from coastal ranges of volcanic intrusive and metamorphic rocks, across low undulating hills of sandstones to a coastal plain of recent sandy deposits. Some small intrusions of Tertiary volcanics.  Soils dominated by sandy soils on coastal alluvium, and soloths and yellow-red podzolic soils on the coastal sandstone hills.	High

Sawlog Allocation Zone	Land Resource Area / Land Management Area	Climate characteristics	Dominant geological and soils characteristics	Overall suitability for commercial hardwood plantations
Yarraman-Toowoomba Gatton-Toogoolawah Boonah-Warwick Brisbane South East	Moreton	Most of the area >800 mm mean annual rainfall. Steep rainfall gradient declining from west (1,500 mm) to east (<800mm).  Rainfall exceeds evaporation in the east, but evaporation exceeds rainfall in the west.	Dissected hilly landscape dominated by sandy solodic and yellow and red podzolic soils on sandstone siltstone and shale (>445,000 ha). Other soils include shallow soils on metamorphic hills (243,000 ha), and soils developed on volcanic basalts, andesite, dolerite and gabbro (190,430 ha).	Moderate-High
Boonah-Warwick	Stanthorpe-Rosenthal	Mostly <800 mm mean annual rainfall over entire area.  Average evaporation rates exceed rainfall for each month of the year.	Eastern slopes of the Great Dividing Range. Complex dissected landscape with radial drainage to north, south and west.  Soils dominated by shallow gravelly soils on hard traprock hills (164,566 ha), and shallow to deep gritty sands amongst rocky granite outcrops (>100,000 ha).	Very low

## 5.2 Site requirements

The expert panel assembled for the Queensland CRA/RFA steering committee (1998)<sup>22</sup> categorised sites in terms of the capability of geology, soils and rainfall for growing plantations. The following tables show a simplified and pragmatic extract of this information for the target species discussed in this report. Small adjustments to expected yields have been made based on the interaction between soil rooting volume and rainfall.

**Table 8: Capability of soils derived from parent rock types in SE Queensland**

Stratigraphic unit	<i>E. pilularis</i>	<i>E. cloeziana</i>	<i>C. citriodora</i>
Alluvium	High	High	High
Siliceous sand	Medium	Low	Medium
Saline alluvium	Incapable	Incapable	Incapable
Acid granites	Low	Low	Medium
Coarse intermediate granodiorite	Medium	Medium	Medium
Fine intermediate igneous	Low	Low	High
Basic igneous	High	High	High
Ultra basic serpentines	Incapable	Incapable	Incapable
Labile sedimentary	Medium	Medium	Medium
Quartzose sandstone	Low	Low	Medium
Metasediment	Low	Low	Medium

**Table 9: Expected MAI (m<sup>3</sup>/ha/yr) for *E. pilularis* and *E. cloeziana* plantations established on soil types in rainfall zones (after Queensland CRA/RFA steering committee 1998)**

Rainfall (mm/yr)	Soil capability			
	High	Medium	Low	Incapable
>1,300	>20	15-20	10-15	0
>1,000	>20	15-20	10-15	0
>800	15-20	10-15	0	0
<800	0	0	0	0

Notes: The only modification to the original table is shown in italics. The modification is an increase in productivity for highly capable soils with greater than 1,000 mm rainfall. Under these conditions, soil attributes will ensure very high productivity. Higher rainfall will produce even higher productivity, but there is no information on which to quantify this.

<sup>22</sup> Queensland CRA/RFA steering committee 1998 SE 1.5 commercial plantation land capability analysis of south east Queensland. Revised draft report, September 1998.

**Table 10: Expected MAI (m<sup>3</sup>/ha/yr) for *C. citriodora* plantations established on soil types in rainfall zones (after Queensland CRA/RFA steering committee 1998)**

Rainfall (mm/yr)	Soil capability			
	High	Medium	Low	Incapable
>1,300	>20	15-20	10-15	0
>1,000	>20	15-20	10-15	0
>800	15-20	<i>10-15</i>	<i>0</i>	0
<800	<i>10-15</i>	<i>0</i>	<i>0</i>	0

Notes: The modifications to the original table are shown in italics. The modifications are at the lower end of productivity. The original productivities were estimated to be higher at the lower ends of rainfall and soil capability. This was based, most probably, on the performance of the species in low rainfall and shallow soils. Yield information is not readily available to support the yield obtained by native stands under these conditions. In a plantation environment it is unlikely that commercially viable yields can be obtained in rainfall zones of less than 800 mm/year except on the best soils. As soil capability drops, the rooting volume available to trees also generally decreases, thereby limiting effective rainfall availability.

Taking the above information into account, results of the screening process are as follows:

**Table 11: Sawlog allocation zones and plantation development suitability**

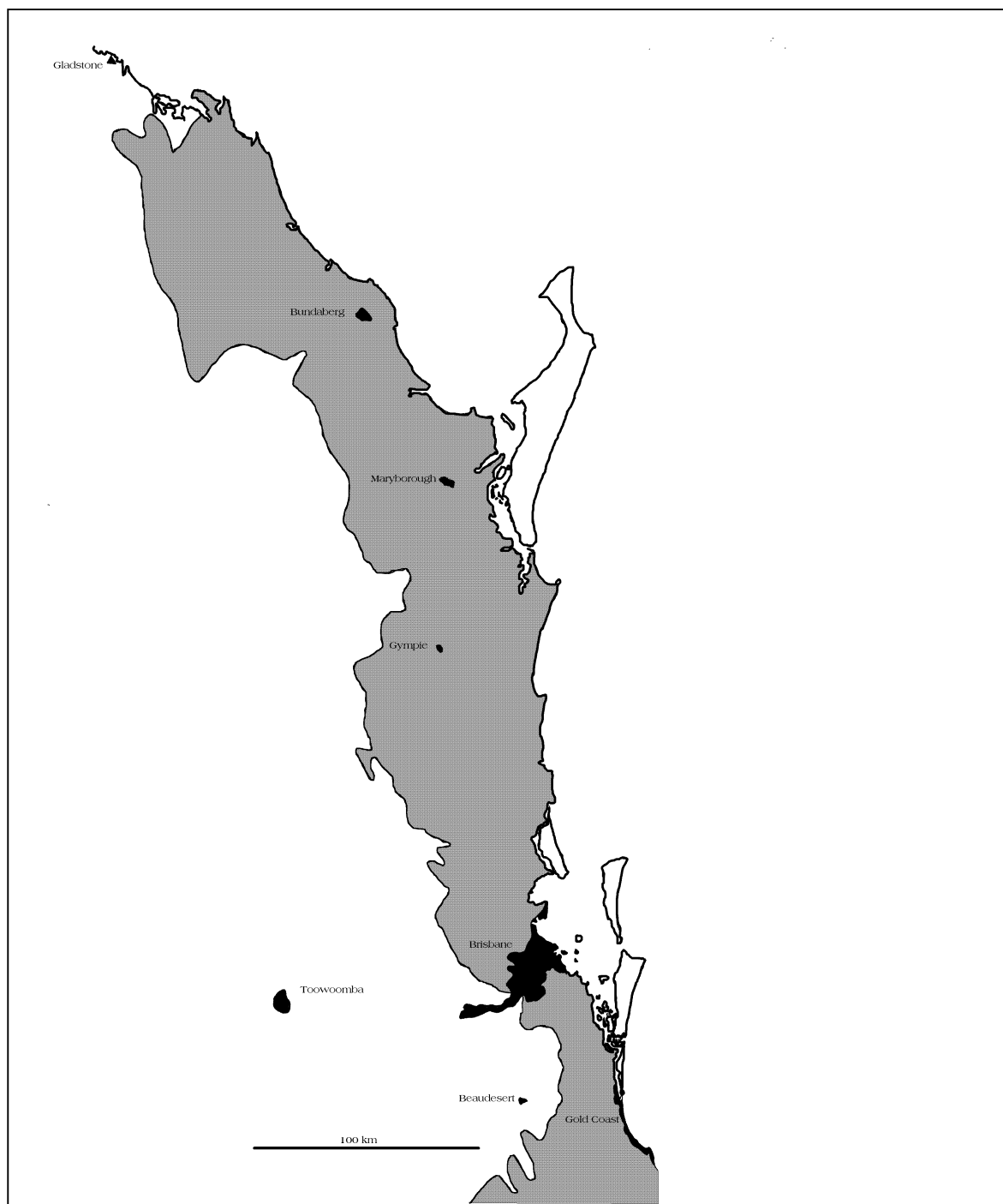
Allocation Zone	Suitable for sawlog plantations*	Suitable for pulpwood plantations**
Boonah-Warwick – Moreton LRA	Yes (moderate-high yield)	Yes (moderate-high yield)
Boonah-Warwick – Stanthorpe LRA	No	No
Brisbane-South East	Yes (moderate-high yield)	Yes (moderate-high yield)
Builyan-Gladstone	Yes (moderate-high yield)	Yes (moderate-high yield)
Bundaberg	Yes (moderate-high yield)	Yes (moderate-high yield)
Eidsvold-Monto	No	No
Gatton-Toogoolawah	Yes (moderate-high yield)	Yes (moderate-high yield)
Gayndah-Mundubbera	No	No
Gympie	Yes (high yield)	Yes (high yield)
Kilcoy-Woodford	Yes (high yield)	Yes (high yield)
Maryborough	Yes (moderate-high yield)	Yes (moderate-high yield)
Murgon-Wondai	No	No
North Coast Zone	Yes (high yield)	Yes (high yield)
Yarraman-Toowoomba	Yes (moderate-high yield)	Yes (moderate-high yield)

\* Sawlog plantations refer to those established ultimately for the growing of logs suitable for production into solid wood products, however these are integrated and will sell a range of products including pulpwood over the life of the plantation. These can be medium and high growth rates only.

\*\* Pulpwood plantations refer to those established specifically for the growing of logs on short rotations for harvest and conversion to woodchip. These can be medium and high growth rates only.

The distribution of land areas highly suitable for commercial hardwood plantations is shown in Figure 2 overleaf.

**Figure 2: Distribution of generally highly suitable land for hardwood plantations in the SEQ RFA region (shaded area)**



It is important to note that the traditional sawlog allocation zones should be used as a guide to the areas only. Due to the significant area within each allocation zone, in many cases not the whole zone may be suitable for sawlog or pulpwood plantation development. Where this exists, there are often small “pockets” of areas suitable for plantation development. These areas are where the suitable variables of rainfall, soil and infrastructure interact, and can only be determined through more detailed survey.

The four zones Gympie, North Coast, Kilcoy-Woodford and Maryborough could potentially come under competition from further exotic softwood plantation development. The impetus for this development is in both resource shortfall from the existing exotic softwood estate, and the desire of processors to come up to world scale mill size. This is discussed further in Section 12.5.

## **6. Silvicultural management regimes for sawlog and pulpwood production**

### **6.1 Sawlog regimes**

Silvicultural management applied has been based on full product sales for an integrated timber industry. The plantations are expected to supply woodchips, treated posts, saw logs, poles and veneer logs. Stands are assumed to be planted at 1,111 stems/ha (4 metres between cultivated rows and trees planted 2.25 metres apart within the row), and thinned in two stages to 60% residual stems and 45% residual stems. A final clearfall harvest is done at the age of maximum MAI.

Pruning is carried out very early in the rotation (c. age 2 - 4 years) on 300 select stems/ha in order to yield veneer logs.

### **6.2 Pulpwood regimes**

Silvicultural management regimes for pulpwood are relatively simple. These involve cultivation, preferably with contour ploughed lines at 4 metre intervals, and planting at 1,250 stems per hectare (one tree every 2 metres along the row). The aim is to have canopy closure within the plantation at an early age to minimise weed competition. Maintenance operations such as weed control, fertilising and pest control will be conducted throughout the rotation as necessary, and clearfall harvest will be at age 10 years, with 100% of products being pulpwood.

## 7. Creation of synthetic yield curves for sawlog and pulpwood regimes

### 7.1 Construction of synthetic yield curves

Because of the absence of yield curves for hardwoods grown in plantations in SE Queensland, synthetic growth curves were created as follows.

Total volume growth in was calculated using an equation belonging to the Von Bertalanffy family of growth equations (Vanclay 1994)<sup>23</sup>.

The equation is derived from an equation of tree volume increment:

$$\Delta V = R \cdot LA \left( 1 - \frac{H}{H_{\max}} \right) \quad (1)$$

where  $LA$  is tree leaf area,  $H$  is tree height,  $H_{\max}$  is the maximum value for the species and  $R$  is a constant. Annual increment in volume is proportional to leaf area reduced by a factor that accounts for the respiratory demands of standing biomass. Equation (1) is from Botkin et al. (1972)<sup>24</sup> as modified by Moore (1989)<sup>25</sup>.

Assuming  $V \approx D^2 H$ ,  $H \approx kD^2$  and  $LA \approx CD^2$ , where  $k$  and  $C$  are constants, we can express volume growth as:

$$\Delta V = RGR \sqrt{V} \left( 1 - \sqrt{\frac{V}{\text{Max}V}} \right) \quad (2)$$

where  $\text{Max}V$  is maximum volume or carrying capacity for the site, and  $RGR$  is the relative growth rate of the species on a site. This equation can be applied to an even-aged stand as a whole.

Equation (2) calculates annual volume increment as a function of standing volume. It can be integrated to calculate volume as a function of stand age in years, given zero volume at age zero:

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<sup>23</sup> Vanclay J.K. (1994) *Modelling forest growth and yield: applications to mixed tropical forests*. CAB International, Wallingford.

<sup>24</sup> Botkin D.B., Janak J.F. and Wallis J.R. (1972) Some ecological consequences of a computer model of forest growth. *Journal of Ecology* 60, 849–873.

<sup>25</sup> Moore A.D. (1989) On the maximum growth equation used in forest gap simulation models. *Ecological Modelling* 45, 63–67.

$$V(Age) = MaxV \left( 1 - e^{\frac{-RGR \cdot Age}{2\sqrt{MaxV}}} \right)^2 \quad (3)$$

Mean annual increment of volume (MAI) can be calculated simply as  
 $MAI = V(Age) / Age$ .

The two parameters MaxV and RGR can be calculated for a stand given its maximum MAI and the age at which it occurs. RGR can be calculated from MaxV, harvest age and MAI at harvest.

Individual tree sizes were calculated from the yield curves based on an assumed form ratio of ht:dbh of 100:1. Thus tree size derived from tree volume is:

$$Ht = \sqrt[3]{\frac{120,000xV}{\pi}} \quad (4)$$

Parameters used for modeling each yield class are shown below:

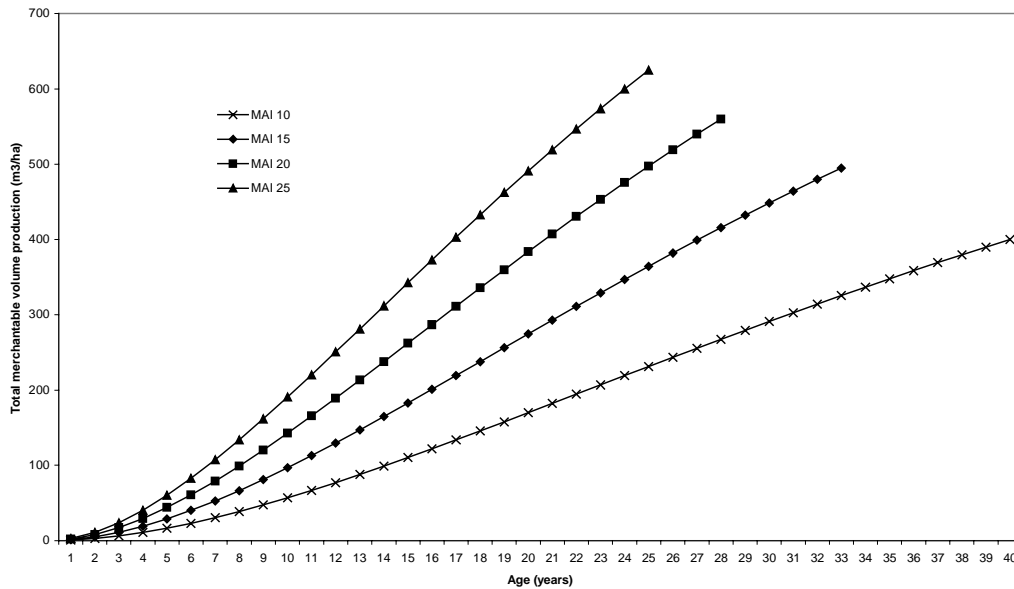
**Table 12 : Model parameters for yield classes**

Yield class	Max. MAI (m <sup>3</sup> /ha/yr)	Rotation length (years)	Max V (m <sup>3</sup> /ha)	RGR
High	25	25	1221	3.5
Medium	20	28	1100	3.0
Low	15	33	970	2.4

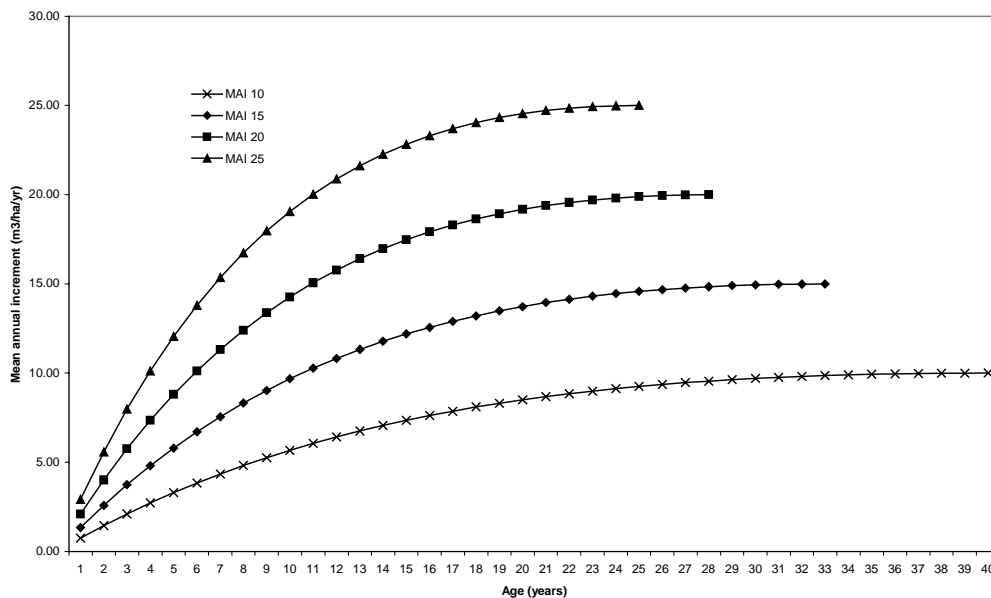
## 7.2 Sawlog plantations

Synthetic yield curves were established as part of the original study to cover plantations of *E. cloeziana* and *E. pilularis* across low (15 m<sup>3</sup>/ha/yr), medium (20 m<sup>3</sup>/ha/yr) and high (25 m<sup>3</sup>/ha/yr) growth rates. These curves and yield tables are presented here, together with yield for very low productivity sites (10 m<sup>3</sup>/ha/yr) in order to provide data for economic evaluation of poorly growing plantations. A summary of the yields, average stem volumes and product breakdown is presented in Table 13.

**Figure 3: Synthetic yield curves for hardwood sawlog plantations in south east Queensland**



**Figure 4: Synthetic MAI curves for hardwood sawlog plantations in south east Queensland**



**Table 13: Tree size, volume and product table for sawlog regimes**

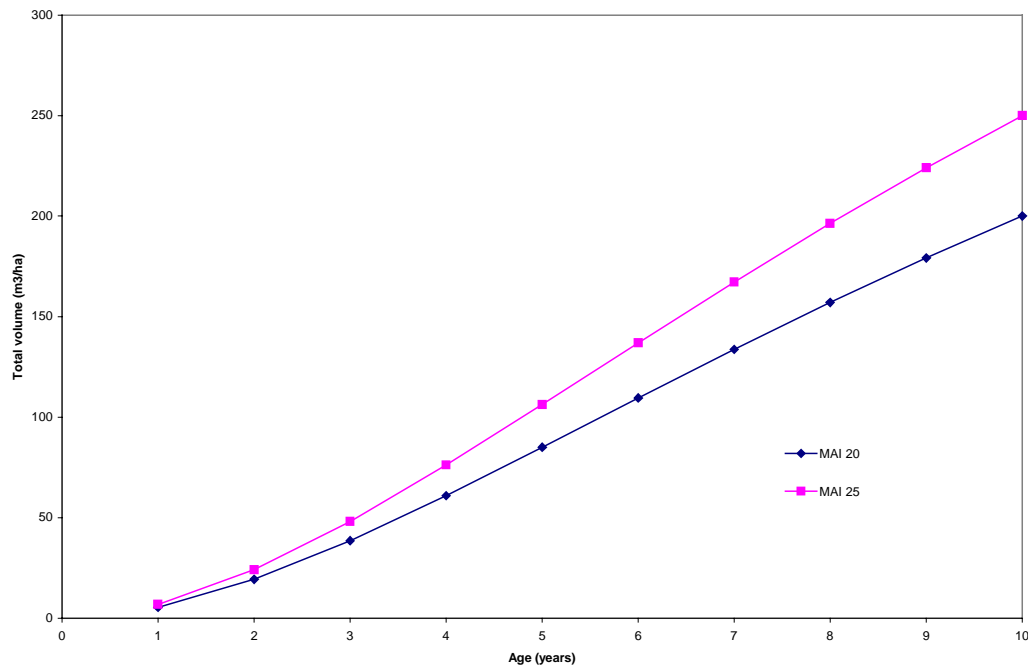
Yield class	Harvest age	Removed stems						Products (m3/ha)				
		Volume (m3/ha)	Stems removed	Individual stem volume (m3)	Individual basal area (m2)	Diameter (m)	Height (m)	Veneer logs	Poles	Sawlogs	Treated posts	Chips
<b>MAI 10</b>	17	54	444	0.12	0.02	0.17	16.63				27	27
			40%								50%	50%
	30	160	367	0.44	0.05	0.26	25.54	16		72	32	40
			55%					10%		45%	20%	25%
	40	186	300	0.62	0.06	0.29	28.73	56	37	56	19	19
			100%					30%	20%	30%	10%	10%
<b>Total</b>		<b>400</b>	<b>1,111</b>					<b>72</b>	<b>37</b>	<b>128</b>	<b>77</b>	<b>85</b>
								<b>18%</b>	<b>9%</b>	<b>32%</b>	<b>19%</b>	<b>21%</b>
<b>MAI 15</b>	12	52	444	0.12	0.02	0.16	16.46				26	26
			40%								50%	50%
	22	171	367	0.47	0.05	0.26	26.11	17		77	34	43
			55%					10%		45%	20%	25%
	33	272	300	0.91	0.08	0.33	32.58	82	54	82	27	27
			100%					30%	20%	30%	10%	10%
<b>Total</b>		<b>495</b>	<b>1,111</b>					<b>99</b>	<b>54</b>	<b>159</b>	<b>87</b>	<b>96</b>
								<b>20%</b>	<b>11%</b>	<b>32%</b>	<b>18%</b>	<b>19%</b>
<b>MAI 20</b>	10	57	444	0.13	0.02	0.17	16.98				29	29
			40%								50%	50%
	20	211	367	0.58	0.06	0.28	28.00	21		95	42	53
			55%					10%		45%	20%	25%
	28	292	300	0.97	0.09	0.33	33.36	88	58	88	29	29
			100%					30%	20%	30%	10%	10%
<b>Total</b>		<b>560</b>	<b>1,111</b>					<b>109</b>	<b>58</b>	<b>183</b>	<b>100</b>	<b>110</b>
								<b>19%</b>	<b>10%</b>	<b>33%</b>	<b>18%</b>	<b>20%</b>
<b>MAI 25</b>	8	54	444	0.12	0.02	0.17	16.63				27	27
			40%								50%	50%
	18	238	367	0.65	0.07	0.29	29.15	24		107	48	60
			55%					10%		45%	20%	25%
	25	333	300	1.11	0.10	0.35	34.86	100	67	100	33	33
			100%					30%	20%	30%	10%	10%
<b>Total</b>		<b>625</b>	<b>1,111</b>					<b>124</b>	<b>67</b>	<b>207</b>	<b>108</b>	<b>120</b>
								<b>20%</b>	<b>11%</b>	<b>33%</b>	<b>17%</b>	<b>19%</b>

### 7.3 Pulpwood plantations

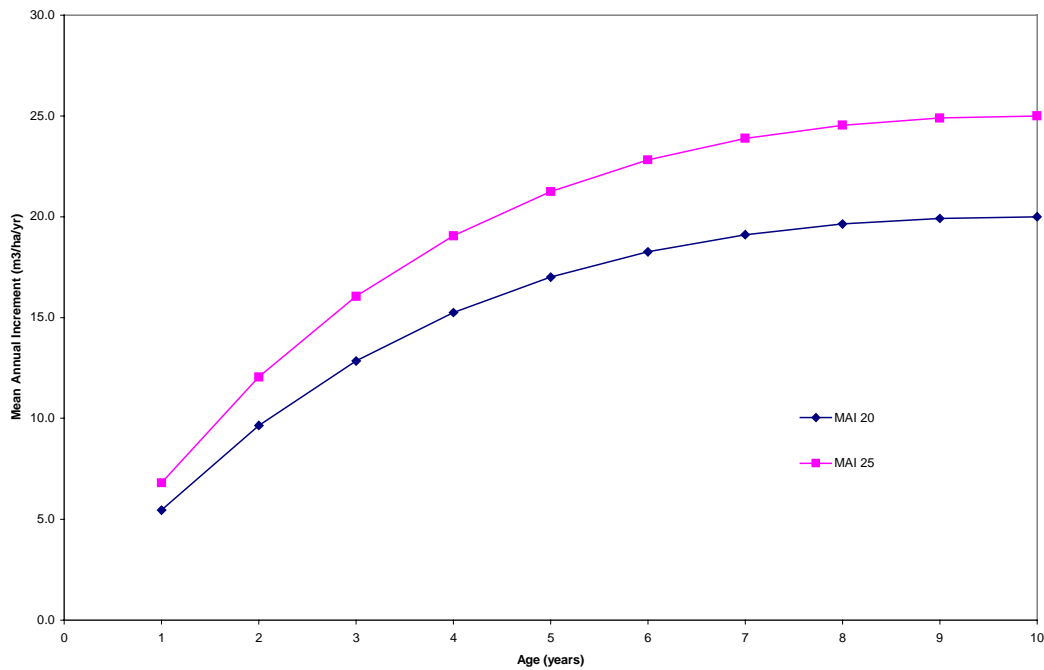
The following synthetic yield curves and product table were created for *E. grandis* pulpwood rotations grown on a 10 year rotation at a stocking of 1,250 stems/ha. Yields have been estimated for two yield classes namely: High (MAI 25 m<sup>3</sup>/ha/yr) and Medium (MAI 20 m<sup>3</sup>/ha/yr).

These yields are the same as those for the sawlog regimes modeled. The difference in the performance of the plantations is that the pulpwood plantations achieve the carrying capacity of the site in a shorter time frame at a faster growth rate and with more stems per hectare. In both cases of sawlog and pulpwood modeling, the curves shown here are synthetic yield curves and serve as an indication of the yields which may be achievable under favourable conditions.

**Figure 5: Synthetic total volume production curves for *E. grandis* pulpwood rotations**



**Figure 6: Synthetic mean annual increment (MAI) for *E. grandis* pulpwood rotations**



**Table 14: Tree size, volume and product table for *E. grandis* pulpwood regime**

Yield class	Harvest age	Volume (m3/ha)	Individual stem (m3)	Individual basal area (m2)	Diameter (m)	Height (m)
MAI 20 (Medium)	10	200	0.16	0.026	0.18	18.3
MAI 25 (High)	10	250	0.20	0.030	0.20	19.7

## 8. Log prices

### 8.1 State Forest hardwood sawlog

Prices for sawlogs harvested from State Forests are currently defined by the Queensland Department of Primary Industries - Forestry. DPI log royalties vary greatly according to volume under tender, log size, species and distance from the purchaser's mill. Hardwood stumpages range from around \$15 m<sup>3</sup> for small diameter thinnings, \$35/m<sup>3</sup> for sawlogs, to \$70/m<sup>3</sup> for poles.

A Queensland Forest Research Institute study<sup>26</sup> into the economic aspects of eucalypt hardwood plantation forestry suggests that sawlog royalties (stumpage) will double in the foreseeable future. The authors quote Dyason and Lovell<sup>27</sup> in a paper on the economics of small forestry, stating that "log royalties will increase by 100% in real terms in the medium term (10 years) and that in the long term (30 to 50 years) they expect royalty rates will increase at a long term trend rate of 3 percent greater than the rate of inflation".

The above study makes use of two modeled financial scenarios for eucalypt plantation development. The current assumption uses \$35/m<sup>3</sup> stumpage, and the second scenario assumes doubling of the royalty or stumpage paid to the grower to \$70/m<sup>3</sup>. The realistic price falls somewhere between these two extremes.

### 8.2 Private property hardwood sawlog

Anecdotal evidence suggests that stumpage paid for hardwood logs from private land can be twice as much as that paid for logs from State owned land. Current prices paid for hardwood sawlogs harvested from private property range from \$35/m<sup>3</sup> to \$60/m<sup>3</sup>.

### 8.3 Hardwood pulpwood

Hardwood pulpwood prices are more difficult to estimate given there are few sales of hardwood sawmill residues and no hardwood woodchips that may compare with prices for export woodchip. Using other States as a benchmark, it could be estimated that pulpwood stumpages for the region would be in the range of \$15 to \$30 per m<sup>3</sup>. This requires further detailed investigation, as there are a number of factors such as establishment and management costs (which vary depending on ownership and management regime), harvesting and transport costs, distance to port, growth rate and species that all heavily impact on stumpage.

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<sup>26</sup> Leggate, W. Palmer, G. and Walduck, B. Economic Aspects of Hardwood Plantation Forestry, A case study on *E. cloeziana* plantations in S.E Qld. Australian Forest Growers Conference 1998

<sup>27</sup> Dyason, R. and Lovell, D. The economics of small plantation forestry: ABARE Outlook '98, pp. 381-393

## 9. Plantation costs for sawlog and pulpwood regimes

### 9.1 Establishment costs

Establishment costs for hardwood sawlog and pulpwood plantations are as follows:

**Table 15: Hardwood plantation establishment costs (\$/ha) for south east Queensland**

Operation	Cost (\$/ha)
Soil survey, site analysis	\$104
Light clearing, fire protection and access tracks	\$130
Perimeter fencing*	\$325
Cultivation slope <12%	\$150
Cultivation slope >12%*	\$560
Pre-plant weed control	\$170
Seedlings (1,111 stems/ha)	\$720
Planting	\$180
Fertiliser and application	\$130
Post plant weed control	\$230
Maintenance costs (\$/ha/year annual charge)	\$200

\*Note this cost can be reduced and/or eliminated through site selection

There will be a small difference in establishment costs for the pulpwood regime, as there are around an extra 100 trees planted per hectare. This will result in an additional \$65 per hectare for establishing pulpwood plantations.

Note there is a cost for management of the plantation estate that has not been included in these figures.

## 9.2 Silvicultural and operational costs, sawlog regimes

**Table 16: Silvicultural and operational costs, sawlog regimes**

Activity	Cost
Pruning (300 stems/ha age 4 years) (\$/ha)	\$449
Roading for each thinning (\$/ha)	\$133
Inventory and analysis (\$/ha)	\$70
Marking for thinning (\$/ha)	\$50
Harvesting for each thinning (\$/m <sup>3</sup> )	\$21
Roading for clearfall (\$/ha)	\$133
Harvesting clearfall (\$/m <sup>3</sup> )	\$18
Road transport for all logs (\$/m <sup>3</sup> /km)	\$0.13

Note these costs assume planting and harvesting on a conventional (ie: <18 degree slope) basis. Planting above these slopes leads to significant additional roading, weed control, harvesting and transportation costs. Note also cultivation above 12<sup>o</sup> slope incurs significant additional cost (refer Table 15).

Note there is a cost for management of the plantation estate that has not been included in these figures.

## 9.3 Silvicultural and operational costs, pulpwood regimes

**Table 17: Silvicultural and operational costs, pulpwood regimes**

Activity	Cost
Roading @ establishment (\$/ha)	\$133
Inventory cost (\$/ha)	\$70
Harvesting costs (\$/m <sup>3</sup> )	\$18
Roading @ clearfall (\$/ha)	\$133
Road transport for all logs (\$/m <sup>3</sup> /km)	\$0.13

Note these costs assume planting and harvesting on a conventional (ie: <18 degree slope) basis. Planting above these slopes leads to significant additional roading, cultivation, weed control, harvesting and transportation costs.

Note there is a cost for management of the plantation estate that has not been included in these figures.

The costs for pulpwood regimes above assume harvest and transport of whole logs to a fixed chipping facility either on the wharf or in close proximity. There is the potential for usage of the existing Queensland Rail network to transport either logs or woodchips to port. The cost/benefit of this option in regard to infield chipping versus fixed chipping, transport of logs versus chips and the costs of loading and unloading need to be further investigated and will depend in large part on the location of the plantation relative to transport infrastructure.

## 10. Discussion of impediments

This section discusses some of the actual and potential impediments to plantation development in the region, and proposes some methods of rectifying these.

Perhaps the most critical impediment to plantation development in Queensland has been the dominance of the State forestry enterprise and the lack of private competition in the past, with the exception of plantings by the then APM Forests Pty Ltd. This has resulted in a lack of recognition of plantation forestry as a viable venture in which to invest in Queensland. To correct this, key steps are to improve the knowledge base concerning plantations, and to improve the perception of investing in forestry as a safe and attractive investment.

### 10.1 Codes of Practice

A positive step in raising the acceptance of plantation forestry in a number of States has been implementation of Codes of Practice outlining how operations should be conducted. These are generally to ensure compliance with all relevant legislation, and are unrelated to the issue of export of unprocessed wood from regions that operate under an approved Code.

There is a process currently underway, co-ordinated by the Department of Natural Resources, investigating implementation of a Code of Practice for native forest operations in Queensland. There is an opportunity to include plantation development in this as a separate section. Otherwise, there are a number of Codes throughout the country that indicate how a Code specifically relating to plantations should work, which could be used as a guide for developing such for Queensland. This may help in improving the public perception of plantations in Queensland, and hence encourage future plantation investment.

The current absence of an agreed Code of Forest Practice for the region means that, at the moment, no hardwood plantation products could be exported from the region without special agreement with the Commonwealth Government. This uncertainty is an impediment for investment.

There have been moves within some local councils to develop Codes of Practice applicable to plantation development in their respective shires. This has the potential to cause difficulty for industry by causing uncertainty about the future feasibility of harvesting their own plantation timber. If Codes are to be implemented, these should be all-encompassing, regulated and enforced by one, preferably State Government, body, and be backed by State legislation.

## 10.2 Export woodchip licences

Currently there is a requirement to obtain a licence from the Commonwealth Government for the export of woodchips from the region. This applies to plantation grown timber as well as native forest timber. This is an impediment to investor confidence in hardwood plantations since there is uncertainty about the ability of any venture to export the product from its plantations as of right in the same way as any other primary industry producer. This situation should be remedied in the south east following the acceptance of the RFA.

As illustrated in Section 10.1 above, there is a need to establish a Plantation Code of Practice for private companies (as well as DPI Forestry) establishing plantations in Queensland. This will form the basis of responsible and sustainable land management practices, and obviate the need for further Commonwealth Government intervention.

## 10.3 Impacts of planning legislation on plantation investment

The Expert Panel on Ecologically Sustainable Forest Management in Queensland has undertaken work in relation to ensuring sustainability mechanisms for the management of private lands do not impede long-term investment security for private property plantation growers. The expert panel report recommended the development of a planning tool for the long-term sustainable management of private lands. The opportunity exists to amend the Integrated Planning Act legislation to incorporate this approach while ensuring investment security for investors in private forestry.

It is uncertain how these recommendations will be interpreted in the development of legislation resulting from the RFA.

### 10.3.1 The Valuation of Land Act and rural property values

There has traditionally been an issue in terms of interpretation of land values for rating purposes based on land use. The Department of Natural Resources – Queensland (DNR) offer rate concessions under the Valuation of Land Act where the land use is farming in an “urban fringe” area (note this area is currently arbitrarily determined, and legislation is proposed to address the issue). The aim of the concession is to insulate farmers against the effects of real estate and subdivision on land prices and hence rateable value.

DNR have a set of criteria for determining if the business enterprise is defined as “farming”, and as such if it qualifies for rate concessions in these areas. Criteria used for assessment by DNR include annual profits/returns, application of a business plan and property management plan, and contribution to the economy. Up until recently, commercial forestry did not qualify for rate concessions, and hence incurred market rates in these land areas at significant cost.

Recently, this was successfully challenged in the Land and Environment Court. As part of a DPI Forestry joint venture plantation, a landowner had registered the trees on his property as a Forestry Right (profit-a-prendre agreement separating the land title from the produce of the land). DNR argued unsuccessfully that, as the landowner could be different from the owner of the trees, the rate concession should not apply. The Court ruled that the determining factor was the use to which that land was being put, not the owner of the land.

This means that, where plantation development occurs in these “urban fringe” areas (predominantly in the south east corner of the state), the precedent exists for rate concessions, hence reducing the cost of plantation forestry significantly.

#### **10.4 Impediments to investment in plantation development**

The investment term for the development of pulpwood plantations is relatively short in forestry terms: around 10 years. However, the investment term for the development of an integrated hardwood plantation unit, growing high value logs for domestic processing and export, is at least 25 years. Historically, Australian investors are reluctant to enter into long term forestry investment projects. Some of the reasons for that reluctance are:

- A lack of investor knowledge of the plantation industry and the potential presented by a well-managed plantation investment;
- A lack of understanding of the investment risk profile of plantations and the international recognition and support of plantation investment as an investment class of its own;
- No co-ordinated resource base with benchmark information on costs, international prices and trends, returns and developments;
- General lack of information on international fibre markets and commentary on the effects on Australia (as with metal products and more traditional agricultural products);
- Little active government promotion of the plantation industry and targeted encouragement for investment in high value plantation products and value adding industries in Australia;
- Tax structure that is interpreted as discouraging a secondary market in immature plantation and therefore liquidity in plantations prior to harvest.

Where there is an existing resource that may be purchased to generate immediate cashflow from harvesting and sale of forest products, many of these issues are minimised (e.g.: Victorian Plantations Corporation sale). However, given the small area of hardwood plantations established in the region to date, this is infeasible in this case.

Many of the issues require education and promotion both through legislation and the media. This should include:

- Active promotion of the plantation industry and opportunities and analysis of developments in Australasia and the activities of international and national plantation owners;
- Open debate on the need for private investment in the plantation industry and the potential for corporatisation and privatisation of state owned assets (eg: sale of the Victorian Plantations Corporation);
- Recognition of the export potential of commodity and value added plantation fibre to the region, and the role of plantation forestry as a sustainable resource development priority for the future of Australia.

Activities on the finance side also serve to educate and lift the awareness of the investing public. These can include:

- Encouragement of State owned institutions (pension funds and banking) and local authorities to invest in plantation development as part of their long term investment strategies;
- Making land available for development of plantations targeted at local processing markets;
- Providing investment incentives for the development of local processing and value adding facilities, and creating a demand for sustainable resource.

## 11. Infrastructure analysis

### 11.1 Road infrastructure

The region is well serviced by both sealed and unsealed roads, with the Bruce Highway providing high quality road access in a north-south line through the region. In terms of roading infrastructure, it is unlikely that significant major upgrading or improvement of the existing road network would be required for an expanded plantation forest industry given the development of this infrastructure and historical usage patterns by the forestry industry.

Heavy haulage companies currently use “B-double” trucks on the Bruce Highway, however there is a general need to improve highway grades and widths from Eumundi to Gladstone. The advent of “B-double” timber trucks and associated increased traffic flows will increase the need for upgrading. There will also be a need for “local” road improvements and new access to be constructed. This will be associated with any plantation development, and is not necessarily a specific restriction or impediment to plantation development, provided there is good co-ordination between relevant agencies. It may also require collaboration (and potentially funding) by local, State and Commonwealth agencies as well as industry.

## 11.2 Rail infrastructure

Rail is a potentially inexpensive and effective means of transport for wood and/or woodchips in the region. The region is well serviced by the main north-south railway line and supporting networks. As for many rural rail networks, however, a number of smaller sidings have closed in recent times due to lack of use. There is scope for improvement in the commercial focus, pricing and services of the State rail system. Such improvements have the potential to attract forest products customers to rail services, and take pressure off highway transport.

If plantation development plans to use rail, there is a likelihood targeted sidings could be reopened for use specifically for transporting forestry cargo. In addition, there is the potential for construction of new “off-shoots” of rail lines for specific purposes, such as the Canterwood woodchip mill railway line construction south of Maryborough.

## 11.3 Port infrastructure

The woodchip export facilities at the two main export ports in the region, Brisbane and Gladstone, are summarised as follows.

**Table 18: Port infrastructure for export woodchip**

Port	Infrastructure	Loader type and rate	Current volume of woodchip throughput	Capacity
Brisbane	Stockpile at wharf – chips delivered by road and rail.  Shiploader is the grain terminal managed by Globex. QCE pay a per tonne fee for stockpile management and shiploading	Grain loader capable of 2200 tonnes/hour. Average around 1800 tonnes/hour.	377,614 green tonnes (1997/1998 figures)	See 11.3.1 below
Gladstone	Stockpile at wharf – chips delivered by road and rail.  Shiploading uses a multi-use berth exporting woodchips, magnesite and calcite. Canterwood pay a per tonne fee for stockpile management and shiploading	Twin loaders capable of 400 tonnes/hour each. Average around 350 tonnes/hour each	342,620 green tonnes (1997/1998 figures)	See 11.3.2 below

### 11.3.1 Port of Brisbane

The Globex grain terminal being utilised by QCE for shiploading is unlikely to be able to handle significant additional volumes of woodchips due to existing commitments.

Sufficient land exists at the wharf to allow for stockpiling, however new shiploading infrastructure will be required for any significant volume of woodchips to be exported.

Port charges at the Port of Brisbane are:

- Wharfage: \$0.80/green tonne

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- Harbour fees: \$0.80/green tonne (measured by ship survey post-loading).

### **11.3.2 Port of Gladstone**

At the Port of Gladstone, the major impediment to expansion of the export woodchip facilities is stockpile space at the current Auckland Point berths. There is currently only enough room on the wharf for stockpiling around 1 to 2 shiploads, or around 60 - 80,000 tonnes of woodchips. If a significant woodchip export industry develops in the region, it is likely dedicated woodchip stockpile and shiploading facilities will be required.

Currently, there is a large coal bulk handling facility (Barney Point) adjacent to the bulk terminal handling woodchip exports (Auckland Point). The shiploader has a capacity of 2,000 tonnes of coal per hour. This facility is accessed by road and rail, however the coal loader would require conversion to handle woodchips (resulting in about halving the loading capacity), and the site would also require de-contamination and construction of suitable base for the woodchip stockpiles prior to being established as a woodchip handling facility. This option would, however, be far less expensive than constructing new facilities.

General port charges at the Port of Gladstone are:

- Wharfage and harbour fees \$1.70/green tonne.

## **11.4 Social infrastructure**

The region supports a broad range of skills that can be applied to the development of a new industry based on hardwood forest plantations. Socio-economic analysis has been undertaken as part of the RFA process. The plantation estate will likely be regionally-based, providing employment opportunities to Queensland's depressed rural sector at a localised scale.

Broadly speaking, there are four main areas of expertise in plantation development and management. These are the technical (forestry) management skills, business and management skills, marketing skills and contracting skills. There is a significant base of the first three of these skills in the region, based on the intellectual resources currently within DPI Forestry and private industry. In addition, these will develop with any plantation estate as it expands.

The contracting base for developing hardwood plantations in the region exists currently. This base is predominantly experienced in the establishment and tending of exotic and native softwood plantations, however with efficient management the knowledge base of the contractors in the region will develop rapidly.

There is also scope for contractors in northern NSW experienced in the establishment and tending of hardwood plantations to travel to the region. Silvicultural contracting is a very mobile industry, and contractors can operate from one end of the region to the other with little difficulty. This still contributes to local employment, as these contractors will source local labour for operations such as weed control and planting. Such influxes will stimulate the start-up of locally based contractors.

## 12. Land availability and cost analysis

Land prices for the traditional sawlog allocation supply zones were derived from local Real Estate agents in key towns, from the Department of Natural Resources, and from GRO's experience in plantation development and management in south east Queensland.

The conclusions from the land analysis across the region are:

- Land types investigated were restricted to cattle grazing/fattening, as it is likely this is the land type that would be targeted for plantation development;
- Closer to the coast in each of the supply zones, land availability and parcel size decreases due to increased competition from intensive cropping and residential land uses;
- Improvements do not seem to significantly impact on land price; and
- Land for residential purposes attracts a price significantly higher (2 – 3 times) greater than the next highest value landuse.

**Table 19: Statistics for land sales across supply zones in SE Queensland**

Supply zone	Price	Parcel size (ha)	Total purchase price (\$)	Parcel price (\$/ha)	Number of records analysed
Boonah-Warwick	Max	2,280	\$1,450,000	\$9,201	
	Min	20	\$30,000	\$186	
	Average	168	\$186,852	\$1,687	167
Brisbane South-East	Max	472	\$1,143,000	\$13,027	
	Min	18	\$50,000	\$366	
	Average	112	\$310,475	\$4,118	123
Builuan-Gladstone	Max	493	\$700,000	\$9,841	
	Min	6	\$22,988	\$169	
	Average	184	\$164,643	\$1,211	102

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Supply zone	Price	Parcel size (ha)	Total purchase price (\$)	Parcel price (\$/ha)	Number of records analysed
Bundaberg	Max	439	\$1,680,000	\$24,989	24
	Min	10	\$35,000	\$105	
	Average	129	\$185,250	\$2,364	
Eidsvold-Monto	Max	2,676	\$1,600,000	\$8,000	80
	Min	20	\$40,000	\$208	
	Average	239	\$266,632	\$1,487	
Gatton-Toogoolawah	Max	720	\$1,000,000	\$6,376	137
	Min	17	\$49,150	\$273	
	Average	168	\$201,251	\$1,721	
Gayndah-Mundubbera	Max	7,477	\$2,200,000	\$10,510	97
	Min	32	\$30,000	\$47	
	Average	561	\$334,063	\$1,433	
Gympie	Max	3,020	\$2,900,000	\$113,031	144
	Min	8	\$30,500	\$73	
	Average	131	\$343,530	\$5,537	
Kilcoy-Woodford	Max	2631	\$1,600,000	\$21,875	57
	Min	8	\$76,280	\$137	
	Average	211	\$336,974	\$4,869	
Maryborough	Max	466	\$650,000	\$8,869	82
	Min	24	\$26,500	\$206	
	Average	183	\$189,875	\$1,575	
Murgon-Wondai	Max	753	\$1,035,000	\$5,560	82
	Min	16	\$45,000	\$430	
	Average	131	\$197,719	\$1,742	
North Coast Zone	Max	925	\$2,000,000	\$92,676	120
	Min	5	\$50,000	\$376	
	Average	69	\$328,928	\$10,700	
Yarraman-Toowoomba	Max	704	\$799,000	\$7,426	119
	Min	20	\$20,000	\$124	
	Average	155	\$176,679	\$1,655	
<b>Combined areas</b>	<b>Max</b>	<b>7,477</b>	<b>\$2,900,000</b>	<b>\$113,031</b>	<b>103</b>
	<b>Min</b>	<b>5</b>	<b>\$20,000</b>	<b>\$47</b>	
	<b>Average</b>	<b>184</b>	<b>\$250,778</b>	<b>\$3,251</b>	

**Note the figures for maximum, minimum and average are independent and not necessarily related.**

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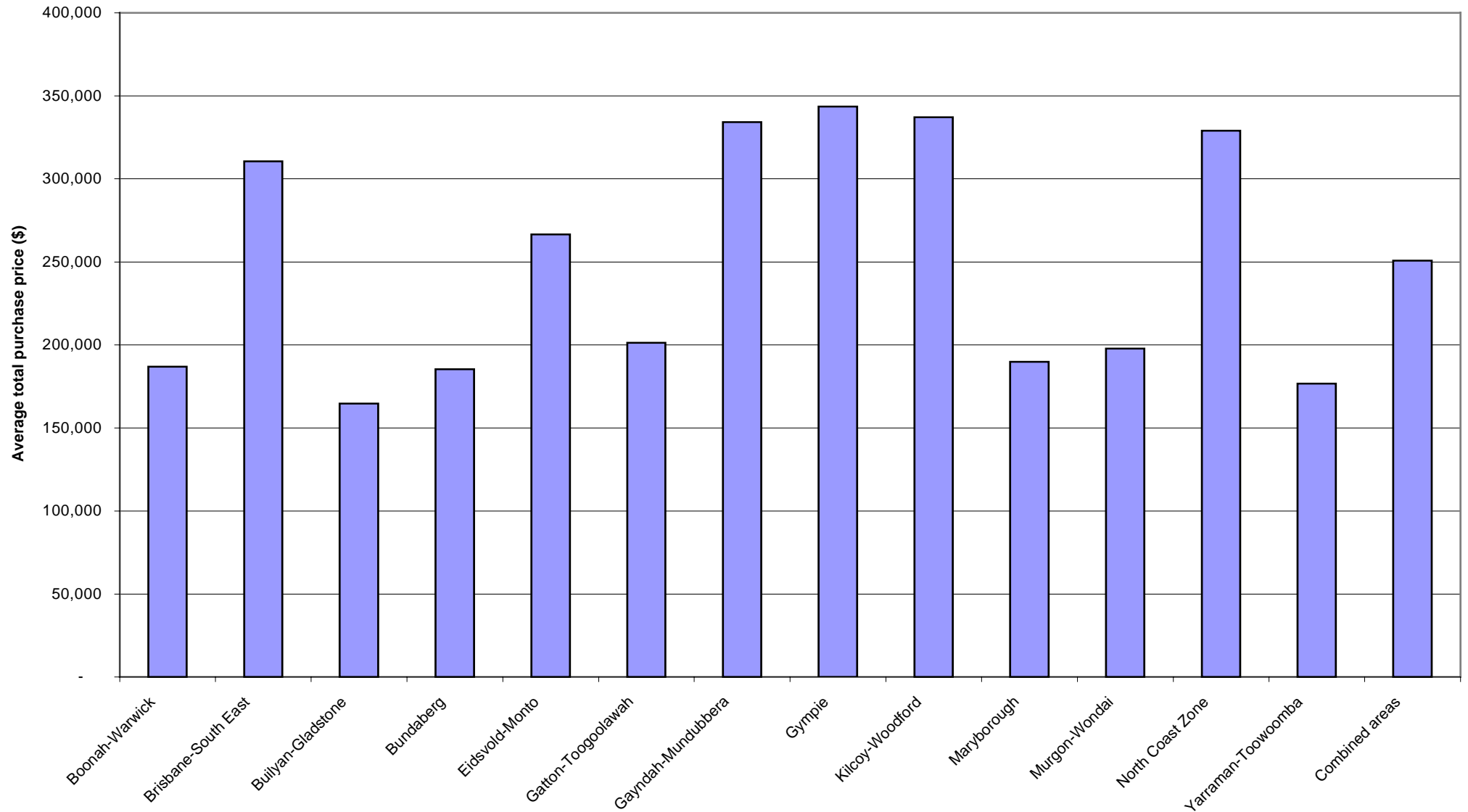
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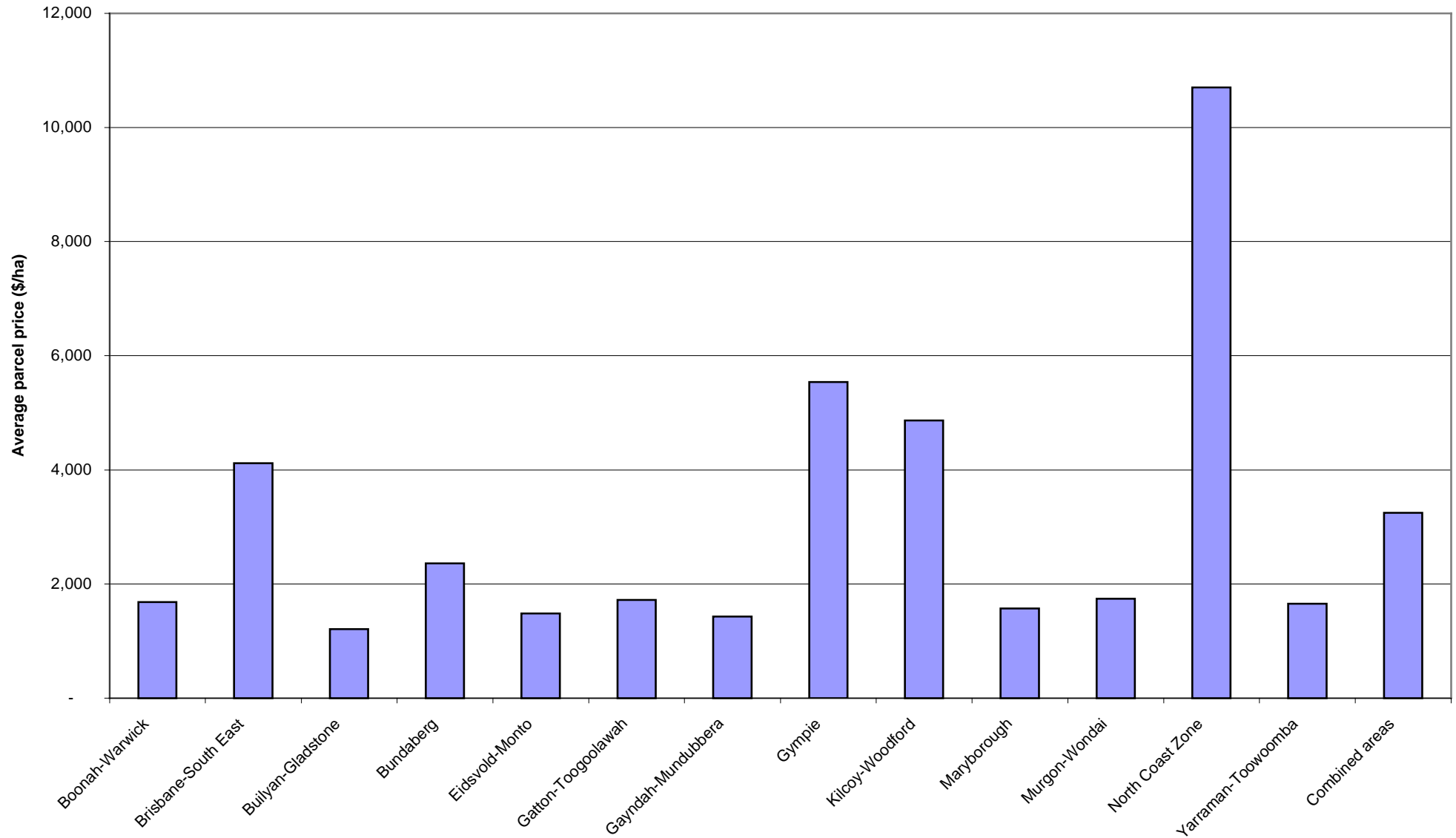
Following are a series of charts showing for each supply zone

1. Average total land purchase price by supply zone (\$);
2. Average parcel price by supply zone (\$/ha);
3. Average parcel size per supply zone (ha); and
4. Relationship between parcel size and land price (for all supply zones).

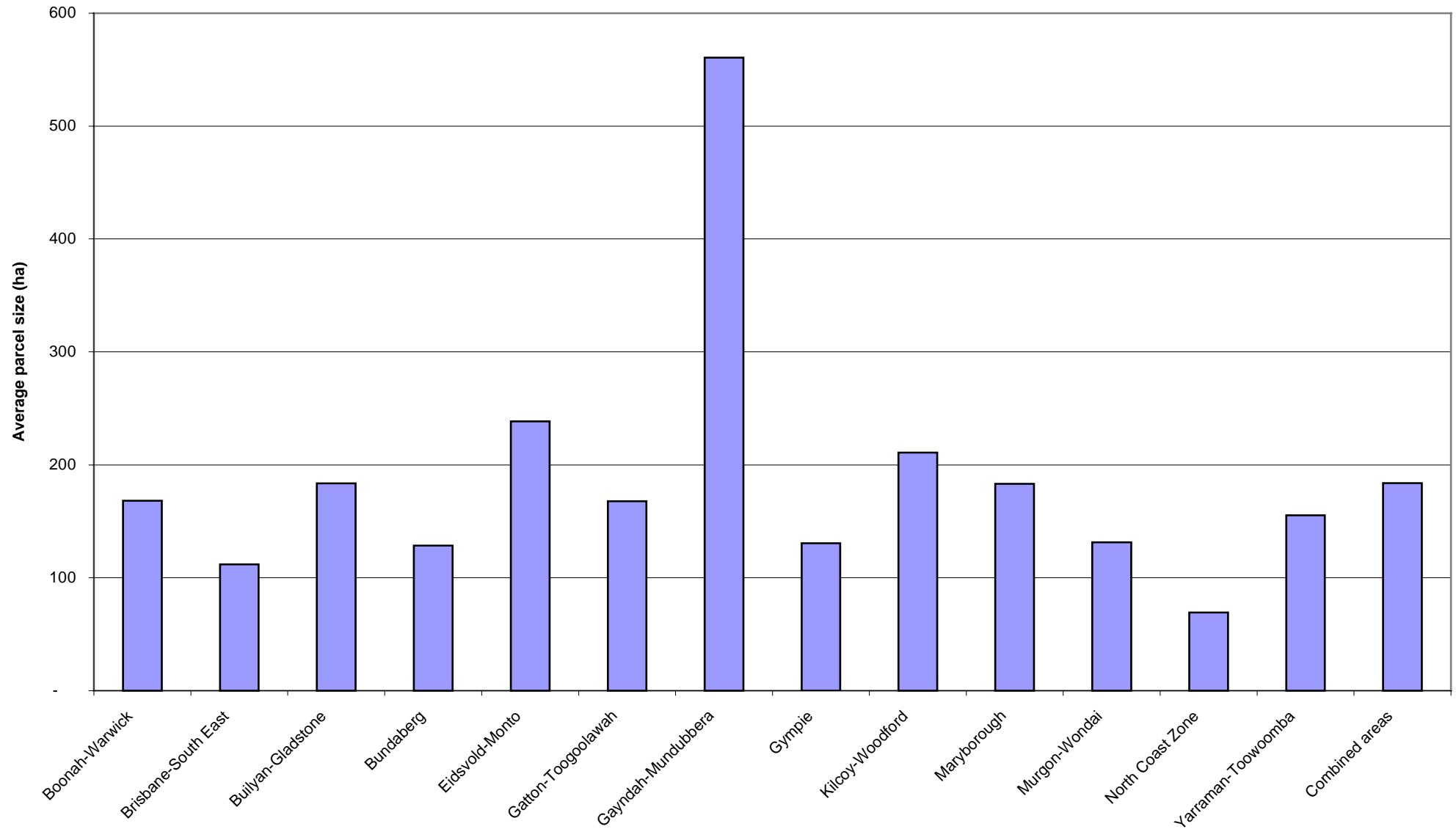
**Figure 7: Average total land purchase price per supply zone (\$)**



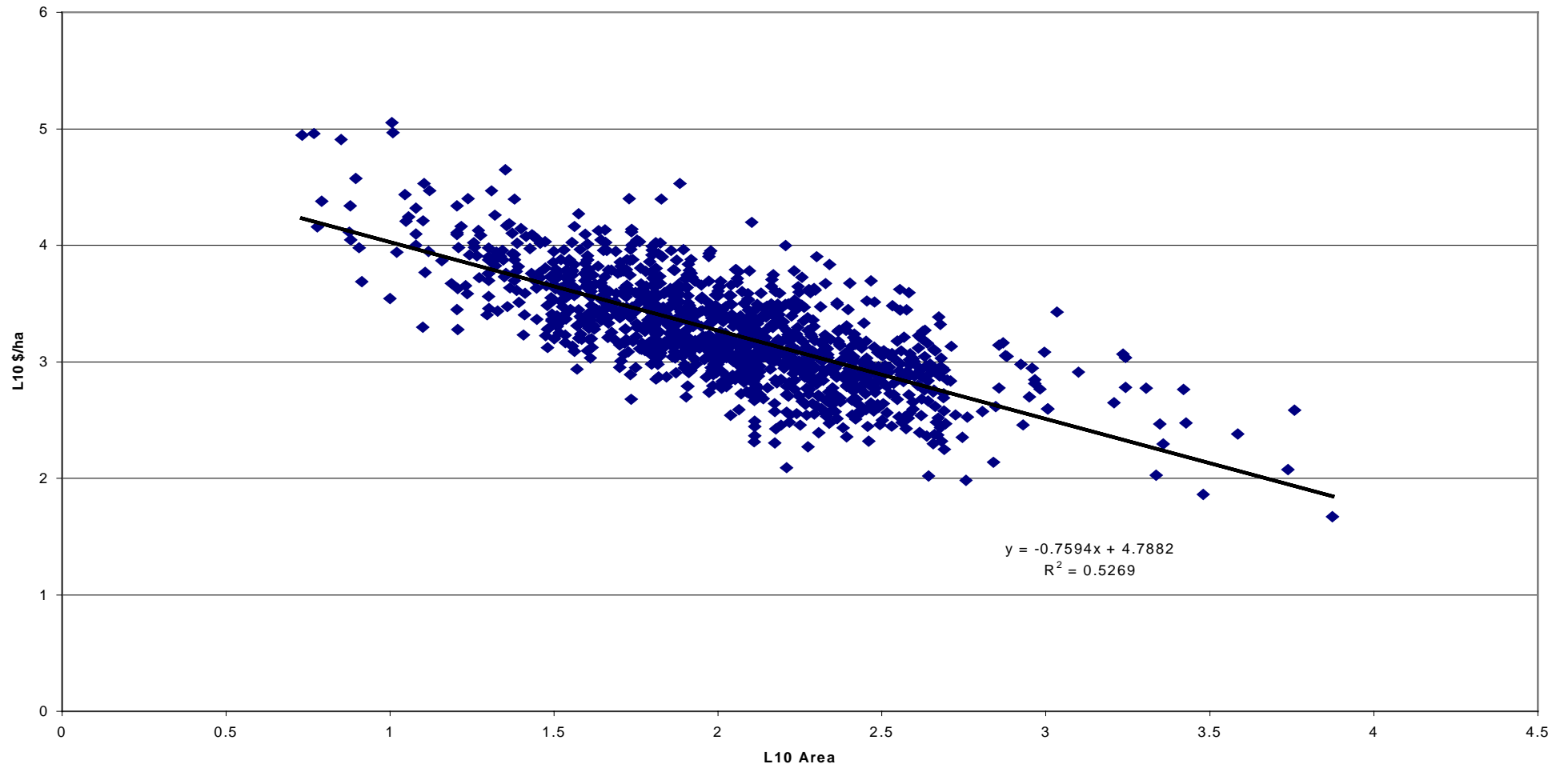
**Figure 8: Average parcel price per supply zone (\$/ha)**



**Figure 9: Average parcel size per supply zone (ha)**



**Figure 10: Relationship between land price (\$) and parcel size (ha) for supply zones (note logarithmic scale)**



## 12.1 Discussion of land cost

A summary of the charts is presented in Table 19 and as follows:

- The highest land prices per hectare are paid for land suitable for plantations in the North Coast (\$10,700), Gympie (\$ 5,537), Kilcoy-Woodford (\$4,869) and Brisbane South East (\$4,118) zones;
- The lowest land prices per hectare are paid for land suitable for plantations in the Builyan-Gladstone (\$1,211), Maryborough (\$1,575), Yarraman-Toowoomba (\$1,655), Gatton-Toogoolawah (\$1,721) and Bundaberg (\$2,364) zones. Note for Bundaberg this is because the database represented cattle land only and excluded sugar cane – one of the major landuses in the zone;
- The largest land parcel sizes were found in the Gayndah-Mundubbera (561 ha), Eidsvold-Monto (239 ha), Kilcoy-Woodford (211 ha), Builyan-Gladstone and Maryborough zones (184 and 183ha). The average parcel size across all supply zones is 184 hectares;
- The total sale price ranged from \$2,900,000 in the Gympie zone to \$20,000 in the Yarraman-Toowoomba zone. The average sale price across all supply zones is \$250,778 (total), and \$3,251 per hectare;
- Improvements appeared to have little impact on total property price;
- There is a remarkably consistent general trend across the study area for unit land price (\$/ha) to increase as parcel size decreases.

## 12.2 Detailed analysis – Gympie, Kilcoy-Woodford and North Coast Supply Zones

As part of the study, land cost and availability in the three supply zones Gympie, Kilcoy-Woodford and North Coast zones were analysed in detail.

These three supply zones were segregated into sub-supply zones for the purposes of analysing land parcel size, land use and land price. The basis for splitting these was generally a notable change in current landuse, a change in land price, or a significant geographical split between the two areas, as is the case with the northern and southern portions of the Gympie supply zone. These are indicated in Table 20 as follows:

**Table 20: Sub-supply zone land prices and characteristics**

Supply Zone	Sub-unit	Boundary between sub-units	Landuse classification (see below)
<b>Gympie</b>	Gympie North	Town of Gympie	Limited crop land, some high quality crop land, native pastures, improved pastures, residential
	Gympie South		Some high quality crop land, limited crop land, improved pastures, native pastures, residential
<b>North Coast Zone (NCZ)</b>	NCZ East	About 20km west of the Bruce Highway	High quality crop land, improved pastures, residential
	NCZ West		Improved and native pastures, some high quality crop land, limited crop land, residential
<b>Kilcoy/Woodford</b>	K/W North	State Forest boundary	Non-agricultural land (native and plantation forest), improved pastures, limited crop land, residential
	K/W South		Improved and native pastures, high quality and limited crop land, residential

Definitions of land use classification are as follows (source: DNR):

- **High quality crop land:** Land which is suitable for current and potential crops with limitations to production which range from none to moderate levels;
- **Limited crop land:** Land that is marginal for current and potential crops and suitable for pastures;
- **Pasture land:** Land suitable for improved or native pastures;
- **Non-agricultural land:** Land not suitable for agriculture.

Following are a series of charts showing for each sub-supply zone

1. Average land price (\$/ha);
2. Average parcel size (ha);
3. Average sale price (\$), and;
4. Relationship between parcel size and land price (for all supply zones).

The data used to derive the charts are shown in Table 21 below:

**Table 21: Statistics for land sales in 3 supply zones in SE Queensland**

Supply zone	Price	Area (ha)	Total \$	\$/ha
Kilcoy/Woodford North	Max	2630.8	1,521,251	2,301.6
Kilcoy/Woodford North	Min	109.0	82,000	137.2
Kilcoy/Woodford North	Average	645.9	369,977	807.7
Kilcoy/Woodford South	Max	459.6	1,600,000	21,875.0
Kilcoy/Woodford South	Min	7.5	76,280	359.6
Kilcoy/Woodford South	Average	106.9	329,082	5,839.8
NCZ East	Max	924.7	2,000,000	92,676.5
NCZ East	Min	5.4	80,000	648.9
NCZ East	Average	70.2	338,134	11,265.3
NCZ West	Max	382.6	1,500,000	91,296.9
NCZ West	Min	5.9	50,000	375.8
NCZ West	Average	68.5	321,645	10,253.5
Gympie North	Max	1749.2	2,900,000	13,736.3
Gympie North	Min	16.1	68,500	224.7
Gympie North	Average	166.9	373,838	3,697.9
Gympie South	Max	3020.0	2,600,000	113,030.6
Gympie South	Min	7.6	30,500	72.8
Gympie South	Average	106.9	323,673	6,742.4
<b>Combined areas</b>	<b>Max</b>	<b>3020.0</b>	<b>2,900,000</b>	<b>113,030.6</b>
<b>Combined areas</b>	<b>Min</b>	<b>5.4</b>	<b>30,500</b>	<b>72.8</b>
<b>Combined areas</b>	<b>Average</b>	<b>121.9</b>	<b>336,907</b>	<b>7,348.7</b>

**Figure 11: Average total land purchase price per sub-supply zone (\$)**

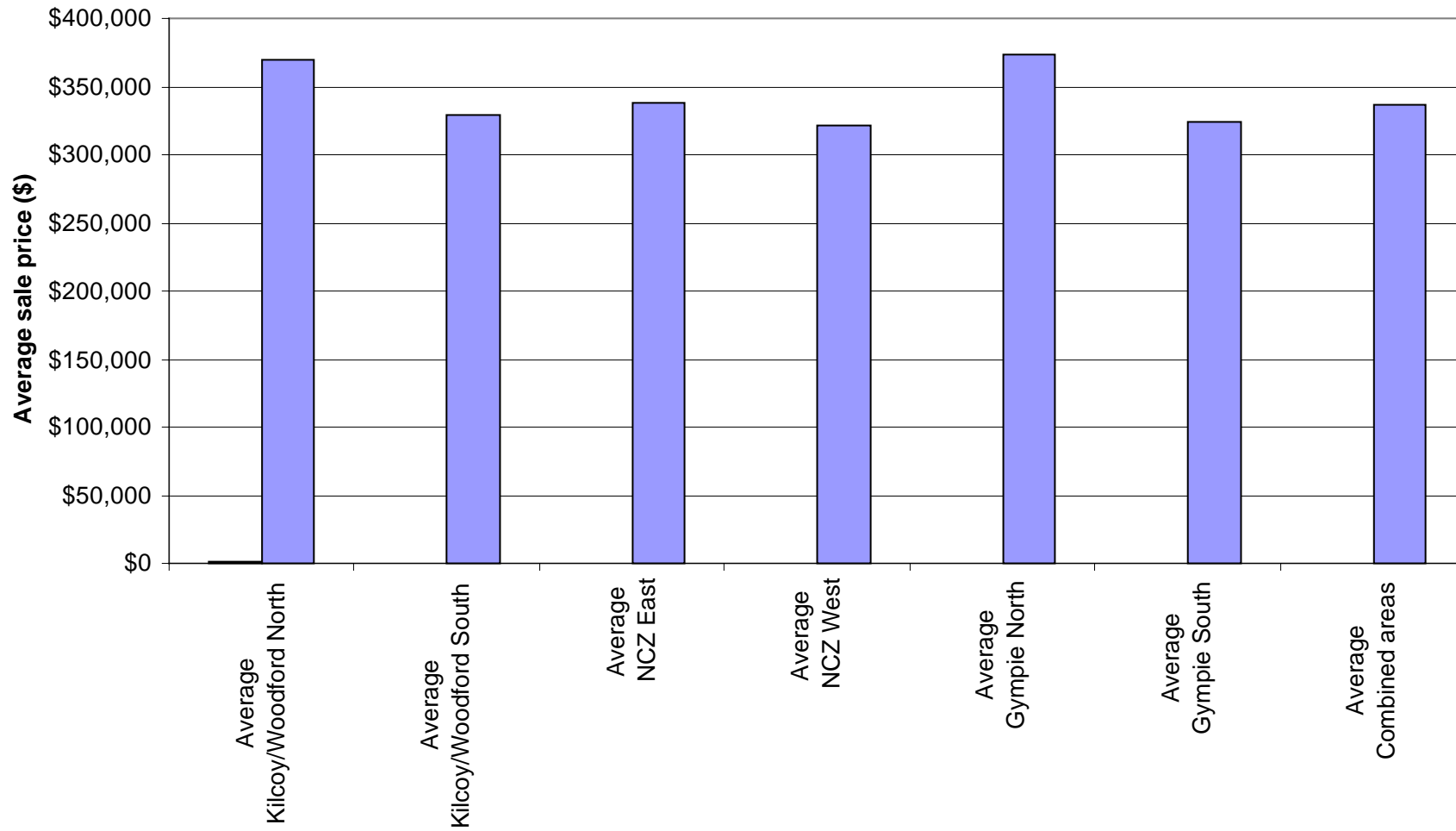
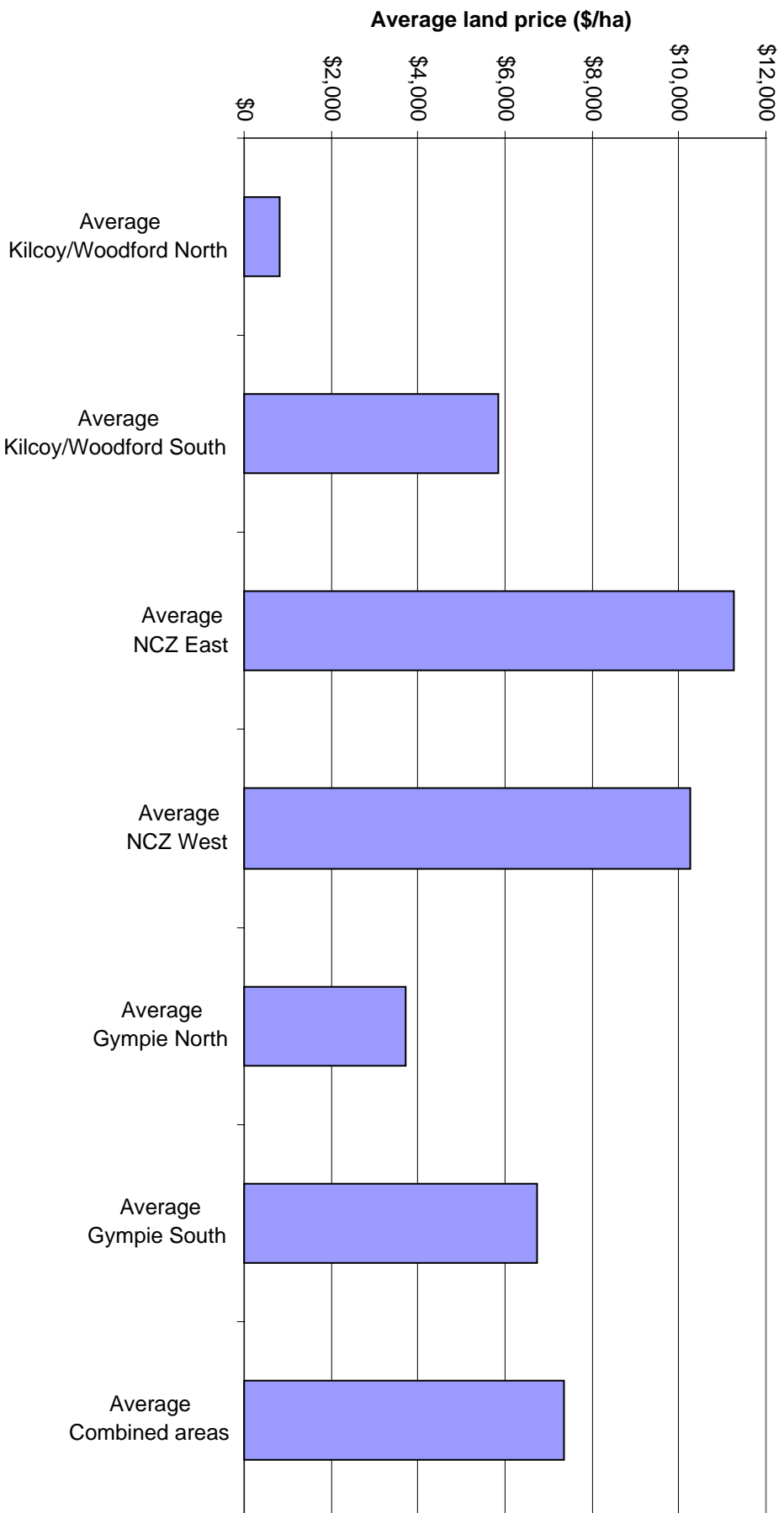


Figure 12: Average parcel price per sub-supply zone (\$/ha)



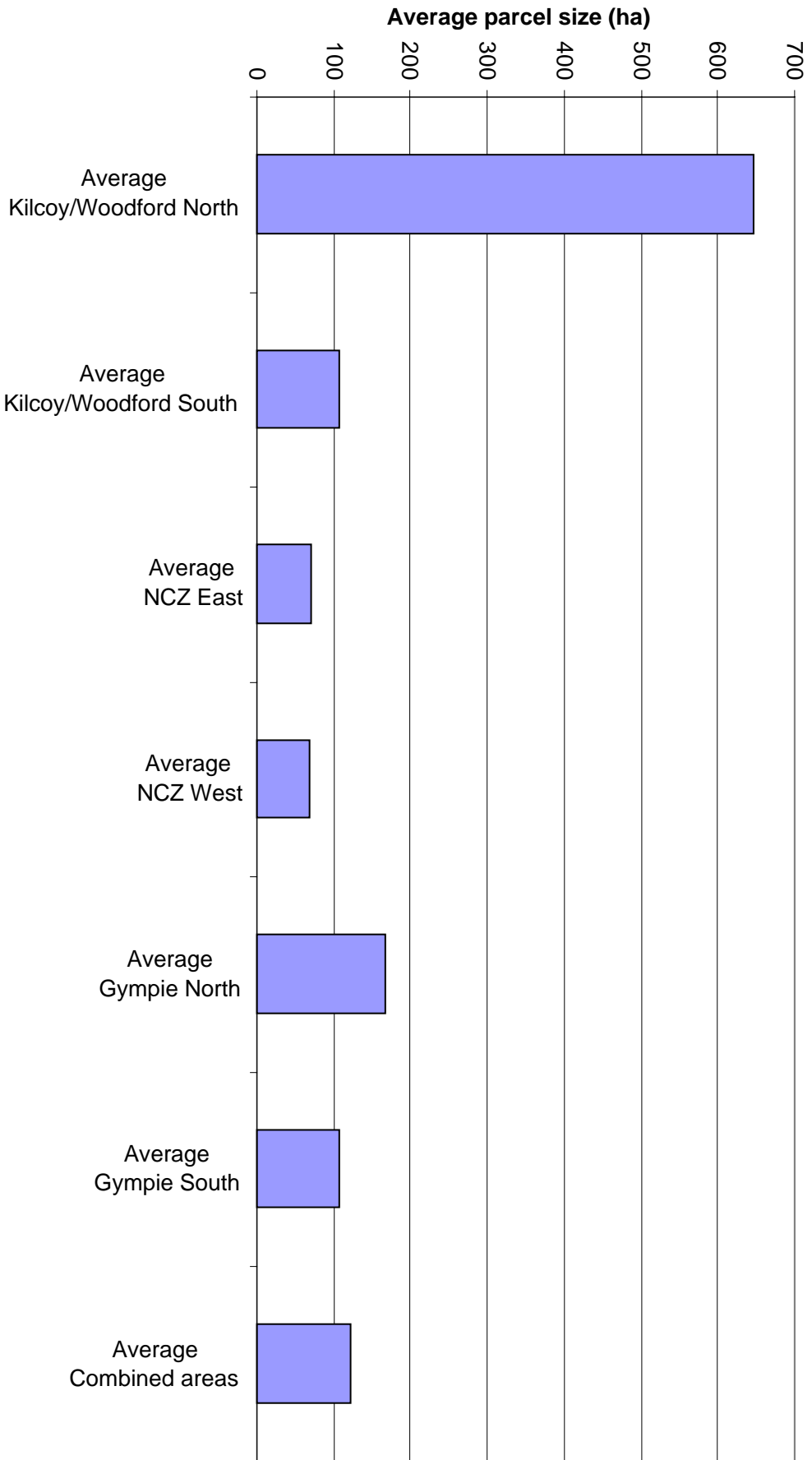
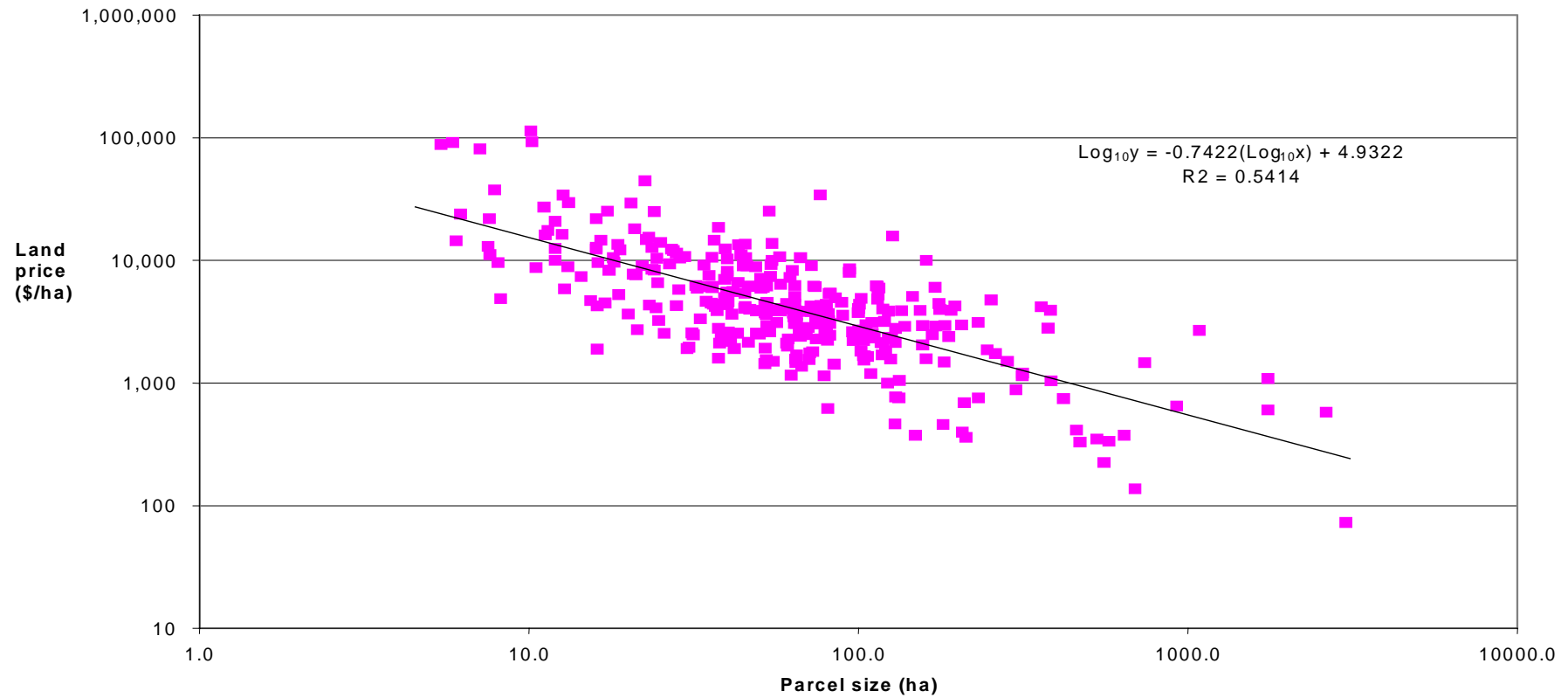


Figure 13: Average parcel size per sub-supply zone (ha)

**Figure 14: Relationship between land price (\$) and parcel size (ha) for sub-supply zones (note logarithmic scale)**



## 12.3 Discussion of land cost

A summary of Figure 11 to Figure 14 is as follows:

- The highest land parcel prices (average \$11,265/ha) are paid in the North Coast Supply Zone. This reflects the preponderance of high value cropping land close to the coast and the influence of the “urban fringe” (Figure 12);
- The lowest land prices (average \$807/ha) is found in the hilly wooded area of the northern part of the Kilcoy/Woodford supply zone (Figure 12);
- Higher land prices in Gympie south (average \$6,742/ha) compared to Gympie north (average \$3,697/ha) reflects the greater influence of urbanisation in the south (Figure 12);
- Average parcel sizes sold are between 68 ha (NCZ west) and 166 ha (Gympie north) with the exception of an average parcel size of 646 ha in Kilcoy/Woodford north (Figure 13). This reflects the relatively small parcel size of land exchanged, and the larger parcel sizes found in the hilly and wooded northwestern part of the supply zone;
- The range in average sale price is surprisingly narrow between \$321,645 and \$373,838 (Figure 11). This narrow range of c. \$50,000 may reflect the availability of money for land purchases in the community. For a debt to equity ratio of 2.3 (70:30), a purchase price of \$350,000 would equate to average bank borrowings of c. \$250,000 per buyer;
- There is a remarkably consistent general trend across the study area for unit land price (\$/ha) to increase as parcel size decreases (Figure 12). The explanation for this may be similar to that above, and may reflect the availability of money, in particular bank finance.

## 12.4 Land assembly and access

From GRO’s investigations and experience in the region, it is apparent land is readily available for purchase in each of the supply zones. However, detail is required on the suitability of this land for plantation establishment. This can only be achieved through canvassing available land, and undertaking field site suitability analysis. One of the critical determinants in site suitability analysis is determining nett plantable area, as this has a significant impact on plantation costs. This can be achieved by assessing each land parcel for slope, soil type, access requirements and existing infrastructure analysis. These can take from one to three months to enable purchase of adequate, suitable land.

### 12.4.1 Methods of acquiring land

The purchase of large tracts of land for development of hardwood plantation forestry may be an issue, particularly with some local councils, who may not wish to attract such development. These are more likely to be those associated with urban expansion such as in the North Coast Supply Zone. Analysing some type of formula applying to rateable land to be converted to hardwood plantations may assist in this case in improving the perception of forestry as a viable agricultural landuse.

There are a number of examples throughout the world where incentive schemes have been put in place to assist in fostering plantation establishment for the general socio-economic benefit of countries or regions. These schemes and their relative success or failure are outside the ambit of this report, however, methods of potentially assisting in land acquisition in the three supply zones covered by this study may include:

- Analysing some method of re-rating or rate subsidies for land on which plantation hardwood forests are to be grown to ensure local councils maintain their revenue base, and landowners investing in plantation forestry are not disadvantaged;
- Tax breaks, particularly for capital items, assistance with infrastructure and legislation to support development of the plantation forestry;
- State Government or other assistance in survey and legal costs for registering forestry rights on the Title of the land; and
- Potentially waiving State Government stamp duty on land purchases for forest plantation establishment.

## 12.5 Competition from softwood plantation development

The exotic softwood resource covers around 120,000 ha in the study area, and is focussed mainly around Gympie-Maryborough. The softwood resource in the study area represents some 90% of the exotic pine estate in Queensland. QDPI softwood resource data<sup>28</sup> indicate a levelling off in supply of softwood from the plantation resource of 1.2 million m<sup>3</sup>/yr by 2015. The resource consisted initially of plantings of *Pinus elliotii* on wet sites and *P. taeda* on dry sites. Genetic improvements in *P. caribaea* resulted in plantings of this species for a short period on dry sites until a hybrid between *P. caribaea* and *P. elliotii* was developed. This hybrid has wider site adaptability and better wood quality characteristics than *P. caribaea*.

The exotic softwood plantation estate is currently fully committed to existing processors. The two major softwood sawmilling processors, Hyne and Son Pty Ltd at Tuan with a log

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<sup>28</sup> DPI Forestry Plantation Resource Outlook. Available from  
<http://www.forests.qld.gov.au/forind/forestry/plantres.htm>

intake of around 370,000 m<sup>3</sup> per annum, and CSR Timber Products at Caboolture, with a log intake of around 280,000 m<sup>3</sup> per annum are well below world scale size.

Current world scale softwood sawmill size is around 500,000 to 750,000 m<sup>3</sup> per annum log intake. In addition, there are a number of smaller processors in the region with a log intake of around 30,000 to 50,000 m<sup>3</sup> per annum.

In relation to the softwood resource in the study area:

1. The slash pine resource will be virtually exhausted by 2006 at Byfield, 2015 at Beerburrum and by 2020 at Tuan Toolara Wongi (TTW);
2. The Caribbean pine resource will reach a peak and dominate wood supply, mainly from TTW between 2020 and 2030;
3. The hybrid pine resource will dominate the log supply from 2030 onwards.

The softwood resource has not been established on a regular annual basis, and wood production and harvesting profiles show a severe shortfall in wood availability from 2023. This is referred to as the “TTW hole”, referring to wood flow from Tuan Toolara and Wongi. The TTW resource is projected to supply from 60% to 77% of the sawlog supply into SE Queensland and is the single most important exotic softwood resource in SE Queensland.

The nett effect of the “TTW hole” will be to stimulate increased planting of softwoods in the very near future in order to maintain an elevated wood supply for industries geared to utilisation of the south east Queensland softwood resource. It is estimated that an additional 20,000 – 30,000 ha of well growing softwood will be required to fill the supply hole.

This development, if it occurs, will provide competition for land for plantation establishment within a radius of approximately 100 km from Gympie/Maryborough, as it is these areas which are adjacent to existing softwood processing facilities. This correlates to the Gympie, North Coast, Kilcoy-Woodford and Maryborough supply zones.

## **12.6 Competition from carbon sequestration and renewable energy demands**

Australian fossil fuel users and the power sector face an uncertain future. Electricity demands are forecast to rise, and greenhouse gas emissions are set to rise in concert with supply of electricity, resulting in a rise in emissions of some 41% by 2010. The industry faces requirements to both increase renewable energy and to reduce and offset greenhouse gas emissions. These include increasing efficiency within power generation facilities and in distribution, reducing carbon emissions at source, and alternative power supply scenarios. However, the magnitude of the problem is likely to be such that substantial investment will be required to implement these remedies as well as establishing extensive plantations for carbon sequestration. Under ‘business as usual’ scenarios, there is

insufficient land available in Australia to grow plantations to meet carbon sequestration requirements.

Currently the United Nations Framework Convention on Climate Change (UNFCCC) is formulating rules concerning carbon sequestration. These rules may insist that such plantations are never harvested. If this is the case then these plantations will play no role in stabilising the hardwood timber industry, and will only result in increased competition for land for the establishment of hardwood plantations.

Within a decade, the electricity industry will also be compelled to meet a 2% target for renewable energy, set by the Federal Government. Forest plantations grown on short rotations may be an option in some cases for contributing to the target. Bio-fuel plantations will be grown similar to pulp wood plantations, but the preferred species will be those with high density and calorific value: almost the opposite to pulpwood requirements. Similarly, the demand for such plantations will increase competition for land hardwood plantations in the study area.

## **13. Employment implications under sawlog and pulpwood plantation scenarios**

This section examines the potential for employment generation by developing new plantations for sawlog and pulpwood production. It is based on a review and analysis of existing information supplemented with GRO's own experience in plantation development in the region.

### **13.1 Existing exotic softwood plantations**

A reasonable estimate or "rule of thumb" for comparison of employment numbers in plantation development is to compare the current employment numbers in the existing exotic softwood estate. The majority (over 90%) of this estate is managed by DPI Forestry. The analysis starts in the nursery and finishes at the mill gate.

The 10,000 hectares of private forest in the region is gradually being harvested and not replanted, as real estate values are forcing a land use change, however the employment numbers relating to this resource have been included. A sectoral breakdown of employment numbers in the management of the exotic softwood estate is as follows.

**Table 22: Full-time equivalent employment, SEQ exotic pine estate (~120,000 ha)**

Sector	Direct employment, DPI Forestry	Contracting/private direct employment
Roading	27	3
Nurseries	42	0
Silvicultural and fire protection operations	98	24
Planning and administration	31	10
Research and development	38	0
Harvesting and haulage	0	295 <sup>#</sup>
Marketing	34	0
Other (general)	36	2
<b>TOTAL</b>	<b>306</b>	<b>334</b>

Source: Industry survey, press releases and annual reports

The “contracting direct employment” indicates the number of full-time equivalents employed to undertake the various tasks listed as part of the management of the exotic pine plantation estate.

The employment per ten thousand hectares of exotic pine plantation by sector is as follows:

**Table 23: Full-time equivalent employment per 10,000 ha, SEQ exotic pine estate**

Sector	Direct employment DPI Forestry	Contracting/private direct employment
Roading	2.3	0.3
Nurseries	3.5	0.0
Silvicultural and fire protection operations	8.2	2.0
Planning and administration	2.6	0.8
Research and development	3.2	0.0
Harvesting and haulage	0.0	24.6
Marketing	2.8	0.0
Other (general)	3.0	0.2
<b>TOTAL PER 10,000 HECTARES</b>	<b>25.5</b>	<b>27.8</b>

Importantly, employment depends on a number of specific assumptions such as tree species and silvicultural regime, rotation length, intensity of management and the rate of expansion or contraction in area managed (around 2,000 hectares of exotic pine plantation forest are harvested and around 1,500 hectares replanted each year). No such assumptions have been made in presenting the above figures – they simply represent on a linear basis the current employment levels for the SEQ exotic pine estate as a proportion of the total as per Table 22.

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## 13.2 Case study – northern NSW hardwood plantation industry

Development of hardwood plantations in northern NSW commenced in the 1970's, with APM planting the first *E. grandis* and *E. dunnii* plantations in the Coffs Harbour region. From this time, there has been little plantation development up until the early 1990's, when State Forests of NSW commenced a significant hardwood plantation establishment program. The program, operational since 1993, plans to establish between 5,000 and 10,000 hectares of new hardwood plantation per year.

The program is planting both sawlog and pulpwood crops. The main species planted for sawlog is spotted gum (*C. henryi*). This is usually established at an initial espacement of around 800 stems per hectare. Pulpwood plantations of *E. dunnii* are established at 1,200 stems per hectare.

The program employs a significant number of State Forests direct employees as well as contractors. An estimate of the employment generated by the program is one direct job is created and/or maintained for each 20 (including processing employment) to 50 hectares (excluding processing employment) of plantation established and/or under management<sup>29</sup>.

A summary of the SFNSW Hardwood Plantations Division employment is as follows. The core assumption in these figures is that the plantation establishment rate is 5,000 hectares per year.

**Table 24: Full-time equivalent employment for annual planting of 5,000 ha, SFNSW northern NSW hardwood plantation estate**

Sector	Direct employment, SFNSW	Contracting/private direct employment
Roading	2	0
Nurseries	18	20
Silvicultural and fire protection operations	18	150
Planning and administration	40	0.5
Research and development	2	0.5
Harvesting and haulage	0	0
Marketing	3	0.5
Other (general)	0	0
<b>TOTAL</b>	<b>83</b>	<b>171.5</b>

Source: Industry survey

The “contracting direct employment” indicates the number of full-time equivalents employed to undertake the various tasks listed as part of the management of the hardwood plantation estate.

<sup>29</sup> Ian Sandeman, State Forests of NSW, pers. comm.

Importantly, the numbers in the Contracting/private direct employment sector under planning and administration, research and development and marketing are consultants to State Forests of NSW. It is likely the numbers of contractors as indicated here is conservative, as the nature of the employment varies depending on the estate size and the variability in annual planting targets. As a result, the numbers represented here are an average for an estimated 5,000 hectare per year establishment program.

The most significant change in employment numbers over time in this case is likely to be an increase in the number of staff managing the existing estate as it grows. However, this is relatively small in comparison to the number employed in actually establishing and tending the estate. Also, in time (around 10 – 15 years from now) it is likely a significant number of contractors will be employed in harvesting and haulage for the program.

It is difficult to extrapolate these figures to a fixed annual planting program of, say, 1,000 hectares per year. This would require, for example:

- Analysis of the management intensity required, as this will vary depending on the ownership of the land and the plantation estate itself;
- Assessment of the land area and planning/administration requirements in land acquisition and management;
- Operational inputs such as nursery location and ability to supply (do we construct a nursery specifically or use existing infrastructure), availability and expertise of labour and establishment experience of contracting and management base;
- Specific R&D and marketing requirements for plantation products, as trees must be grown for a specific market, and;
- Silvicultural regime analysis and implementation.

Comparison of employment numbers in the current softwood plantation industry in the south east Queensland region, and employment numbers in the northern NSW hardwood plantation region result in an estimation of between 50 (south east Queensland) and 500 (NE NSW) full time equivalent employees per 10,000 ha. The estimate from south east Queensland is probably more appropriate because of the size and maturity of the industry. Moreover, the current softwood plantation industry is run largely by the State; privately run plantation industries would most probably employ fewer staff than the current softwood plantation industry. Thus it is most likely that development of hardwood plantations in the region would result in employment figure of less than 50 full time employee equivalents/10,000 ha.

There are several fundamental differences between employment in pulpwood and sawlog plantations, although this difference is difficult to quantify. The latter are more intensive, and require a series of silvicultural operations and management. As a result, employment in establishment and management of sawlog plantations is generally higher than pulpwood plantations.

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## 14. Conclusions

Realistic prospects for hardwood plantations for timber (sawlog and pulpwood) in the study area are restricted to high quality well watered coastal sites and three hardwood species (*E. cloeziana*, *E. pilularis* and *E. grandis* and hybrids). This industry itself has no established markets for the volume of products that may be produced, and faces uncertainties with respect to conversion into timber products, and competition from *E. globulus* plantations for pulpwood grown in temperate zones in Australia.

### 14.1 Species and site selection

For commercially viable plantations and in order to attract investment, plantation species and sites need to be reduced to a manageable series of options which have reasonably reliable outcomes for investors. This results in recommendations for *E. cloeziana* and *E. pilularis* for sawlog plantations, and *E. grandis* for pulpwood plantations. This is with the proviso that hybrids of *E. grandis* are required to confer greater disease and insect resistance on the species.

Site selection can be focussed on regions with the most favourable growing conditions and which are likely to result in a commercial timber crop within a reasonable time frame. These areas include LMAs of

- Moreton (allocation zones Yarraman-Toowoomba, Gatton-Toogoolawah and part of Boonah-Warwick);
- Near North Coast (allocation zones Gympie, North Coast Zone and Kilcoy-Woodford), and;
- Coastal Burnett (allocation zones Builyan-Gladstone, Bundaberg and Maryborough).

Other LMAs in the study area have low rainfall and high evaporation combined with poorly productive soils. The supply zones to which these LMA's relate are the Eidsvold-Monto, Gayndah-Mundubbera, Murgon-Wondai and Boonah-Warwick zones (Stanthorpe-Rosenthal LMA).

### 14.2 Competition for land

Competition for land will come from the establishment of softwood plantations to meet projected shortfalls and to maintain industry targets. Competition will also come from the establishment of plantations for carbon sequestration and for renewable energy. Both of these industries have economic drivers more compelling and less marginal than those for hardwood plantations grown for timber.

Development of softwood plantations, if occurring, will provide competition for land for plantation establishment in the supply zones Gympie, North Coast, Kilcoy-Woodford and Maryborough.

### **14.3 Infrastructure**

The region is well served by existing infrastructure of roads, rail and ports, and requires only moderate upgrading to allow for an expansion in plantation activities. Processing infrastructure required for new products from hardwood plantations will likely result in a geographical and commercial re-focussing of the processing industry.

### **14.4 Employment**

Employment in the region will be stimulated by an expansion of forest plantation activities. However, the actual numbers of individuals employed in the plantation industry are modest, running at around 50 full time employee equivalents/10,000 ha. Privately operated plantation enterprises are likely to employ fewer people than this.

### **14.5 Encouraging investment**

Improving investor perception of the plantation forestry industry is critical in encouraging investment. This should include:

- Active promotion of the plantation industry and opportunities and analysis of developments in Australasia and the activities of international and national plantation owners;
- Open debate on the need for private investment in the plantation industry and the potential for corporatisation and privatisation of state owned assets (eg: sale of the Victorian Plantations Corporation);
- Recognition of the export potential of commodity and value added plantation fibre to the region, and the role of plantation forestry as a sustainable resource development priority for the future of Australia.

Activities on the finance side also serve to educate and lift the awareness of the investing public. These can include:

- Encouragement of State owned institutions (pension funds and banking) and local authorities to invest in plantation development as part of their long term investment strategies;
- Making land available for development of plantations targeted at local processing markets;
- Providing investment incentives for the development of local processing and value adding facilities, and creating a demand for sustainable resource.