Green Triangle Forest Industries Hub

Trees on Farms initiative

Barriers which inhibit processors, harvesters and hauliers processing smaller amounts of logs from farm forests, and how those barriers may be addressed

Prepared by D.J. Geddes and L.J. Parsons for the Green Triangle Forestry Industries Hub Project 2 – June 2023

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Government of South Australia
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Addressing barriers to harvesting farm forests

Information current as of 30 June 2023

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This report contains generalised local trees-into-farming information to help landowners determine whether more detailed support is needed. Prior to taking action, any landowner should first consider obtaining independent advice that may relate to their specific circumstances.

About the Trees on Farms initiative

Launched in March 2022, the Trees on Farm initiative is aimed at growing and developing the on-farm forest plantation sector, particularly in the Green Triangle region. Key components of the program, including this report, are being delivered in partnership with the Green Triangle Forest Industries Hub (GTFIH).

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Acronyms

AASB	Australian Accounting Standards Board
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFS	Australian Forestry Standard
BDMT	Bone dry metric tonne
Tasmanian blue gum	*Eucalyptus globulus*
CF	Clear fall
cm	centimetre
COC	Chain of custody
COR	Chain of responsibility
CTL	Cut to length
DELWP	Victorian Department of Environment Land Water and Planning
FSC	Forest Stewardship Council
GMT	Green Metric Tonne (a measure of log and woodchip weight)
GST	Goods and Services Tax
GT	Green Triangle

GTFIH	Green Triangle Forest Industries Hub
GTRPC	Green Triangle Regional Plantation Committee Inc
ha	Hectare
JVAP	Joint Venture Agroforestry Program
km	Kilometre
KMP	Koala Management Plan
LED	Large end diameter
LGA	Local Government Area
LLC	Lower Limestone Coast
m^3	Cubic metre (a measure of log volume)
MAI	Mean Annual Increment
MDP	Mill Door Price
ML	Mega litres
OB	Over bark
PEFC	Program for the Endorsement of Forest Certification
Radiata pine	*Pinus radiata*
PIRSA	The South Australian Department of Department of Primary Industries and Regions SA
SE	South-east
SED	Small-end diameter
SEDUB	Small-end diameter under bark (a softwood log description term)
SPP	Small private plantation
SW	South-west
SQ	Site Quality
T1, T2 and T3	Thinning type, e.g. T1 = first thinning, T2 = second thinning and T3 = third thinning
THP	Timber Harvesting Plan
UB	Under bark
WAP	Water Allocation Plan
WTC	Whole tree chipping

Report authors

For nearly 30 years, Geddes Management Pty Ltd has been providing forestry consulting services in Australia and New Zealand, and has worked on projects in South America and Fiji. Forestry consultancy work has been undertaken in every plantation forestry region of Australia. This analysis of barriers for harvesting small-scale plantations was undertaken by two professional foresters, David Geddes and Lew Parsons. Each have over 50 years of practical forestry experience, and regularly work together on forestry consulting projects in Australia. They both have small private plantation clients in the Green Triangle (GT). Between them, as a result of their regular discussions with plantation owners and processors in the region, they have an excellent understanding of harvesting intricacies from the perspectives of growers, harvesting contractors and log purchasers.

Acknowledgements

While the authors gathered much of the information in this report from their own personal understanding of GT forestry, they acknowledge useful discussions with a number of persons associated with small-scale plantations. Current small private growers included Michael Cornish, Peter Feast and Michael McCourt; all are former winners of the coveted *National Tree Farmer of the Year* award from Australian Forest Growers. All three own both hardwood and softwood plantations, and all have harvesting experience. Keith Cumming (from Arborline Nursery at Hamilton) provided intuitive historical views of plantations established on farms in western Victoria. Adrian O'Donnell (from Gambier Timber Sales) was able to explain the steps he has taken to manage harvesting of softwood plantations on a number of farms in the GT. Braden Jenkin's report *Case studies of farmer experiences in commercial tree growing to provide insights supporting additional plantation resources in the Green Triangle* (Jenkin, 2022) identified the motivating factors of 12 individual small-scale plantation owners, and also the views of a range of farm advisers. Finally, the authors particularly acknowledge helpful comments made by Braden Jenkin during drafting of this report.

Key points: barriers and solutions

Most of the Green Triangle (GT) hardwood and softwood plantations are owned and managed by large-scale corporate growers. Only about 4% of the plantation area is private farm-based forestry. Harvested hardwood products are currently all exported to overseas paper makers. Softwood logs are mainly converted into structural timber by local processors, with residue woodchips exported.

Nationally, demand for softwood sawlogs is greater than supply. As a means to address this Australian sawlog shortfall, the Green Triangle Forest Industry Hub (GTFIH) is exploring plantation expansion opportunities, including farm-based woodlots. This report has identified eight separate barriers to harvesting and processing of existing Small Private Plantations (SPP) as a basis of informing future planting design and implementation.

Plantation value barrier

- *Why is it a barrier?* Because plantations are grown over many years before they are due for harvest, the person who now owns a plantation may not be aware of its financial value. Once growers understand the financial value of their standing plantation trees, they are more motivated towards a focus on harvesting requirements.
- *How to overcome the barrier*: Normally (particularly for financial transaction and financial reporting) valuations need to be calculated by a qualified independent person. In general, every plantation has a different value. Forestry Australia lists forestry consultants with valuation experience on its website. Recognising standing plantation tree values are impacted by a long list of variables, including plantation age, standing volume, growth rate, log sizes, log prices, cost of harvesting and transport distance to purchasers, this report provides a table of indicative GT plantation values at varying ages.

Silviculture barrier

- *Why is it a barrier?* For hardwood plantations, there is a need to understand harvesting age trade-offs between keeping rotations shorter to minimise ongoing annual costs, while allowing the trees to grow long enough that harvest volume per hectare optimises harvesting costs. For softwoods, understanding the thinning process, and optimisation of thinning and clear-felling timing is a barrier.
- *How to overcome the barrier*:

- Hardwood plantations are normally harvested when the trees are between 10 and 15 years of age. Harvest timing depends on growth rates, ideally when there is more than 160 GMT/ha of standing volume.
- In softwood plantations, thinning timing depends on Site Quality (i.e. plantation growth rate). For a fast-growing plantation with a mean annual increment (MAI[1]) exceeding 27 m^3/ha/y, first thinning would normally be scheduled at about 10 years of age. For slower growing plantations (less than MAI 18), first thinning could be scheduled as late as 15 years. Each subsequent thinning after first thinning is at approximately 5-6 year intervals with three thinnings prior to final harvest at 30-35 years, depending on growth rates.

Plantation location barrier

- *Why is it a barrier?* If the property is remote from potential log customers, there can be higher haulage costs to transport the logs to the buyer, leading to lower residual harvest returns from a mill gate price. If the plantation is located in a part of the property that is remote from public road log truck access, there can be high internal roading costs required (e.g. to build a suitable road), leading to addition costs to be recovered from the net harvest proceeds.
- *How to overcome the barrier*: The SPP owners need to plan haulage routes, taking into account the range of customers (particularly for softwood growers). If the harvest can be coordinated with other growers in the near vicinity, it provides more incentives to encourage harvesting contractors to remote plantations. This will reduce or offset the higher production costs generally associated with harvesting small scale and/or remote plantations.

On-property roading barrier

- *Why is it a barrier?* Harvested logs must be loaded onto dedicated log trucks relatively near to the plantation. Trucks used for transporting logs to the processor are heavy, and usually cannot travel across farm paddocks without becoming bogged (e.g. in sandy rises). As a result, gravel tracks are needed to provide access from the public road system to the plantation edge and potentially within a plantation.
- *How to overcome the barrier*: Construction of on-property roads for log truck access is expensive, typically costing $18,000-$25,000/km to construct. It is important that such roads are constructed well ahead of harvesting commencing in order to allow time for the roads to settle. Ideally, roads should be constructed in summer and autumn, with winter

[1] MAI = mean annual increment expressed as m^3/ha/y.

not being ideal conditions for road building. Forwarders can transport harvested logs, but long forwarding distances are expensive. There is a cost trade-off between building a longer length on-property road to enable log trucks to drive closer to the harvested logs, compared with the cost of forwarding greater distances.

Plantation scale barrier

- *Why is it a barrier?* There are certain fixed costs associated with preparing formal harvesting plans, building internal harvesting roads, moving harvesting equipment to a property and environmental compliance requirements, including voluntary third-party certification. When there are lower volumes of logs available for harvest and sale from a site, these fixed costs become a higher proportion of overall total costs, and in turn, can significantly impact net returns.
- *How to overcome the barrier*: For very small-scale plantations, there is little that can be done about the fixed costs per hectare. One strategy is to link with other local plantations. Nevertheless, after calculating actual costs and revenues and therefore net revenues, a SPP of quality and market-required trees may well be financially attractive to buyers.

Log sale process barrier

- *Why is it a barrier?* The log sale process is complex. A grower needs to understand potential purchasers of logs from a proposed harvest, their particular log specifications, prices of each log category and log delivery arrangements. They need to know who is able to harvest the trees and who is able to transport the logs to each log purchasing customer.
- *How to overcome the barrier*:
    - Hardwood owners grow their trees to produce woodchip. Local sales are in dollars per green metric tonne ($/GMT), with the products supplied being either woodchip, or pulplog that is chipped near the export facility.
    - Softwood growers have a wide range of product options. This report provides details of local softwood processors and specifications of the log products they purchase. Each processor's log price table is specific to that processor. Generally, prices are higher for larger diameter and longer length logs. When considering various harvesting and transport options, growers need to understand the stumpage for each potential combination of product, volume and customer. Harvesting costs are linked to mean tree volume (costs per GMT are less with higher volume/ha harvests) and operation type (costs per GMT are less at clear fell than for thinnings). Harvesting costs are also linked to product quality.

Transport prices depend on truck size and haul distance. Truck loading costs need to be considered. Calculation of stumpage takes in a number of variable costs. For a SPP grower, it is often advisable to engage an experienced harvesting manager to ensure optimum returns.

Harvesting contractor availability barrier

- *Why is it a barrier*? Most harvesting contractors are engaged by the larger-scale corporate growers to undertake harvesting of specific zones of plantations with contract periods of one to five-year duration. At present there are no harvesting contractors in the GT that service small-scale growers exclusively. However, some contractors will service smaller-scale harvesting tasks.
- *How to overcome the barrier*: There are no local lists of suitable contractors. But SPP owners can engage a log marketer to manage the harvesting operation (who will have established relationships with local contractors). Alternatively, they can seek support from an existing corporate plantation owner (who will have their own contractors engaged by relatively long-term contracts with well-defined contract conditions).

Pre-harvest considerations barrier

- *Why is it a barrier?* Pre-harvest considerations include inventory (e.g. measurement of tree attributes from which standing volume can be estimated), the need to prepare Harvesting Plans, and, for hardwood plantations, formal planning to mitigate the risk of injuring koalas.
- *How to overcome the barrier*:
    - Plantation inventory is a specialist skill, and in most cases is best outsourced to a professional contractor.
    - Harvesting plans need to include landowners name and address, the months during which operations are to occur, estimated timber volumes to be harvested, proposed haulage routes, fire protection measures and a map. The map must show the plantation, significant features including waterways and any areas reserved or specifically managed for protection of biodiversity, historic places or Aboriginal cultural heritage values, the area to be harvested, new or upgraded roads, power lines and any plantation infrastructure.
    - Koala Management is required prior to harvest of any hardwood plantations. There are different regulatory requirements in South Australia and Victoria. In South Australia, plantation owners need to comply with GT Regional Plantations Committee guidelines. In Victoria, an Authority to Disturb is required, and then an approved Koala Management Plan prepared. Koala Management Plans require expert input and for most SPP owners, it is usually best to have them prepared

by someone with the appropriate skills. Once a harvesting operation has commenced, there are on-going responsibilities for the plantation owner. These include having trained koala spotters, retaining a minimum of nine live trees around any koala found (as a food source and habitat for that koala), having at least one person trained in handling koalas, taking action if any koala has been injured and regular assessment of koala welfare both during and after harvesting.

A guide to considering new plantation development in the GT

- *Species*: While a wide range of tree species are able to be grown on farms, in the GT, there are only two species for which there are regular accessible markets with bankable returns. They are *Pinus radiata* (radiata pine; a softwood) and *Eucalyptus globulus* (Tasmanian blue gum; a hardwood).
- *Plantation site location:* When considering establishment of a plantation on a farm, it is important to consider future log truck access. This means either planting the trees near an existing road network on the farm, or else near a public road (that is suitable for heavy log trucks). Also, if there are neighbours with plantations, there are advantages in establishing a new plantation closer to the neighbour's plantation, so that at time of harvesting, with neighbour cooperation, there is potentially a larger-scale harvesting unit formed by the combined resource. Depending on location and scale, proponents in South Australia should also review whether there is a need for a forest water licence under the Lower Limestone Coast Water Allocation Plan.
- *Plantation scale:* Fixed costs (such as for environmental compliance and for developing Timber Harvesting Plans) consume a greater percentage of harvest revenue in small-scale woodlots than in larger-scale plantations (where there is more harvest revenue to absorb these fixed costs). But the plantation shape can be such to fit with other farming activities and to provide stock shelter. For example, the plantation could be longer and narrower.
- *Plantation layout*: The plantation should be designed to facilitate future harvesting. Internal tracks need to be located to facilitate log truck access (ideally so that forwarding distances are less than 400 m). Plantation row direction should be such that forwarders are able to access the plantation tracks. This means that tree rows are not parallel to the tracks, but instead lead to the tracks. Plantation row lengths should not be too short (ideally at least 30 m long) and not too long (ideally less than 350 m long).

Introduction

At 314,411 ha, by area the Green Triangle (GT; located in southeast South Australia and southwest Victoria) is Australia's largest-scale plantation forestry region (ABARES, 2022) and is the second largest softwood region (after the Murray Valley Region). Table 1 presents data from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) plantation area update as at August 2022 and Figure 1 presents plantation coverage (by hardwood and softwood). In the GT, approximately 57% of the total plantation area is *Pinus radiata* (radiata pine; a softwood) and 43% *Eucalyptus globulus* (Tasmanian blue gum; a hardwood).

Table 1: The Green Triangle plantation areas compared with the national plantation estate in 2020/21 (supporting dataset to ABARES, 2022)

	SA (ha)	Vic (ha)	GT (ha)	Australia (total) (ha)	GT % of national estate by area
Hardwood	43,830	89,979	133,809	711,016	18.8%
Softwood	124,163	56,439	180,602	1,010,233	17.9%
Total	167,993	146,418	314,411	1,721,249	18.3%

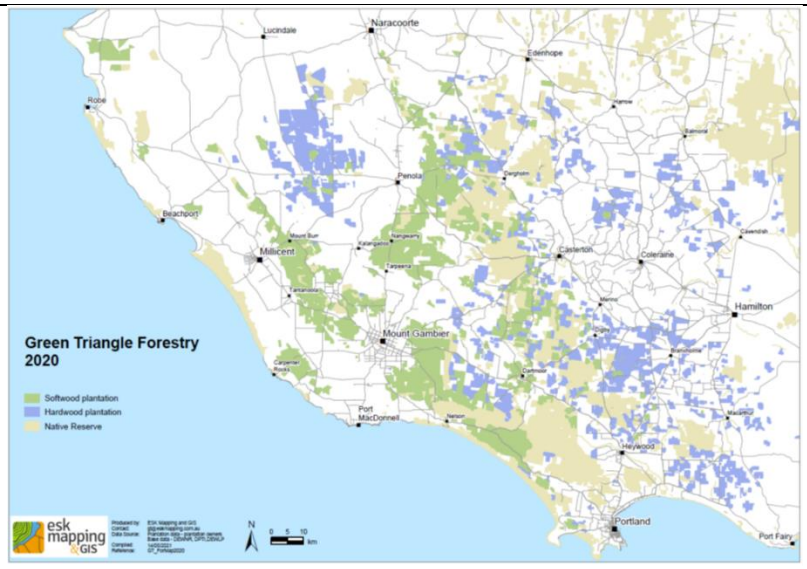

Figure 1: Green Triangle hardwood and softwood plantation coverage (Source: Green Triangle Regional Plantations Committee, 2020)

Based on Geddes Management data, corporate growers account for about 96% of the entire GT plantation estate listed in Table 1. In order of size, softwood corporate growers are OneFortyOne Plantations (the largest), then New Forests Asset Management (managed by Timberlands Pacific), Green Triangle Forest Products and HVP Plantations. Large-scale

corporate growers, Australian Bluegum Plantations and New Forests Asset Management (managed by PF Olsen Australia) control the majority of the hardwood estate. Trees into farming contributes only a small portion of GT regional plantation assets as presented in Table 2.

Table 2: An area comparison of GT corporate growers with smaller-scale growers (Sources: ABARES, with the small grower area estimated by the authors)

	Large-scale growers (ha)	Small-scale growers (ha)	Totals (ha)
Hardwood	128,809	5,000	133,809
Softwood	172,202	8,400	180,602
Total	301,011	13,400	314,411

The softwood plantation estate has been relatively stable for several decades, with little new land developed to plantations. While there was a rapid expansion of the hardwood plantation estate from the early 1990's, since 2008, the area has declined by about 20%. After harvest, some plantations that were less-productive have been converted back to agricultural. As well, water policy restrictions in South Australia have prevented re-establishment, particularly in the Wattle Range area (located west of Penola).

Currently, logs harvested from Australia's plantations are unable to meet domestic sawn timber demand. Woods (2022, p.6) suggested that by 2046, softwood imports will need to increase by 40% to bridge the sawn timber supply gap. Both industry and the Federal Government have identified the need for more plantations to be established. The Green Triangle Forest Industries Hub (GTFIH) recognises that there is an opportunity for more plantation development from the trees on farms sector in the GT.

To encourage private trees into farming in the GT, focusing on the two dominant commercial species (*Pinus radiata*, radiata pine; *Eucalyptus globulus*, Tasmanian blue gum) in 2022, the South Australian Department of Primary Industries and Regions (PIRSA) funded the GTFIH to implement five separate research projects (see Box 1).

As demonstrated (see Attachment A: Partial list of previous trees into farming studies), over the last 30 years, there have been numerous studies, books and reports in support of small-scale plantations into farming lands. Many of these reports have focussed on matters such as relevant species that can be established, site types suited to plantations (e.g. in terms of soils and climatic conditions) and silviculture (including pruning). An information gap

identified in many of these reports has been the logistical aspects of harvesting farm-grown plantations and woodlots.

Box 1: The Green Triangle Forest Industry Hub and South Australian Department of Primary Industries and Regions project portfolio.

- Project 1: Research new shorter rotation silvicultural models for pine plantations and longer rotations for blue gum plantations.
- Project 2: Conduct a study on the barriers which inhibit processors, harvesters, and hauliers processing smaller amounts of logs from farm forests and how they may be addressed.
- Project 3: Conduct a spatial analysis study of suitable land areas for farm forestry based on growth potential and proximity to processing facilities.
- Project 4: Conduct a study on the benefits of participating in the Emissions Reduction Fund under the plantation forestry method compared to the farm forestry method.
- Project 5: Engage a tax expert to provide forestry tax information relevant to farmers.

Project 2 (see Box 1), aims to provide information to assist existing small-scale growers in regard to harvesting and selling their trees and to provide insights to the needs and requirements of the purchasing party. More importantly, this information will assist parties considering commercial tree growing to avoid past barriers to realising a commercial harvest. Barriers that inhibit successful harvesting and processing of logs from small-scale plantations have been explored; the attributes of each barrier have been described, including the implications of each barrier. Strategies have been described to mitigate each identified barrier. This report is structured as presented in Box 2.

Box 2: After the Key points and Introduction, this report has been set out in the following sections.	
Section 2	Describes the GT supply chain and provides an overview of growing trees from the different perspectives of the softwood and hardwood plantation industry sectors. It describes the harvesting process and the intricacies of selling harvested logs. There is a snapshot of the individual GT softwood processors and the hardwood woodchip exporters. It describes environmental compliance requirements when selling logs. Finally, for growers in South Australia, the plantation water licensing system is considered.
Section 3 to 10	Describes each of the eight identified barriers to harvesting and processing SPP plantation resources. • Plantation value. • Silviculture. • Plantation location relative to markets. • On-property roading. • Plantation scale. • Log sale process. • Harvesting contractor availability. • Pre-harvest considerations. For each barrier, subsections describe the barrier, the implications of the barrier and how to address the barrier.
Section 11	Provides future harvesting guidance for growers considering establishing new plantations.
Section 12	A list of reference documents cited in this report.
Attachment A	A partial list of previous relevant studies. While it does not include all studies over the past 30 years, it indicates that there have been many significant reports. In the early 2000's when the Joint Venture Agroforestry Program (JVAP) was active, there were many trees-into-farming and small-scale plantations studies. The JVAP was established in 1993 and was jointly funded by the Rural Industries Research and Development Corporation, the Land and Water Resources Research and Development Corporation and the Forest and Wood Products Research and Development Corporation (see Powell, 2009 for an overview). The JVAP produced close to 200 research reports related to private tree growing.
Attachment B	A list of Forestry Terms.

The Green Triangle supply chain

1.1 Softwood plantations: growing the trees

1.1.1 Tree stocking in softwood plantations

Softwood plantations are normally planted at high stocking rates (1,400-1,600 stems per hectare) to encourage tall and straight tree growth. As the trees grow taller, plantations need to be progressively thinned to provide more space and resources to individual trees to allow greater diameter growth of the remaining trees. This results in larger diameter trees which enables recovery of more valuable sawlog size logs. There are three main thinning considerations; how often to thin, controlling the site, and which trees should be removed. For softwood plantations there are the normally three thinnings (T1= first thinning; T2 = second; T3 = third thinning) and clear felling (CF).

1.1.2 How often to thin

The age of T1 depends on growth rates. For fast growing plantations, T1 can be scheduled at about age 10-years, while for slower growing plantations, T1 can be as late as at age 15-years. Second thinning is normally scheduled about 5-6 years after a T1 event, with T3 in another 5-6 years, and final harvest (clear fell) about 8-10 years after T3 or at a pre-determined rotation age.

Wind firmness needs to be considered. In an unthinned plantation, the surrounding trees protect each other from windthrow. Once a stand is opened up after T1, more wind can blow through a plantation. It takes about 6-months after T1 before the trees adapt to the increased wind. Plantations are vulnerable during that period to windthrow, particularly after wet and windy weather. Chapter 6 of Bulletin 23 (Lewis, et al, 1976) provides basic rules for the number of stems to be left after thinning to reduce risk of windthrow. Known as the Optimum Thinning Guide, it refers to the relationship between Site Quality, stocking and tree height to avoid wind damage. As trees grow taller, it is particularly important to avoid any delay of T1 timing.

1.1.3 Controlling the site

Stocking after thinning needs to be such that a plantation maintains control of a site so the trees shade out the ground to prevent competing weed growth. In the northern parts of the GT, where there are hotter summer temperatures, tree bark can be damaged by sun scald if

there is insufficient canopy to protect (shade) the tree stem. Severe sun scald can cause the cambium layer to die on one side of a tree, leading to wood decay downgrading log quality and reducing potential sawlog recovery.

1.1.4 Which trees should be removed

Thinning can be from above (i.e. taking out the larger trees) or from below (i.e. taking out the smaller trees). Because the objective at clear fell is that all trees are to be tall and straight, in the GT, thinning is usually from below. Generally, T1 involves the removal of a complete row of trees to allow machine access; this can be every second, third or fifth row. At the same time, it is possible that the remaining bays of trees are thinned. First thinning and T2 harvests provide the opportunity to remove trees that do not have potential to produce high quality sawlog. These include suppressed (runt) trees, double leaders (i.e. trees with two main stems), trees with ramicorns (i.e. a large vertical branch), trees with deformed or bent stems and trees with poor crown growth. At T1, sometimes groups of trees are removed because there are so many poor-quality trees together. At T2 and T3, there is more emphasis to ensure an even spacing between individual trees after thinning.

Trees to be removed are either identified by a mark of paint sprayed on the stem by trained tree markers or trees ’operator selected‘ by the harvesting machine operator. There is a cost to employ tree markers, but this cost can be offset by having a better-quality outcome after harvest, as well as slightly cheaper harvesting costs. This is because the harvesting operator does not need to take the time to determine which trees are to be felled.

1.2 Hardwood plantations; growing the trees

Hardwood plantations in the GT are normally grown over a short rotation of 11-14 years before harvest to supply international paper makers with woodchip. Trees are planted in rows at a stocking of 900-1,000 stems per hectare. In the GT, hardwood plantations are not normally thinned prior to harvest.

1.3 Harvesting the trees

1.3.1 Broad systems

Harvesting is the culmination of years of managing and growing trees and is the opportunity for the return on investment in trees to be realised. Careful planning is important so that returns are maximised. Definitions of each of these pieces of forestry equipment are contained in Attachment B: Forestry terms.

There are two types of harvest systems used in the GT.

- Cut-to-length operations: In cut-to-length (CTL) operations each tree is individually felled, de-limbed and cut into log lengths by the harvesting machine at the stump. In hardwood operations a harvester will also de-bark the stem before docking. These logs are forwarded (extracted) to the plantation edge, loaded onto trucks and delivered to a customer. In some softwood operations, certain log products may be chipped at the plantation edge, with or without debarking, and the chips loaded onto a chip truck and delivered to a customer.

- Whole-tree (or in field) chipping operations: With whole-tree chipping (WTC) operations, trees are harvested with a feller-buncher, bunches of fallen trees are skidded to a mobile chipper on the plantation edge and fed through a flail de-limber (which removes branches and bark), and into a chipper to chip the stems and 'blow' the woodchip directly into closed sided chip trucks (see Figure 2).

Figure 2: A WTC operation in a farmer owned hardwood plantation, showing a mobile chipper, a loader and a chip truck (Photo by DJ Geddes©)

1.3.2 Falling the trees

Sophisticated machines with skilled operators are used during harvesting. Falling is undertaken using harvesters; softwoods; Figure 3, Figure 4 and Figure 5 and hardwoods Figure 6, Figure 7 and Figure 8.

Figure 3: A harvesting machine thinning a softwood plantation (Photo by DJ Geddes©)

Figure 4: Clear fell harvesting in a mature softwood plantation (Photo by LJ Parsons©)

Figure 5: Harvesting trees in an older age softwood plantation (Photo by DJ Geddes©)

Figure 6: Harvesting hardwood plantation trees (Photo by DJ Geddes©)

Figure 7: A CTL harvesting in a hardwood plantation (Photo by DJ Geddes©)

Figure 8: Forwarder and harvester at a hardwood clear fell (Photo by DJ Geddes©)

1.3.3 Extraction

Fallen trees and processed logs are extracted to the roadside by specialist equipment (see Figure 9, Figure 10 and Figure 11.

Figure 9: A forwarder loading large diameter logs from an older age softwood clear fall (Photo by LJ Parsons©)

Figure 10: Forwarder loading hardwood logs in a CTL operation (Photo by DJ Geddes©)

Figure 11: A skidder moving bunches of felled hardwood trees to a mobile chipper (Photo by DJ Geddes©)

1.4 Haulage

Various sizes of log trucks are used in the GT. They vary from triaxle semi-trailers (load capacity c.26 green metric tonnes (GMT) and a loaded weight of 43 tonnes), B-doubles (a prime mover towing two semitrailers with a load capacity c.45 GMT and a loaded weight of 68 tonnes – see Figure 12) and A-doubles (a road train with two trailers, with a load capacity c.63 GMT and a loaded weight of 91 tonnes – see Figure 13). Generally, the larger the capacity truck, the cheaper the haulage costs per tonne per kilometre ($/GMT/km). Woodchips are transported in specialist closed sided trucks (see Figure 14 and Figure 15).

Figure 12: A B-double log truck with small diameter logs from a softwood T2 (Photo by DJ Geddes©)

Figure 13: A-double log truck with hardwood logs (Photo by LJ Parsons©)

Figure 14: Chipping pulplog in a softwood T2 (Photo by DJ Geddes©)

Figure 15: Unloading B-double chip trucks at one of the Portland woodchip export terminals (Photo by DJ Geddes©)

1.5 Selling the logs

1.5.1 Arranging log sales

For SPP owners, initial contact with sawmills, log buyers or brokers is normally required at least two years prior to a proposed harvest date, with follow-up meetings each six months to fine tune arrangements. The only current and active GT markets are for logs from radiata pine and Tasmanian blue gum plantations.

1.5.2 Log grades

Processors usually purchase logs from corporate growers under long-term agreements for specific log grades. There are two main types of log for processing through GT sawmills. Better-quality logs (in terms of straightness) are known as sawlogs (with a range of log

lengths and diameters), while industrial logs include shorter length logs (which do not meet sawlog specifications) as well as larger diameter logs with very large branch knots (typically from trees on the plantation edge).

The grade and value of logs sold depends on: log size (i.e. diameter and length), log quality (i.e. straightness and number and size of knots), tree age, volume available, continuity of supply, and the current market situation. Key log attributes are log length (in metres) and log diameter. Log diameter is defined by the small end diameter (SED) as the diameter of the smallest log end or large end diameter (LED) as the diameter of the largest end of a log. Normally diameter measurement of standing trees is over bark (OB) while log diameters are normally measured under bark (UB).

It is common to sell multiple log grades from a single softwood plantation harvest to more than one buyer and indeed from a single tree. Returns can be maximised by organising markets for the full range of products so that residues are minimised. This may mean coordinating a single harvest with log sales to different purchasers; for example pulpwood, sawlog (sometimes with different diameter ranges) and fencing products (e.g. posts, rails and strainers).

1.6 Supporting information including plantation inventory

Prior to planning harvesting, a SPP owner needs to obtain data on area to be harvested, determine the appropriate harvesting operation (e.g. thinning or clear felling), estimate volume by log grades to be produced and the required plantation outcome (e.g. for thinnings, the required stocking level after harvest).

An inventory of a plantation is usually required to estimate harvest yield. Inventory typically requires measurement of sample plots of trees. Trees in particular sized plots (Table 3) are measured for diameter at breast height over bark (DBHOB) and tree height. Those data enable calculation of estimated stocking, basal area and standing volume. Key steps for a plantation inventory include to have an accurate map of the plantation (e.g. from GoogleEarth®) and stratify the plantation into like site types (e.g. in terms of stocking and tree growth). A point of caution is that while comprehensive guides are available (e.g. Abed & Stephens, 2003), planning, undertaking and interpretation of a plantation inventory is a specific skillset. In general, the greater the target accuracy of the estimate, the larger the sample required and therefore the higher the cost to determine an expected harvest volume.

Table 3: Sample plot sizes for different stocking rates

Stocking (stems/ha)	Plot size (ha)	Rectangular plot size (m)	Circular plot radius (m)
400-500	0.05	25.0 x 20.0 m	12.6 m
500-700	0.04	20.0 x 20.0 m	11.3 m
700-1,000	0.02	16.0 x 12.5 m	8.0 m

1.6.1 Arranging a sale of trees

Once harvest yield estimates (i.e. products by volume) are available, there are a number of different ways a SPP owner can arrange a sale. Which-ever method is used, the SPP owner must resolve how payments will be made, when (e.g. fortnightly, monthly or at completion) and whether a deposit is required upfront prior to delivery of the first load of logs. The basis of sales options are as follows.

- On the stump sales: There is the option to sell the trees on the stump based on a prediction of expected yield and products. The buying party then arranges and manages the harvest and potential sale to external parties or supplies to their own site. As the risk of not achieving predicted volumes lies with the purchaser, they will normally discount the price to ensure they do not make a loss. This may reduce the overall net price. The benefit to the SPP owner is up-front money for the sale of their logs, rather than waiting until the logs have been delivered to a processor.

- Mill door price basis: It is possible to negotiate a mill door price (MDP) with processors, depending on how many products are likely to be produced, provided the processors are prepared to purchase the logs. This requires the SPP owner to arrange the harvesting and harvest management. While a SPP owner theoretically could undertake their own harvesting, for a range of reasons, most processors will not accept products unless they are supplied by a professional harvesting contractor.

- An intermediary: A SPP owner could sell their trees through a log marketer who negotiates with the purchasers, engages the harvesting contractor and manages the harvesting and haulage operations (e.g. planning, approvals, certification and safety). There are several organisations that can provide this service in the GT. With this type of sale, the SPP owner may not be informed of the MDPs for each product. There are two options. The SPP owner could be paid a residual stumpage for each product or (less likely) a single stumpage for a pool of products. Residual stumpage is the MDP less

harvesting, transport, management, roading and other costs; it is the residual received by the grower.

- An add-on: It may be possible to arrange a local corporate plantation owner to organise the harvesting and sale of all logs to their normal processor customers, potentially as part of their current supply chain. This ensures that the harvesting is carried out by competent and compliant contactors. The SPP owner will receive a residual stumpage. Corporate plantation owners can be reluctant sell logs from SPP growers as they will potentially displace and forego sales of their own logs into the market.

1.6.2 Determination of quantities sold

Most processors purchase log by weight, while others measure the logs and pay by volume (cubic metres; m^3). It is important to understand which system is being used and ensure there is a method to check the quantity actually removed and delivered. Depending on the quantity, this may mean, for example, that several sample loads need to be weighed at an independent weighbridge to ensure the processor's weighbridge is correct. Or it may be possible to view an audit process used by the processor to verify weighbridge accuracy. There also needs to be a system in place to check that each load leaving a plantation is measured and then reconciled with the delivery dockets used for invoicing or payment by the log buyer.

While all hardwood logs and woodchips are sold on a GMT basis, with softwoods, the terms log volume and log weight are often interchangeable, given one green metric tonne of softwood log is approximately equivalent to one cubic metre of log. If an alternative conversion factor is used, it needs to be verified.

1.6.3 A contract; a Wood Supply Agreement

In summary, when negotiating with log purchasers, SPP owners need a documented contract of supply that includes log product to be recovered, estimated quantity to be sold, delivery responsibility, log specifications, measuring system, log price and payment arrangements. Responsibility for roading, vehicle speed limits on the property, any clean-up after harvest and environmental care should be documented.

1.7 Local softwood processors

1.7.1 Softwood markets

Based on Geddes Management data, current annual GT harvest volumes from the 180,602 ha of softwood plantations is approximately 3.65 million GMT per year (GMT/y). Of this annual harvest, approximately 2.39 million GMT/y of sawlog is processed through regional sawmills, 0.24 million GMT/y is processed in preservation plants, 0.13 million GMT/y is used for particleboard and the remaining 0.89 million GMT/y is exported as roundwood (e.g. pulplog and sawlogs) or woodchip through the Port of Portland.

Statistics from a report commissioned by GTFIH (GTFIH, 2022, p.2), notes that the region supplies about 35% of Australia's locally produced house framing and interior sawnwood, 25% of the nation's particleboard, 48% of the packaging and industrial grade timber and 60% of the poles, posts, fencing and similar products, used in agricultural, horticultural and external environments.

1.7.2 Sawlog

Sawlogs are sold in varying lengths and diameters (grades), with the common feature being that they need to be straight (e.g. without bends or kinks). Collectively, six local sawmills purchase the majority of sawlogs from GT softwood plantations: OneFortyOne Wood Products, McDonnell Industries, and Whitehead Timber Sales (all located near Mount Gambier, SA), Timberlink Australia (located at Tarpeena, SA), AKD Softwoods (located at Colac, Victoria) and South East Pine Sales (located near Glencoe, SA). Three other smaller-scale sawmills process less than 2% of the softwood sawlogs available.

1.7.3 Preservation logs

Four timber treaters purchase roundwood suitable for fencing products; Roundwood Solutions (with facilities at Yahl and Snuggery, SA), Portland Pine Products (located near Heywood, Victoria), Alliance Timber (located at Dartmoor, Victoria) and Plantation Treated Timber (located at Kalangadoo, SA). This is a specialist low-volume but high-value market with ability to supply constrained by stringent straightness and diameter criteria. Treatment products (particularly fence posts) are obtained from small-diameter logs, down to 75 mm small-end diameter under bark (SEDUB).

1.7.4 Board products

Borg Manufacturing, operating as Australian Panel Products, is Australia's largest-scale particleboard manufacturer. Borg has two particleboard plants with one located at Lakeside and the other at White Avenue, both on the western side of Mt Gambier. The company plans to construct a single new facility in Mt Gambier to replace its two existing plants.

1.7.5 Softwood exports

The softwood logs exported are typically in smaller-diameter pulplog sizes not required by local sawmills. Previously the main markets were in China. Volumes exported has reduced considerably since November 2020 when China implemented bans on Australian sourced logs. Lower volumes of logs are now exported, mainly to customers in India. Woodchip exported is largely sourced from sawmill residues, with additional volume from chipped pulplogs. There are two softwood chip export terminals at the Port of Portland with a combined capacity of approximately 1.0 million GMT/y.

1.8 Hardwood chip sector

Hardwood plantations are generally not thinned prior to CF at around age 11 to 15 years. Harvesting of GT hardwood plantations for export woodchips commenced in 2006 and volumes have grown progressively since that time. An average of 5,580 ha/y was planted each year between 2001 and 2020 in the GT. The ABARES (ABARES, 2021, Table 13) notes that there is only a small area of hardwood remaining in the GT that was planted before 1996. Overall, all hardwood trees established prior to 2005 are now over-mature and are being progressively harvested. Logs recovered from GT hardwood plantations are all exported through the Port of Portland, mainly in the form of woodchip. There are two hardwood chip export stockpiles at the Port of Portland. Based on Geddes Management data, harvest volumes from the 133,809 ha of hardwood plantations is approximately 2.8 million GMT/y (range 2.5-3.0 million GMT/y, depending on global demand). The Port of Portland has a maximum export capacity of approximately 3.0 million GMT/y of hardwood woodchip.

1.9 Environmental compliance

There are two key international voluntary third-party environmental certification organisations; the Program for the Endorsement of Forest Certification (PEFC) and the Forest Stewardship Council (FSC). In Australia certification is possible under the

Responsible Wood certification scheme (endorsed by PEFC) or FSC (administered by FSC Australia).

Most purchasers require logs or woodchips to be sourced from voluntary third party (environmentally) certified plantations. This is to satisfy customer requirements (including international pulp mills) that the trees have been grown with sustainable forest management practices. Most customers, for either sawn timbers or woodchip supplied by a sawmill, will require that the products have suitable environmental accreditation. Processors usually require Chain of Custody (CoC) certification to prove to their customers that the logs purchased were obtained from voluntary third party certified (sustainably managed) plantations.

From a SPP owner perspective prior to harvest, a suitably skilled party is required to prepare the necessary documentation to prove to an auditor that the plantation meets the requirements of PEFC and/or FSC. Such documentation includes a Forest Management Plan and evidence that native vegetation is being protected.

1.10 Plantation Water Licences in South Australia

1.10.1 Impacted locations

Water use is managed within the Lower Limestone Coast (LLC) by a series of sub-catchment management zones presented in Figure 16. Since 2004, plantation forestry has been considered a water-affecting activity in the LLC and is therefore accounted for in the water management system (Geddes, 2019, p.28-30). This is because plantation tree roots are deemed to extract aquifer water to enhance tree growth, and plantations are deemed to restrict recharge of the aquifer from rainfall (Benyon, 2002, p.10 & 16).

Figure 16: Lower Limestone Coast groundwater management zones (Source: South East Natural Resources Management Board, 2013, Figure 2)

1.10.2 Contributing plantation attributes

In terms of reduction in recharge and direct extraction, the deemed volume of groundwater impacted by plantations depends on several factors including the following.

- Tree species: There are deemed differences in water use between Tasmanian blue gums and radiata pine, particularly with regard to rotation length and the period of fallow between plantation rotations.

- Age and crown development of a plantation: There are known variations in water use throughout the plantation life cycle. While trees are in the juvenile phase, they occupy a reduced portion of the site. After harvesting, sites are left fallow prior to replanting and do not intercept rainfall or extract water from the aquifer.

- Soil type: Water holding capacity of a soil and the depth of soil to which roots can penetrate.

- Site occupancy: Plantations do not fully occupy a site (title). Existing plantations occupy around 85% of a site (e.g. net plantable area or the actual area planted), leaving 15% unoccupied. Some properties have less than 70% net plantable area.

1.10.3 Holding a water licence and deemed water use

Under the provisions of the *Landscape South Australia Act, 2019* (which superseded the *Natural Resources Management Act, 2014)* plantation owners are required to hold a Forest Water Licence (Natural Resources South East, 2015). A Forest Water License authorises a specific plantation at a specific location; it attaches to the land title. It includes a water allocation, a water allocation property right, a water allocation tradeable only when no longer required and a tradable allocation based on deemed rates in the Water Allocation Plan (WAP) at the time. Where an aquifer is within 6 m of the land surface, a licence is required for plantations deemed to be extracting from the unconfined aquifer. These licences include an annual levy based on deemed water use by plantations as presented in Table 4 and as follows.

- Deep water-table: For a plantation over a deep water-table (i.e. greater than 6 m depth, based on the Digital Elevation Model), there is expected to be no extraction of water. But there will be a recharge interception reduction (percentage of rain falling), based on the rainfall intercepted by the plantation canopy; 83% for softwoods and 78% for hardwoods.

- Shallow water-table: For a plantation over a shallow water-table (i.e. less than 6 m depth), there are provisions for both interception (as above for softwoods and hardwoods) and direct extraction (1.66 ML/ha/y for softwoods; 1.82 ML/ha/y for hardwoods).

Table 4: Deemed water use by forestry plantations (Data source: Natural Resources South East Fact Sheet No 3, March 2015, p.4)

Plantation type	Nominal rotation (y)	Rainfall recharge under plantation	Extraction where water table < 6 m (ML/ha/y)
Hardwood	10	22%	1.82
Softwood	35	17%	1.66
Hardwood coppice	8	22%	2.50

1.10.4 Treatment of plantations based on scale

The LLC WAP has different approaches between larger-scale plantations and 'farm forestry'. Natural Resources South East (nd) defines farm forestry as a commercial forest that is situated on a farm and where the net planted area does not exceed 10% of the land described in a Certificate of Title or Crown Lease or 20 hectares, whichever is greater. Farm forestry is considered to be a forestry activity that is integrated with other farming activities. If meeting the farm forestry plantation definition, a forest water licence is not required. If an existing plantation is greater in area than these parameters, it will have already been granted a Forest Water Licence, for which an annual fee is payable to the South Australian Department for Environment and Water.

In 2006, Brown et al (2006, p11) raised concerns about suspected over-allocation of water. In 2012, when the updated LLC WAP was being prepared, two sub-catchment management units (Coles and Short) with extensive plantations were considered to be over-allocated and at 'high risk'. Figure 16 identifies these two 'at risk' zones where future plantation area reductions could be implemented. If plantations are located in 'at risk' water management zones, the plantation activity can continue until the trees are clear felled. At that time, a manager may either need to secure an additional water licence before a plantation is replanted, or else, only a portion of the plantation can be replanted with the remainder converted to grazing activities.

1.11 Forestry codes of practice applicable to the Green Triangle

There are state-specific forestry regulated codes applicable to plantations in the GT as follows.

- Victoria: Plantations must be managed according to the *Code of Practice for Timber Production 2014 as amended 2022* (DEWLP, 2022*)*. While much of the code is devoted to public native forests in Victoria, a section addresses plantations and includes

harvesting matters presenting details required in a Timber Harvesting Plan (e.g. content and notifications).

- South Australia: Plantations must be managed according to the *Environmental Management Guidelines for Plantation Forestry in SA 2009* (PIRSA, 2009). It summarises mandatory requirements on a forest owner to ensure delivery of appropriate environmental, social and economic outcomes. There is a specific chapter about harvesting with the sub-headings of; planning, operation, soil and water resources, harvest management and post-harvest.

Plantation asset value

1.12 Why plantation asset value is a barrier

Often a person who establishes a plantation has some understanding of the potential future worth of the trees. Alternatively, because a plantation is not part of the day-to-day management of a farm, even the person who established it may have forgotten about the potential future tree value.

As plantations have long rotations (e.g. softwoods can be up to 35 years), it is not uncommon for the ownership of a property (and therefore the trees) to change before the trees have matured and are ready for their final harvest. This ownership change could be due to the sale of the property or an inheritance as the property is handed down to the next generation. If a plantation is only a small area of a property, the new owners may not recognise that the trees have a value. Indeed, the trees may not have been assigned any value at the time of changing hands. Similarly, it was found (Jenkin, 2022) that a financial institution may not recognise plantation values and for determining asset values against which bank loans are secured, the institution may only include the land value.

Once plantation owners (and their financiers) understand the value of their standing plantation, they are likely to be more motivated towards best practice harvest management.

1.13 The barrier implications of plantation asset value

1.13.1 Scale and owner focus

As plantations are often a small area and part of an overall agricultural enterprise, plantation management matters are not usually considered on a day-to-day basis. This contrasts with agricultural enterprises where management and pricing information can be found on a daily basis via rural radio programs (e.g. the ABC *Country Hour*) and through specialist agricultural weekly newspapers (e.g. the South Australian *Stock Journal* or the Victorian *Stock and Land*), and from stock agents.

1.13.2 Plantation valuation

When purchasing goods in a shop, those goods are labelled with a price. Similar quoted prices are not available for standing trees. There are also non-cash values of plantation trees including farm shelter, climate amelioration, preserving soil and supporting wildlife. In

the GT (South Australia and Victoria), it is legally possible to separate the assets and values of standing trees, land and carbon sequestered by those plantation trees.

Standing plantation tree value is influenced by a number of factors. These include species, effective plantation area, annual maintenance costs (e.g. surveillance, firebreaks, weed and pest control, insurance, land rent and council rates), tree growth rate and standing merchantable volume (which not only includes the volume of logs sold, but also influences harvesting costs), terrain (which influences harvesting costs), distance from log processor customers (which influences haulage costs), and log prices. Therefore, to gain a current estimate of plantation value, it is often necessary to have that plantation valued. There are a range of drivers of a need for a plantation to be valued and to understand likely future cash-flows.

- Cash-flows:
    - Harvest revenue: The plantation owner may wish to understand the indicative return from a forthcoming harvest.
    - Farm cash-flow analysis: The SPP owner may wish to link cash-flows of future harvests with cash-flows from the main agricultural enterprise.
- Valuations:
    - Financial transactions: These include from many different perspectives; as a buyer, a seller, an investor, an insurer, an inheritor or a taxpayer.
    - Financial reporting: If the purpose of the valuation is for formal financial reporting as required by the Corporations Act 2001, compliance with the Australian Accounting Standards Board (AASB) accounting standards is mandatory.

To estimate expected cash-flows from plantations due for harvest in the near future, an inventory is normally required to estimate expected harvest volumes often broken down by product or grade. Note: inventory is discussed in Section 1.6.

If a valuation is required for financial transactions or financial reporting, a formal valuation is normally required using methods described in the Australian Standard for Valuing Commercial Forests (Leech & Ferguson, 2012) (the Standard). In such cases, a professional forester with plantation valuation experience is required to undertake this work (see Box 3). There are four main methods for formal valuations described in the Standard.

- Transaction method: A value determined by comparing the plantation with sales of other similar plantations.
- Cost based method: A value calculated by summing all costs (from time of site preparation) to provide an estimate of value based on sunk costs.
- The lump sum method: A valuation (also referred to as the immediate liquidation method) normally used for mature plantations that are ready for final harvest. It assumes that the trees are harvested and the products sold into the market on the date of the valuation.
- The expectation approach: Value is determined by preparing an expected cash-flow of all future costs and harvest returns from the date of the valuation until the trees have been harvested and products sold. This method is also referred to as the present value method. An appropriate discount rate is applied each year to the cash-flow to arrive at a net present value (NPV). This method is the most commonly used plantation valuation method in Australia.

Box 3: Plantation asset valuation is a specific task requiring specific skills.
Normally (particularly for financial transaction and financial reporting) valuations must be determined by a qualified and independent person. Forestry Australia lists forestry consultants with valuation experience on its website, (www.forestry.org.au/find-a-registered-forestry-professional-rpf); search for forestry consultants listed under *Forest and Tree Valuation.*

1.14 How the plantation asset value barrier can be addressed

Small private plantation owners need to recognise that plantations are an asset and have a value. Value of very young plantations are normally based on the costs of establishment (the cost-based method). This includes the cost of laying-out a plantation, site preparation costs (e.g. tillage), pre-plant weed control, planting stock, planting, fertilising and post-plant weed control. For older-age plantations, standing plantation tree value per hectare is influenced by a number of factors including the following.

- Markets: Logs from hardwood and softwood plantations in the GT are sold into high-volume commodity markets, but pricing structures between the two are quite different.
- Annual maintenance costs: These include surveillance, firebreaks, weed and pest control, insurance, land rent and council rates.

- Pre-harvest costs: The cost of preparing harvesting plans, ensuring environmental compliance and shifting harvesting equipment to a plantation are relatively fixed. For a small-scale plantation (with only moderate total harvest recovery), these costs have a much higher impact on the net returns per tonne than with a larger-scale plantation.
- Tree growth rates: Growth rates influence standing merchantable volume which defines the volume of logs sold and impacts harvesting costs. Harvest costs with a high volumes per hectare are lower per tonne than for a low volumes per hectare. This is because a harvesting machine can process a large tree (with high stem volume) in approximately the same time as a smaller tree (with low stem volume).
- Haulage distance: The longer the haulage distance to a log processor customer, the higher the haulage costs per tonne of logs delivered.
- Log prices: Log prices vary with the type of log. For example, the Australian Pine Log Price Index report for the January-June 2022 period indicates that the range of stumpage prices for softwood logs varied from a low of $\$28.17/m^3$ for small diameter sawlogs to a high of $\$131.94/m^3$ for large diameter sawlogs (KPMG, 2022, Table 2). Hardwood prices are based on the global woodchip price traded in US dollars. Woodchips are sold on the basis of bone-dry metric tonnes (BDMT) which limits the impact of variation in wood density and moisture content. A BDMT is a measure of the quantity of bone-dry wood. The price paid for export woodchips depends on the world price which fluctuates with supply and demand, and due to currency exchange rates.

As a result of all these factors, generally, different plantations have different values per hectare. For plantations with very poor growth rates or those located with 'longer' haulage distances to customers, plantation value per hectare may be very low or even negative. But for plantations with higher growth rates and with shorter distances to processors, plantation values per hectare can be high. Recognising the wide number of variables to plantation values per hectare, a generic set of indicative plantation values by age class is presented in Table 5 (based on NPV). Low asset values take into account lower growth rates and higher haul distances, while high values assume higher growth rates and shorter haul distances.

Table 5: Indicative plantation asset valuations per hectare as at December 2022 (based on confidential data held by the authors)

Age class (years)	Hardwood ($/ha)			Softwood ($/ha)		
	Low	Average	High	Low	Average	High
0-2	$1,000	$1,750	$2,500	$1,500	$2,000	$2,500
3-5	$3,000	$4,500	$6,000	$3,000	$3,500	$4,000
6-10	$4,000	$9,000	$14,000	$4,000	$7,000	$10,000
11-15	$4,500	$12,250	$20,000	$5,000	$9,500	$14,000
16-20				$7,000	$12,500	$18,000
21-25				$10,000	$17,500	$25,000
26-30				$12,000	$21,000	$30,000
31-35				$15,000	$27,500	$40,000

It must be stressed that these are indicative values, merely to provide a guide. They cannot be relied on as a specific value for any plantation because every plantation will be different. Some plantations can have lower values than presented in

Table 5, and some will have higher values. Hardwood plantation values are particularly high in 2022 due to strong global demand for plantation grown Tasmanian blue gum woodchips.

Silviculture

1.15 Why silviculture is a barrier

Silviculture is management of trees for timber production. In this context, silviculture includes harvesting options as tools to address target outcomes. Harvesting options are different for hardwood and softwood plantations. Hardwood plantations are not thinned prior to final harvest. A SPP owner needs to understand harvesting timing (age) trade-offs between keeping rotations shorter to minimise recurring annual costs, while allowing the trees to grow long enough that harvest volume per hectare optimises harvesting costs. Softwood plantations are grown principally to provide sawlog that can be converted into structural sawn timber products. Supply of softwood sawlogs requires thinning of plantations up to three times prior to final harvest.

It can be difficult for a SPP owner to determine the appropriate harvesting option to maximise the value of a plantation, potentially resulting in sub-optimum choices. Understanding the thinning process, and optimisation of thinning and clear-felling timing is therefore a barrier for some SPP owners.

1.16 The barrier implications of silviculture

1.16.1 Softwood plantations

Within reasonable stocking limits (stems/ha), a plantation will grow the same standing volume over a given time, regardless of the number of trees per hectare. To optimise sawlog products from softwood plantations, they are normally planted at high stocking rates to initially encourage tall straight trees. Once the trees have achieved a certain size, they need to be thinned so the stem wood produced will be distributed amongst fewer trees, resulting in larger individual tree stem diameters at earlier ages, than if left unthinned. Optimising thinning of softwood plantations requires an understanding of growth patterns as well as market options for the various log sizes.

1.16.2 Hardwood plantations

Hardwood plantation silviculture does not have the complexity of that for softwood plantations. Hardwood plantations are not usually thinned, but it is important for the SPP owner to understand the trade-offs between a shorter rotation age (and reduced annual fixed

costs) and growing a plantation on for a few more years in order to have a higher harvesting quantity and therefore lower unit harvest costs.

1.17 How can the silviculture barrier be addressed

1.17.1 Softwood plantations

Softwood plantations in the GT are normally thinned three times prior to clear fell (see Section 1.1). Indicative GT softwood stem wood volumes by age and harvest type are presented in Table 6. Thinning timing depends on site quality (i.e. the attributes of a site contributing to plantation growth rates). For a fast-growing plantation with a MAI exceeding 27 m^3/ha/y, T1 would normally be scheduled at about 10 years of age. For slower growing plantations (less than MAI 18 m^3/ha/y), T1 could be scheduled as late as 15 years. Expert silvicultural advice is required to determine optimum timing of thinning schedules and final clear felling (see Box 4).

Table 6: Indicative softwood harvest yields in m3/ha (adapted from Lewis et al, 1976, Table V2)

	Site Quality 1-2				Site Quality 3-4				Site Quality 5+			
	Age (y)	Pulp log yield	Saw log yield	Total yield	Age (y)	Pulp log yield	Saw log yield	Total yield	Age (y)	Pulp log yield	Saw log yield	Total yield
T1	10	105	0	**105**	12	90	0	**90**	15	80	0	**80**
T2	16	40	50	**90**	18	40	40	**80**	21	35	35	**70**
T3	22	30	110	**140**	24	43	90	**133**	28	35	75	**110**
CF	33	35	530	**565**	34	62	400	**462**	35	45	280	**325**
Total		210	690	**900**		235	530	**765**		195	390	**585**
MAI				27.3				22.5				16.7

Box 4: A key to best plantation management outcomes is accessing appropriate technical advice.

Softwood silviculture is complex. The Woods and Forests Department of South Australia Bulletin 23 (Lewis et al, 1976) provides a wealth of technical information. A key to a successful silvicultural outcome based on this information is securing an experienced forester to provide advice.

1.17.2 Hardwood plantations

Hardwood plantations are normally harvested when the trees are between 12 and 15 years of age. ABARES data (ABARES, 2021, Appendix C, p.71) suggests average GT hardwood yields are about 204 GMT/ha at age 12 years; this is an MAI of 17 GMT/ha/y. If expected

yields are less than 120 GMT/ha, then harvest costs can be excessive and have a significant impact on net harvest returns. If inventory (see Section 1.6) indicates that standing volume is less than 120 GMT/ha, it may be beneficial to delay harvesting to increase the volume available at harvest. This decision must be balanced with haulage costs and annual costs considerations. Transport cost is lower with short-haul distances, allowing some flexibility with higher harvesting costs. Annual costs of maintaining the plantation include council rates (typically between $18-28/ha), surveillance costs, firebreak maintenance costs and insurance costs. Plantation insurance options have been significantly limited since 2021 when the largest-scale insurer exited the Australian market. When insurance was previously available, annual costs ranged from 0.6 to 1.9% of the plantation value.

Plantation location relative to markets

1.18 Why plantation location is a barrier

There are two aspects to plantation location as a barrier; the property location relative to a market and the location of a plantation within a property relative to a public road.

- If a property is remote from potential log customers, there will be higher haulage costs to transport the logs to the buyer, leading to lower net harvest returns or worse, no interest from potential markets.
- If a plantation is located in a part of the property that is remote from public road log-truck access, there can be significant internal roading required, leading to addition costs to be recovered from the harvesting proceeds. This is addressed as a separate issue.

1.19 Barrier implications of plantation location

Depending on plantation area, location can be a barrier for SPP owners, particularly if the plantation is internally remote from log truck access, remote from other plantations, and remote from potential log customers. Harvesting costs for a remote plantation may be high, particularly if it is a small area, simply because the relocation costs of harvesting machinery will be high relative to total returns. There will be resistance from harvesting contractors to move machinery to such a plantation.

Access to suitable Local Government Authority (LGA) roads is also a key aspect of plantation location. Some LGA roads may have weight limits, requiring alternative routes for log trucks.

Distance to customers can be a significant barrier to harvesting. Typically, a radiata pine plantation may have a range of potential customers; up to 10 sawlog customers, four pulpwood customers and four timber treatment customers. Each customer will have a different transport distance, and therefore different costs, and different product prices, so it is necessary to consider the compendium of different log customers and the total net revenues which may be generated to determine whether harvesting of that plantation is financially positive. It is too simplistic to just have a single ‘maximum haulage distance’ to any log customer location.

Hardwood plantations currently have only export markets, with pulplogs for conversion into woodchips with potentially at least three different customers. All require woodchips to be

exported via the Port of Portland, so distance to that port is critical. Again, each plantation should be costed individually and a single ‘maximum haulage distance’ is too simplistic.

1.20 How can the plantation location barrier be addressed

A SPP grower need to consider optimum harvest and haulage options for the range of potential customers. Scale impacts on harvesting rates and float costs. Most contractors will lose a day moving equipment either side of the harvesting operation. If the entire harvest is five days, two days of moving equipment is a significant cost and will be recouped from the plantation owner. If the harvesting contractor is on site for six weeks, rates and moving costs will be far more competitive.

The costs of moving harvesting equipment to a property may be diluted if there are adjoining or nearby plantations that can be harvested in association with a small plantation. For example, it will be relatively simple to arrange harvesting of a 5 ha private plantation that adjoins a 100 ha industrial plantation by coordinating harvesting of both plantations, particularly if they both require a similar harvesting operation (e.g. a T1 operation). Similarly, if there are a number of small plantations in a locality, they can all be harvested sequentially making each more financially viable due to economies of scale (e.g. one machinery shift). Harvesting planners can usually facilitate this co-ordination. However, if there are no nearby plantations to a SPP plantation, it is likely net harvest revenues may be severely compromised. Land owners need to be aware of this when considering establishing small-scale plantation units.

Transport costs will be cheaper if using an A-double truck (see Figure 13), compared with a B-double (Figure 12). A B-double truck will have lower transport costs per tonne than a tri-axle semi. Therefore, for remote plantations, transport costs per tonne are cheaper with larger payload trucks provided that they have road access.

Within-property roading

1.21 Why within-property roading is a barrier

It is expensive to use forwarders to transport harvested logs more than several hundred metres to a roadside truck loading area from a plantation. Therefore, harvested logs must be loaded onto trucks relatively close to a plantation. Trucks used for transporting logs to processors are heavy, typically weighing between 68 and 91 tonnes when fully loaded. Such trucks generally cannot travel across farm paddocks without becoming bogged. As a result, gravel internal tracks are required to provide access from the public road system to a plantation edge. Figure 17, Figure 18 and Figure 19 illustrate building an internal road suitable for log trucks on a farm near Lucindale in preparation for T1. The gravel was recovered from a rocky rise on the farm; it is prudent to check as to any LGA or other government approvals required to recover such materials.

1.22 The barrier implications of on-property roading

Whatever size truck is used to haul logs from a plantation to a processor, they will need a well-constructed track for internal access. The location of a plantation within a property is important. If a plantation is located near a log truck trafficable public road, then forwarders may be able to deliver harvested logs to a truck loading area adjacent to a public road with minimal internal roading costs. A plantation established well away from suitable road access will require significant expenditure on construction of roads to provide log truck access. A small-scale plantation which adjoins a suitable harvesting road is more attractive for harvesting than a larger area which has poor roading access. This needs to be considered when planning plantation location and establishment.

If an internal road is required to be constructed across farm paddocks to a plantation, then roading costs can be considerable. Often, a significant part of this cost is the sourcing and transporting gravel. Depending on the source and location of roading material, a harvesting road can cost c. $18,000-$25,000/km to construct. Therefore, if an expected harvest was for example, 100 semi-trailers (2,600 GMT), with a one km road to be built, roading costs would be $6.94-$9.60/GMT, reducing net harvest proceeds by this amount. If only 50 semi-trailers of logs were to be harvested (1,300 GMT), those roading costs would increase to $13.88-$19.20/GMT that one km road to be built.

Figure 17: Raising road making materials (gravel) in a farm quarry (Photo by DJ Geddes©)

Figure 18: Using a scraper to build a log truck road using gravel recovered on the farm (Photo by DJ Geddes©)

Figure 19: Farm log truck tracks must have allowance for trucks to turn around (Photo by DJ Geddes©)

1.23 How can the within-property roading barrier be addressed

As noted, within-property roads for log truck access are expensive. Forwarders can transport harvested logs, but long forwarding distances are also expensive. There is a cost trade-off for building a longer length within-property road to enable log trucks access to harvested logs, compared with the cost of forwarding greater distances. Normal practice would be for a harvesting contractor to forward logs up to 500 m. This distance is measured from the centre of a plantation compartment to the site where logs can be loaded onto road trucks. If the forwarding distance is greater than 500 m as part of routine harvesting costs, the contactor may request an increase in the harvesting rate to cover this additional forwarding. This increased rate will apply to all logs forwarded from that compartment. Additional forwarding costs beyond 500 m (as at February 2023) are presented in Table 7. A SPP owner can use these additional cost premiums to calculate whether it is more cost-effective to pay the contractor addition money for long forwarding, or to invest money constructing additional roading (a farm asset).

Table 7: Additional GT harvesting costs for lengthy forwarding distances; these indicative costs are based on confidential data held by the authors.

Total forwarding distance (m)	Additional harvesting rate charges ($/GMT excluding GST)
500-600	$1.10
600-700	$2.10
700-800	$3.20
Over 800	$4.30 (or more, as negotiated)

Experienced earthmoving contractors know how to build plantation roads. Figure 18 presents a scraper used by an earthmoving contractor to shift gravel from an on-farm quarry and spread on a within farm harvesting access road.

Published information is available. For example, the Victorian *Code of Practice for Timber Production 2014 (as amended 2022)* (DELWP, 2022, s.4.4) has considerable information about plantation road design and construction. A series of road making considerations are presented in Box 5. For any future plantation development on farms, in order to reduce harvest roading costs, it is important to locate a plantation with reasonable access to public roads.

Box 5: A checklist of considerations in regard to plantation roading.

When planning a harvest road on a property, consider the following practical matters.

- Seek approval from the responsible LGA; they may have weight limits on some public roads that could require alternative cartage routes for log trucks.
- The location of the approach from a public road must ensure public road users are able to see log trucks entering that road.
- While most of the terrain in the GT is flat to gently undulating, if there are slopes, then road position should be carefully considered, recognising that side cuts will be needed.
- Ensure a road for truck access is located to minimise forwarding distances. Ideally it will be located through a plantation to enable forwarding from each side.
- Consider where log stockpiles will be positioned on the edges of a road.
- Ensure that there is a place for log trucks to turn around.
- Ideally, construct roads at least a year prior to harvesting to allow the road time to settle before use by log trucks.

When building a road, consider the following.

- Road width must be at least 4 m wide.
- Avoid road construction in winter. The ideal timing for road construction in the GT is summer and autumn.
- Location of gravel pits; the further the source of gravel from the plantation, the higher the road building cost. It is worth spending time to locate closer sources of gravel (see Figure 17).
- Depending on property soil types and the type of gravel to be used, gravel depth may need to be in excess of 300 mm.
- Culverts may be required when crossing drainage lines or water courses; specific permission may be required.
- The road surface should have a slight crown to allow rain water to flow-off the road, rather than allowing water to gather on the road potentially causing boggy areas for heavy log trucks.
- If a road is in sloping terrain, then water bars at a 30° angle downslope may be required to allow rain water to flow off the road and avoid subsequent erosion. Outflows from the water bar should be designed to prevent water from accumulating.

Plantation scale

1.24 Why plantation scale is a barrier

There are fixed costs for any harvesting operation. These include preparing formal harvesting plans, building internal harvesting roads, moving harvesting equipment to a property and environmental compliance. For smaller-scale plantations with lower quantities of logs available for harvest, these fixed costs become a higher proportion of overall costs and in-turn can significantly impact net harvest revenues.

1.25 What are the barrier implications of plantation scale

As SPP plantations are typically small-scale, with smaller quantities of logs sold, fixed costs per GMT are much higher than with larger-scale plantations. The following considers the fixed costs and implications of each.

- Formal harvesting plans: Typically, the cost to prepare a timber harvesting plan is the same for each property, regardless of the size of the plantation area.

- Moving harvesting equipment to the property: Harvesting of plantations is undertaken by sophisticated and expensive machinery. There are costs to relocate harvesting equipment to a SPP on low-loaders. With large-scale plantations, the fixed-cost of moving harvesting equipment on low-loaders to a site can often be absorbed in the overall harvesting costs because the machinery will operate in the same plantation for several months at a time. But with SPPs, when harvesting can be completed in days (rather than months) such relocation costs are not able to be absorbed by the harvesting contractor. As a result, there will usually be a charge for machinery relocation expenses. Depending on the relocation travel distance and the number of machines to be shifted (e.g. in softwood plantations, at a minimum, a harvester and a forwarder), such costs can exceed $2,000. This cost will be deducted from the harvest revenue reducing net harvest revenues. For example, with 100 semi-trailer loads (2,600 GMT) of harvested logs, machinery relocation costs would be $0.77/GMT. If only 50 semi-trailer loads (1,300 GMT) were recovered, such costs would be $1.54/GMT.

- Environmental compliance: The costs of producing the required certification documents and their auditing are independent of the total area to be harvested. Such compliance costs per GMT are much greater for SPPs with lower quantities recovered.

1.26 How can the plantation scale barrier be addressed

A pro-active approach is to ensure that future plantings are in larger blocks. For current very small-scale plantations, fixed costs per hectare can be reduced by the following.

- Aggregation: Movement of harvesting equipment fixed costs can be diluted by coordination of harvest between a number of local plantation growers in a location.
- Out-grower: It may be possible to form an arrangement with large-scale industrial growers in a region to facilitate harvesting in conjunction with that estate.

Nevertheless, after calculating actual costs and revenues and therefore net revenues, a SPP of quality and market-required trees may still be financially attractive to a processor.

Log sale process

1.27 Why the log sale process is a barrier

The log sale process is complex. A grower first needs to understand the potential purchasers of logs from a proposed harvest, species to purchased, their particular log specifications, MDP of each log category (and stumpage implications) and log delivery arrangements. They need to know who will harvest the trees and who will transport the logs to each log purchasing customer. Most SPP owners do not have the experience to deal with the log sale process and be confident that they are receiving a fair market price, without engaging a log marketing expert. The log sale process can be a considerable barrier to SPP owners. Softwood plantations are managed to produce high-quality sawlog with small knots, which are suited for production of fit-for-purpose structural timber. High-quality sawlogs are maximised by thinning plantations up to three times prior to clear-felling. First thinning produces mostly pulplog, but with each subsequent thinning there is an increasing percentage of sawlog in the product mix (see Table 6).

Because logs from hardwood plantations are converted to woodchips which are sold to exporters on a per GMT basis, there is less complication associated with different log-types and log-prices. However, the woodchips must still meet the customer's specifications.

1.28 What are the barrier implications of log sale process

1.28.1 The driver of the impediment; determining residual stumpage

Overall, log sales are complicated and most SPP owners do not have the experience to undertake them efficiently.

If a SPP owner has been offered a residual stumpage price, there will be no need to pay harvesting and transport costs as these will have already been deducted in the stumpage calculation. However, how can an owner determine whether the residual stumpage offered is fair and reasonable for the type of plantation to be harvested? This is a significant impediment to generating a return and having the confidence to establish a plantation. The following addresses the elements of determining a residual stumpage.

A SPP owner must understand the term residual stumpage and its determination. Residual stumpage is the key determinant of whether a sale will be profitable. For a particular product type from a single plantation source, stumpage is defined as the MDP received for that

product delivered to a processor, less the harvesting and transport costs from a source plantation to that mill, less any supervision, management, roading and other costs of production. In effect, it is what is left over (the residual) from the MDP paid by the purchaser after all costs of production are deducted (net harvest returns at the stump).

If a SPP owner engages a log marketer, they must assume the marketer knows local MDP's and harvesting costs, and that the residual stumpage offered is fair and reasonable. Because residual stumpages are based on the MDP less harvesting and transport costs, each harvesting site will generate a different residual stumpage. Therefore, it can be difficult for the SPP owner to know if the residual stumpage they are to receive is reasonable.

1.28.2 Calculating residual stumpages

Calculation of residual stumpage is the difference between the MDP and a number of variable costs per GMT, as presented in Equation 1.

Equation 1: Residual stumpage

Residual stumpage = MDP – sum of costs (Harvesting + Transport + Supervision cost + On-farm roadworks).

For a SPP grower, it is often advisable to engage an experienced harvesting manager to ensure optimum returns. In calculating stumpages, a plantation owner will need to consider that harvesting prices are linked to mean tree size and quantity to be removed per hectare (costs per GMT are less with higher volumes per hectare harvests) and operation type (costs per GMT are less at clear-fell than for thinnings). Harvesting costs are linked to product quality. Sawlog recovery takes more time to cut accurately and therefore it costs more for harvesting than pulpwood; pulpwood is a more flexible product because a range of log lengths are acceptable.

1.28.3 Units of trade and log sales

While products from hardwood plantations are always measured by weight, softwood logs can be measured by weight (in GMT) or by volume (in m^3). Log processors normally prefer to purchase logs and other products on an MDP basis (i.e. \$/GMT or \$/m^3), delivered to a mill. This is in effect the value of each product to the processor and is irrespective of transport distance. It is possible that MDP's may vary with operation type (e.g. logs from clear fell are generally more valuable than similar size logs from first thinning), log age, and

diameter (generally larger diameter logs are more valuable, but it depends on the preferred log size of each processor).

1.28.4 Softwood log type and dimensions

Logs from first thinning are smaller in diameter, and as plantations mature, each successive harvesting operation can produce larger diameter (and usually more valuable) logs. The range of softwood log types are presented in Table 8.

Table 8: Typical softwood log products by harvest operation

Product	Description (diameters are in SEDUB)	Harvest type
Roundwood for treatment	Preservation products include posts, rails, strainers and poles to service the local viticulture, horticulture and agricultural industries. In order of market demand, product sizes are: • Posts: 1.8 m length (100-125 mm), 2.1 m length (100-125 and 125-150 mm) and 2.4 m length (100-125 mm). • Strainers: 1.8 m length (150-175 mm) and 2.4 m length (150-175, 175-200 and 200-225 mm). • Rails: 3.0 m length (125-150 mm) and 3.6 m length (125-150 mm).	T1, T2
Pulplog	Logs that do not meet the strict straightness criteria for preservation products or sawlogs, can be sold as pulplog	T1, T2, T3, CF
Small sawlog	Straight logs with SEDs greater than 15 cm can be processed by sawmills. Log lengths vary from 3.65 to 6.05 m.	T1
Medium sawlog	Logs SED of 25-40 cm. Log lengths vary from 3.65 to 6.05 m.	T2, T3
Large sawlog	Logs SED of greater than 40 cm. Log lengths vary from 3.65 to 6.05 m.	T2, T3, CF

1.28.5 Softwood log prices

Each processor's log price table ($/GMT or $/m^3 by diameter class) is specific to that processor and is commercial in confidence, hence they are not public documents. Generally, prices are higher with larger diameter and longer length logs. There is no current mechanism for a SPP owner to know if the price being offered is a fair market price.

Compiled by KPMG, the Australian Pine Log Price Index (APLPI) provides a public guide of net log stumpage prices (KPMG, 2022). Based on confidential data provided by corporate growers in New South Wales, Western Australia, Victoria and South Australia (together representing eight separate Australian plantation regions), amalgamated log pricing data is published every six months from logs sold to domestic customers (KPMG, 2022, p.5). Within the index are seven softwood log types as presented in Table 9. There are also export sawlogs and export pulplogs included in the analysis. However, while it is useful, pricing data

from the APLPI requires expert interpretation, because the log types are not aligned with those used by processors in the GT.

Table 9: Domestic softwood log types in the APLPI (KPMG, 2022, Table 3)

Log type	Description
Small sawlogs	Logs suitable for sawmilling with SEDUB less than 24 cm.
Intermediate sawlogs	Logs suitable for sawmilling with SEDUB 24.0-31.9 cm.
Medium sawlogs	Logs suitable for sawmilling with SEDUB 32.0-43.9 cm.
Large sawlogs	Logs suitable for sawmilling with SEDUB greater than 43.9 cm.
Preservation logs	Logs sold to treatment plants for posts, strainers and poles.
Pulplogs	Logs sold to domestic paper and fibre-based panel manufacturers.
Salvage logs	Logs not included in the above categories (e.g. plantation edge trees).

1.28.6 Softwood processor reluctance to purchase logs from SPP owners

Many log processors are reluctant to purchase logs (of any type) from SPP growers for a range of reasons, including the following requirements.

- OHS requirements: That the logs purchased are harvested, transported and delivered in compliance with current safety procedures. This is achieved by having harvesting undertaken by experienced and current contractors.
- Log specifications: All logs delivered meet individual log specifications (e.g. length, diameter, knot size, sweep and taper).
- Certification: All logs have appropriate environmental certifications as any products produced, including woodchips, require such certification to meet their own (subsequent) customer requirements.
- Ownership: That the SPP grower has legal title to the resource and an ability to sell the logs.
- Negotiations: A purchaser will seek to avoid an extended price negotiation for a small quantity of logs.
- Administration: It requires that a processor and buyer have in-house accounting processes to handle small-scale log supply transactions.

Transport prices depend on truck payload (e.g. single, B-double or A-double) and haul distance. Truck loading costs need to be considered; sometimes it is part of a harvesting cost, sometimes it is part of transport cost and sometimes it can be an additional stand-alone cost.

1.28.7 Using residual stumpage to determine best options

When considering various harvesting and transport options, a harvesting manager should calculate the stumpage for each potential combination of product, volume and customer. The sum of all products is the total residual stumpage the plantation owner will receive from a harvesting operation. Using this process, various harvesting, haulage and market options can be evaluated. Using three examples, it is possible to assess each option as follows.

- Access: Build at a cost, additional within property plantation roading, or pay the harvesting contractor a premium to forward logs a greater distance to the truck loading point (see Table 7)?
- Markets: Recover small volumes of higher MDP logs for a mill far away (with higher haulage costs), or sell greater volumes of lower MDP log to a closer mill (with lower haulage costs)?
- Truck type: Make use of a single trailer (with higher haulage costs per tonne) to transport the logs over a short distance, or use a B-double (with lower haulage costs per tonne) over a longer haul distance to avoid a bridge with truck weight restrictions on B-double road use?

1.28.8 Harvest supervision and management

There are other issues to consider including the payment process for logs sold, the measuring system (e.g. weight or individual log volume measurement) and the monitoring (check) process to ensure each load leaving the plantation is measured and then reconciled with the delivery dockets used for invoicing the log buyer.

1.29 How can the log sale process barrier be addressed

1.29.1 Softwood log categories

As discussed, the APLPI log categories (Table 9) are not applicable for practical day to day softwood log sales transactions in the GT. Recognising different mills have different log grade definitions, Table 10 presents a list of current log specifications.

Table 10: Current GT softwood log specifications (unpublished information based on industry experience)

Product	Length		Diameter			Sweep		Max knot diameter	
	Dimensions	Comment	SED	LED	Comment	Basis	Comment		Basis
	(m)		(cm)	(cm)				(cm)	
Sawlog	4.25, 4.85, 5.45, 6.05		15.0	55.0	Range depends on mill capacity	<SED/4		5.0	
Industrial Sawlog	2.45, 3.65, 4.85, 5.45, 6.05	Length depends on diameter and mill	15.0	no max	Range depends on mill capacity	<SED/3		20.0	SED/2
Pulpwood	4.8 to 6.0	Some mills may take shorter lengths	10.0	30.0	May be smaller, depends on mill capacity	No sharp kinks or bends.		No limit	
Preservation	1.8, 2.1, 2.4, 2.7, 3.0, 3.6.		10.0	22.5	Different lengths have different diameter ranges.	<SED/4	no double sweep	2.5	

1.29.2 Mill door price

The first step to calculate a residual stumpage is to determine the MDP for each log type offered by each processor (as per Equation 1). This requires personal discussions with each purchaser; a key point is that a processor is not obliged to provide such information. Derived from recent consultation with industry, GT relevant softwood processors and the log types they purchase are presented in Table 11.

Table 11: Log lengths purchased by GT softwood log processors

Processor	Location	Log lengths (m)
Sawlog down to 15 cm SED		
AKD	Colac, Vic	4.85, 5.45, 6.05
OFO	Mount Gambier, SA	4.85, 5.45, 6.05
Timberlink	Tarpeena, SA	4.85, 5.45, 6.05
SE Pine	Glencoe, SA	3.65, 4.25, 4.85
Whiteheads Timber Sales	Mount Gambier, SA	3.65, 4.25, 4.85, 5.45, 6.05
New Gen Timber	Mount Gambier, SA	3.65, 6.05
McDonnell Industries	Mount Gambier, SA	3.65, 5.45
Industrial log		
Finwood	Mount Gambier, SA	2.45, 3.05, 3.65
SE Pine	Glencoe, SA	2.45, 2.75, 3.05
A2C	Portland, Vic	3.65
New Gen Timber	Mount Gambier, SA	3.65, 4.85
Domestic pulp log		
McDonnell Industries	Mount Gambier, SA	3.65
Preservation log		
Roundwood Solutions	Yahl, SA	1.8, 2.1, 2.4, 2.7, 3.0, 3.6, 4.25
Portland Pine Products	Heywood, Vic	1.8, 2.1, 2.4, 2.7, 3.0, 3.6, 4.25
New Gen Timber	Mount Gambier, SA	2.4, 3.0, 3.6
Alliance Timber	Dartmoor, Vic	1.8, 2.1, 2.4, 2.7, 3.0, 3.6, 4.25
Plantation Treated Timber	Kalangadoo, SA	1.8, 2.1, 2.4, 2.7, 3.0, 3.6, 4.25

An indicative list of GT MDP's is presented in Table 12. As every mill has a different log pricing mechanism, the MDP's listed in Table 12 are indicative only. However, they are of use to SPP owners for estimating likely returns from any proposed harvest of their plantations.

Table 12: Indicative GT MDP's (as at December 2022)

Product	Diameter range (cm)	Mill door price, excluding GST ($/GMT)		
		Low	Average	High
Small Sawlog	15-30	$70	$83	$95
Large Sawlog	30-50	$110	$125	$140
Industrial Log	15-60	$45	$53	$60
Pulpwood	10-30	$30	$40	$50
Preservation	10-25	$80	$85	$90

1.29.3 Indicative harvesting to on-truck costs by operation type

The next step in calculating a residual stumpage value for an existing plantation is to understand the likely harvesting cost. Based on recent discussions with harvesting contractors, Table 13 provides indicative GT harvesting costs, shown with low, high and average values, for different harvesting operations. There is a wide range of harvestings costs for each operation type driven by variations in tree size, yield per hectare, quality of trees and products to be cut. They may also be modified further to reflect plantation size and location as discussed. Harvesting costs include the cost of loading the logs or chips onto trucks. These indicative harvesting costs are not prescriptive. They will vary, depending on specific circumstances and are provided as a guide only. There is no guarantee they will be applicable for any specific forest.

Table 13: Indicative GT harvesting costs by operation type (as at December 2022), excluding GST

Plantation type	Operation Type	Low ($/GMT)	Average ($/GMT)	High ($/GMT)
Softwood	T1	$28.00	$32.00	$36.00
Softwood	T2	$18.50	$21.50	$24.50
Softwood	T3	$14.50	$16.50	$18.50
Softwood	CF	$9.00	$11.50	$14.00
Hardwood	CF	$29.00	$33.50	$38.00

1.29.4 Indicative haulage costs by distance

After the MDP and harvest cost has been determined, the haulage cost from the plantation to the purchaser is required. Table 14 provides indicative GT log haulage costs, with low, average and high values, for different transport distances. The base rate is for B-double log transport and change in truck type will impact the costs. For single trailers, a c.9% increase in costs is required and for short length preservation, a c.15% increase on this base rate is

required. Woodchip haulage has a slightly higher cost than log transport. These indicative transport costs provide a SPP grower an approximate cost of log haulage from plantation to customer when combined with haulage distance.

Table 14: Indicative GT log haulage costs by distance (as at December 2022)

Haulage distance (km)	Low ($/tonne)	Average ($/tonne)	High ($/tonne)
20	$6.60	$6.00	$5.45
40	$9.00	$8.80	$8.60
60	$11.50	$11.85	$12.25
80	$13.90	$14.80	$15.70
100	$16.40	$17.60	$18.85
120	$18.85	$20.30	$21.80
140	$21.30	$23.00	$24.75
160	$23.70	$25.70	$27.65
180	$26.20	$28.40	$30.60
200	$28.65	$31.10	$33.60
220	$31.10	$33.50	$36.00
240	$33.50	$35.95	$38.40

1.29.5 SPP cooperatives

Race & Curtis (1998, p.28) identified that market brokers can add value to SPP owners by negotiating log sales on their behalf. One mechanism is to develop cooperatives. Race & Curtis (1998, p. 50, Table 6) considered the strengths and weaknesses of SPP cooperatives. They found that aggregating potential harvest volumes from a number of SPP growers had the potential to provide continuity of supply to processors. They also found that while the SPP grower still maintain ownership of a plantation, groups of growers are able to afford to access marketers to sell their logs. Offsetting these benefits, they found a minimum financial turnover of the cooperative is needed for it to remain viable. And there is the potential that growers with larger-scale plantations and with better quality plantations actually cross subsidise other members.

Currently there are not enough SPP owners in the GT to form an effective cooperative.

Harvesting contractor availability

1.30 Why harvesting contractor availability is a barrier

Most harvesting contractors are engaged by larger-scale corporate growers to harvest log-type specific areas of plantation with contract periods of between one and five-years. At present there are no harvesting contractors that exclusively service small-scale plantations, but some contractors will harvest smaller woodlots Therefore, identifying and engaging suitable harvesting contractors is a barrier for SPP owners, particularly in the absence of a compendium of local capacity.

1.31 What are the barrier implications of harvesting contractor availability

Processors in the GT will only purchase logs that have been harvested and delivered by experienced contractors. This is to ensure safety, product quality and legal compliance. Chain of responsibility (COR) legislation requires purchasers to ensure that all safety and legal considerations have been met, including prior to delivery to their mill. Relevant legislation is the Heavy Vehicle National Law (South Australia) Act 2013 and the Heavy Vehicle National Law Application Act (Vic). In some countries (e.g. Scandinavia), land owners can carry out their own harvesting and potentially delivery of logs to a processor. However, this is not common in Australia because of COR requirements and obligations.

Because of different equipment requirements, most harvesting contractors in the GT specialise in either softwood or hardwood plantations. They have relatively long-term contracts with well-defined contract conditions. In contrast, individual SPP owners cannot offer continuity of work. While there are no harvesting contractors that operate exclusively in the SPP sector, several will harvest farm woodlots. One of the largest-scale SPP owners engages a harvesting contractor for about six months of the year.

1.32 How can the harvesting contractor availability barrier be addressed

There are two possible solutions. Firstly, an SPP owner can engage a log marketer to manage their harvesting operation. Such marketers have established relationships with local contractors. Alternatively, a SPP owner can seek support from an existing corporate plantation manager (with their own harvesting contractors).

Pre-harvest considerations

1.33 Why pre-harvest considerations are a barrier

After working through the log marketing process, detailed harvesting planning is required. Pre-harvest considerations include inventory, preparation of a harvesting plan, and, in hardwood plantations, formal planning to avoid injuring koalas. A SPP owner normally requires assistance with some or all of these pre-harvest considerations.

1.34 What are the barrier implications of pre-harvest considerations

1.34.1 The fundamental barrier

In complying with a range of pre-harvest requirements, some of which are legally required, specific skills are required. It is likely that these skills are beyond those held by the SPP owners.

1.34.2 Pre-harvest inventory

Buyers of woodchip or log products normally deal with large-scale suppliers such as the industrial growers. This requires that SPP growers must be clear on what they have to offer for sale and supply. Undertaking a pre-harvest inventory requires a specific skillset; for example, the design of the inventory including consideration of plots size (see

Table 3).

1.34.3 Preparing a harvesting plan

There are different harvest plan legal requirements between South Australia and Victoria, but essentially a harvest plan must identify the area to be harvested, expected yield by product, timing of harvesting activity, mandatory personal protective equipment for anyone on site, plantation access points, hazards on the property, public road access by log-trucks and notification of the responsible LGA (seeking approval), relevant contact numbers (e.g. plantation owner, harvesting managers, harvesting contractor and haulage contractor) and any neighbour issues. A copy of the plan must be kept on the property during the entire time of harvesting activity. The cost of producing a Timber Harvest Plan (for plantations in Victoria) is largely independent of the total area to be harvested, so planning costs per hectare are much greater for SPPs than for harvesting larger-scale plantations.

1.34.4 Consideration of native wildlife (koalas)

During the late 1990's when the establishment of large-scale hardwood plantations in the GT began, the managers did not consider that koalas would cause problems in the plantations because Tasmanian blue gum was not considered to be a preferred food species. Subsequently, the Victorian Department of Environment Land Water and Planning (DEWLP) recognised that Tasmanian blue gum had become a preferred food tree (Conservation Regulator, 2021, p.5). Heard and Ramsay (2020, p.1&17) found that koala populations in the Tasmanian blue gum plantation area of south west Victoria were considerably higher than the rest of Victoria, with an average of 0.89 koalas/ha, compared with 0.03 koalas/ha in the plantation areas of the Strzelecki Ranges and 0.22 koalas/ha in suitable native forest habitats. This infers there are four times the number of koalas per hectare in south-west Victorian hardwood plantations than in suitable native forest habitats.

While koala browsing of blue gum leaves has little impact on tree growth, with large numbers of koalas in plantations in the Victorian side of the GT, there is a risk for injury during harvesting operations. After small-scale experimental harvesting between 2005 and 2007, large-scale harvesting commenced in 2008 when almost 300,000 GMT of hardwood chip was exported that year through the Port of Portland (Cooper, 2015). By about 2010, the Green Triangle Regional Plantation Committee recognised potential injury to koalas and over the next few years developed harvesting guidelines to assist hardwood growers (GTRPC, 2013). In Victoria, these guidelines have been superseded by a DEWLP

Regulatory Guide (Conservator Regulator, 2021) which applies particularly to the area of hardwood plantations located between Mount Gambier in the west, Casterton in the north and Port Fairy in the east, known as the 'koala zone' (see Figure 20).

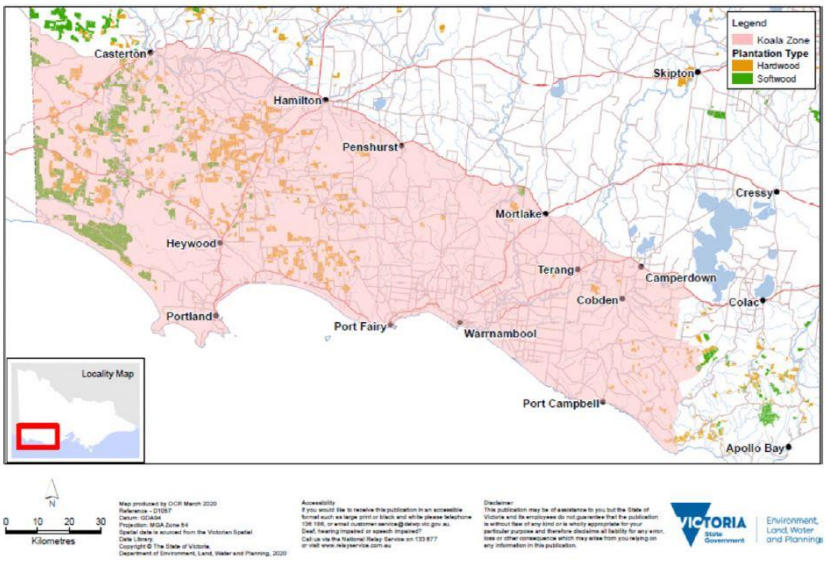

Figure 20: Map showing the Koala Management Zone and Tasmanian blue gum plantation locations (Conservation Regulator, 2021, Figure 1)

Prior to any harvest operation in Victoria, hardwood growers are required to develop and implement a Koala Management Plan (KMP) and then apply to the Victorian Government Conservation Regulator for an Authorisation under the *Wildlife Act 1975* to disturb koalas during plantation management operations. The Conservation Regulator assesses each application on its merits, particularly the acceptability of the KMP. The Authorisation *'sets out specific steps and minimum standards that a blue gum plantation owner or manager must take to minimise impacts and ensure the welfare of koalas is protected during plantation management operations'* (Conservation Regulator, 2021, p.10). These are onerous steps and SPP hardwood owners will require assistance to comply with the regulations.

In South Australia, while koala populations are significantly less than in Victoria, plantation owners need to comply with the South Australian Koala Conservation and Management Strategy (National Parks South Australia, 2016, p 11). This strategy particularly refers to the GT Regional Plantations Committee guidelines (GTRPC, 2013).

1.35 How can the pre-harvest considerations barrier be addressed

1.35.1 Pre-harvest inventory

A pre-harvest inventory will provide a reasonable estimate of log volumes by product type expected from a proposed harvest. It must be emphasised that planning an inventory requires an understanding of mensurational methods, and once the measurements have

been completed, there are interpretive skills required to estimate harvest volumes by product.

1.35.2 Structure of a Timber Harvesting Plan

Most log marketers will prepare the THP on behalf of a SPP owner. In Victoria, harvesting is regulated by the Code of Practice for Timber Production 2014 (as amended 2022) (DELWP, 2022). A THP *'must be prepared and submitted to local government not less than 28 days before the commencement of any harvesting operations'* (DELWP, 2002, s.4.5.1.1). Usually, THP's prepared for use in South Australia use a format similar to that required in Victoria. A THP must be addressed in the THP issues such as protecting environmental values and minimising impacts on water quality and river health (DELWP, 2002, s.4.5.1.2). Specific details are provided of the required mandatory content of a THP (DELWP, 2002, s.4.5.1.3); landowner's name and address, the months during which operations are to occur, estimated timber volumes to be harvested, proposed haulage routes, fire protection measures and a map. The map must show the plantation, significant features including waterways and any areas reserved or specifically managed for protection of biodiversity, historic places or Aboriginal cultural heritage values, the area to be harvested, new or upgraded roads, power lines and any plantation infrastructure.

1.35.3 Structure of a Koala Management Plan (in Victoria)

As with a THP, most log marketers will prepare the KMP on behalf of the SPP owner. The Regulatory Guide (Conservation Regulator, 2021), provides steps on how to apply for a permit to disturb koalas and the required layout for a KMP. In essence, a KMP will become part of a THP. The KMP's must be prepared by a person experienced in KMP writing and in consultation with a qualified ecologist. The required content of a KMP is presented in Box 6.

Box 6: A summary of the details required in a KMP.

Contacts	Harvest and spotter contractors.
Plantation and harvest attributes	Plantation height and age. Estimated harvest rate (ha/day). Harvest system and number of harvesters. Operating hours, shift length and number of shifts per day. Proposed stump treatment. Subsequent land use. Harvest sequence.
Koala specific	Expected koala density.

	Predicted koala spotting difficulty. Specific risks identified and mitigation measures. Number of spotters at start of the operation. Veterinary or wildlife rehabilitators. Maps showing surrounding vegetation, harvest sequence and direction of harvest, and likely koala refuge at end of harvest and planned koala dispersal direction.

Once a harvesting operation has commenced, there are on-going responsibilities for the plantation owner. These include having trained koala spotters, retaining a minimum of nine live trees around any koala found (as a food source and habitat for that koala), having at least one person trained in handling koalas, taking action if any koala has been injured and regular assessment of koala welfare during and after harvesting. Figure 21 presents an example of retained koala trees.

Figure 21: Koala trees left after hardwood plantation harvest (Photo by DJ Geddes ©)

A brief guide to establishing new small private plantations

1.36 Introduction

While this report is aimed at providing guidance to landholders who are already growing plantations, Section 11 identifies key points to consider for landholders considering establishing new plantations on their properties. This is a brief guide only. During the feasibility stage, it is best to first obtain professional technical advice.

1.37 Species

While a wide range of timber species are able to be grown on farms in the GT, there are only two species for which there are regular accessible markets and for which there are bankable returns. They are radiata pine and Tasmanian blue gum. The export market for hardwood woodchips is restricted to a single species underpinned by the 133,809 ha Tasmanian blue gum plantation estate. In the GT, the only market for sawlogs is the softwood processing sector, which is underpinned by the 180,602 ha radiata pine estate.

1.38 Site location

Access to a market for future harvests is a prime consideration. If that criteria is satisfied, then when considering establishment of a plantation on a farm, it is important to take into account future log truck access. This means either planting the trees near an existing fit-for-purpose roadwork system on the farm, or else near a public road suitable for heavy log trucks. Alternatively, the SPP grower must be prepared to invest in log truck access roads from the public road to the plantation.

If there are neighbours that also have plantations, there are advantages in locating the proposed plantation nearer to a neighbouring plantation. At time of harvest, with neighbour cooperation, it may be possible to harvest both plantations at the same time. A larger-scale plantation harvesting area is more attractive to harvesting contractors than individual smaller woodlots.

1.39 Plantation scale

A disadvantage of small-scale woodlots is that fixed costs (e.g. environmental certification and preparing harvesting plans) consume a greater proportion of harvest revenues.

The shape of a woodlot can be variable to fit in with other farming activities, particularly in order to provide shelter for livestock (e.g. a woodlot could be long and narrow in shape). There is a trade-off in log quality when considering long narrow plantations. Edge trees have more branches than trees within the plantation, and logs from those trees will have large knots, making them of less value than logs from trees from within a plantation.

1.40 Plantation layout

There is guidance to plantation design in the two applicable state codes (DELWP, 2022; PIRSA, 2009), particularly with respect to environment protection measures (see Figure 22). The Forest Owners Conference (2017) also provide fire protection guidelines with respect to plantation layout. From a harvesting perspective, the following considerations are required when designing a plantation layout.

- Roading: Internal roads need to facilitate log trucks access to keep forwarding distances are less than 500 m.
- Row direction: Plantation row direction should be such that forwarders are able to access the plantation roads; that is, tree rows are not parallel to the tracks, but instead lead to the roads.
- Row length: Plantation row lengths should not be too short (ideally at least 30 m long) and not too long (ideally less than 350 m long).

Figure 22: A Tasmanian blue gum shelter belt (Photo Sylva Systems Pty Ltd ©)

If a plantation is long and narrow, the minimum number of rows to be planted must be considered for softwood plantations. Softwood plantations are thinned three times prior to final harvest. To provide access for forwarders during the thinning process, every fifth row is removed at T1, with the harvesting machine removing selected trees in the two rows each side of the extraction row. Ideally, the minimum number of rows to be planted in a long narrow plantation is 10. This means row 3 and 8 will be removed as extraction rows, and with two rows of thinned trees on each side. At a spacing of 2.5 m between the rows, a minimum width plantation is 22.5 m (i.e. 9 x 2.5 = 22.5 m).

For hardwood plantations, there is no thinning prior to harvest, and the rows are normally further apart. Typical hardwood spacing is 4.5 m between the rows. A narrow hardwood plantation 22.5 m wide would have six rows.

1.41 Site preparation, establishment and tending

Site suitability

Firstly, check the site suitability including the rainfall zone and soil types. In the GT, softwoods can be established on sites where the average annual rainfall exceeds 600 mm, while hardwoods grow better on sites where the average annual rainfall exceeds 650 mm. Soils to avoid are deep white sands (that will not hold soil moisture) and sites with heavy clay (where tree roots are unable to extract soil moisture). Soil suitability can be determined with a soil survey where each layer can be checked for soil colour, texture, pH, coarse fragments, bulk density, structure and fertility. It is important to avoid areas where there is rock or potential tree root barriers. Soil surveys require technical expertise.

Order seedlings

The next step is to order seedlings. There are several nurseries in the GT that can supply softwood and hardwood seedlings. Orders normally need to be submitted by at least October prior to the following year's winter planting season. When seeking seedling supplies, it is usually worth paying more for better genetic stock, as gains in the long term can be quite dramatic.

Preparing the site

Prior to planting, sites need to be prepared. Typically, this means ripping the planting lines, with follow up mounding over the rip lines. Ripping helps break any hard layers of soil in order to give new trees roots the best opportunity for early growth. Mounding brings the more fertile top soil to the planting line.

The most important step is weed control. This includes controlling competing vegetation prior to planting and then in the following year after planting. Once the trees are 18 months old, they can usually cope without any further weed control. If competing vegetation is not controlled, tree growth will be severely compromised.

Planting and spacing

Planting is carried out in winter, once the soils are wet enough after "break of season" rainfall. While weather dependent, the GT planting season is normally from mid-June to the end of August. Typical tree spacing for softwoods is the trees 2.5 m apart in rows 2.5 m wide (i.e. 1,600 trees/ha). For hardwoods, typical tree spacing is the trees 2.5 m apart in rows 4.5 m wide (i.e. 966 trees/ha). During planting, it is important the trees are "firmed in" and there are no air spaces around the roots.

Monitoring

Particular matters to be checked in the early monitoring period after planting include:

- Prior to October, any areas where trees were inadvertently not planted or where trees have died, that could be refilled that year (to avoid the need to replant in the following season).
- Any areas of missed weed control.
- After October, any areas where trees have failed and where replanting may be required.

Checks during monitoring include tree condition (vigour, foliage, stem form), weed competition (particularly any missed areas), insect damage, vermin damage, fire protection matters and access.

Once the trees are established it is important to monitor for vertebrate and insect pests. Hardwoods are vulnerable to a range of insect pests which chew the leaves, particularly Autumn gum moth larvae and Chrysomelid beetles in younger trees and sawfly larvae in older trees.

1.42 Need for technical support

As noted above, this is a brief guide only. Like many other aspects of plantation forestry, obtaining technical advice during the planning phase will pay dividends by ensuring a more productive plantation.

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Attachment A: Partial list of previous trees into farming studies

Over the last 30 years, there have been numerous trees into farming studies, books and reports. Many of these reports have focussed on site selection and technical tree growing matters. There have been numerous forestry fact sheets produced by various state government agencies. An information gap has been the logistical aspects of harvesting farm woodlots. Amongst these previous studies are such widely varied topics as noted below.

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Attachment B: Forestry terms

Chain of custody	Chain of custody certification is the formal process of tracking wood and forest products from a certified forest to the consumer. Chain of custody certification is available in Australia through Responsible Wood and the Forest Stewardship Council.
Chain of responsibility	The National Heavy Vehicle Regulator requires that everyone in the road transport supply chain shares the responsibility that breaches of road laws do not occur. This is known as the chain of responsibility.
Chip truck	These are trucks with enclosed bin trailers specifically designed to haul woodchip. They are loaded in the forest directly from mobile chippers using a top loading chute. There are several different types of unloading mechanisms; they can be driven onto a large platform which tilts up, allowing the chip to run out the rear doors into a receival area, they can have walking floors which is a hydraulically driven live floor that “walks” the chip out of the horizontal trailer, or they can be bottom dumpers, in which the floor of the bin opens, allowing the chip to fall into a receival area. These come in varying sizes. The larger the capacity truck, the cheaper the haulage costs per tonne.
Corporate grower	Refers to the larger-scale growers in the Green Triangle. Softwood corporate growers are OneFortyOne Plantations (the largest), then New Forests Asset Management (managed by Timberlands Pacific), Green Triangle Forest Products and HVP Plantations. The two hardwood corporate growers are Australian Bluegum Plantations and New Forests Asset Management (managed by PF Olsen Australia).
Feller buncher	An all-terrain vehicle (either tracked or with rubber tyres) that sequentially fells several trees that are held upright in bunches by clamps. Once the required number of trees have been gathered in the clamps, the bunch of trees (with the branches still intact) is lowered to the ground.
Forwarder	A specialised rubber-tyred machine with a crane and log bunks which can pick up and carry harvested logs from the stump to the plantation edge. Forwarding avoids dirt contamination on the logs.
Hardwood plantation	Hardwood plantations in the Green Triangle are mostly limited to the species *Eucalyptus globulus* (Tasmanian blue gum) and they are grown over short rotations with the aim of producing woodchip for overseas papermakers.
Harvester	An all-terrain vehicle (either tracked or with rubber tyres) that fells individual trees, and then delimbs the stem and cuts it into required log lengths. Depending on the log product to be cut, the felling head may be driven by computer-controlled processors to maximise profits by volume optimisation based on the different values of each log type to be sold.
Loader	Either a tracked excavator fitted with a log grapple or rubber-tyred front-end loader fitted with a log grab, used for loading logs from dumps on the plantation edge onto log trucks. Loaders vary in size, depending on the log sizes being handled.
Log truck	Various sizes of log trucks are used in the Green Triangle. They vary from triaxle semi-trailers (load capacity about 26 tonnes and loaded weight 43 tonnes), B-doubles (prime

	mover towing two semitrailers with a load capacity about 45 tonnes and loaded weight 68 tonnes) and A-doubles (road train with two trailers, with a load capacity about 63 tonnes and loaded weight 91 tonnes). Generally, the larger the truck capacity, the cheaper the haulage costs per tonne.
Mean Annual Increment	Mean Annual Increment is a measure of how fast a plantation is growing, it is the average productivity of a plantation to a specific age. It can be measured by calculating the standing stem volume divided by the age of measurement (m^3/ha/y). MAI changes with age during the plantation rotation.
Mobile chipper	A rubber-tyred trailer on which a chipper is fitted that can process individual stems or bunches of whole tree stems into woodchip. Often there will be a chain flail delimbing and debarking system on the in-feed deck prior to the logs being fed into the chipper. Mobile chippers are normally located on the plantation edge, and are able to be towed to the next plantation when required.
Plantation	In this report, plantations are considered to be trees planted in rows and once mature are harvested, with the logs sold for commercial gain.
Silviculture	The scientific practice of managing trees for timber production. Managing trees includes all aspects from site preparation, planting, weed control, fertilising, pruning and harvesting regimes.
Site Quality	Several of the corporate growers in the GT assess their plantations for Site Quality at about age 10 years, mapped to 0.1 ha precision. It is a productivity class assessment, measured in m^3/ha/year in seven SQ classes. The highest productivity class is SQ1 with an MAI of 32.7 m^3/ha/y. There are very few areas in the GT where the SQ is less than SQ6 (MAI of 13.5 m^3/ha/y).
Skidder	A specialised rubber-tyred tractor that drags bunches of felled whole trees (usually with the branches still intact) along the ground through the forest to the plantation edge
Small private plantation	SPP refers to smaller-scale plantations, often with less than five separate age classes. Most SPP plantations are 2-50 ha in size, but there are several Green Triangle SPP growers with more than 300 ha and with multiple age classes.
Softwood plantation	Softwood plantations in the Green Triangle are mostly limited to the species *Pinus radiata* (radiata pine) and they are grown over rotations of 30-35 years with the aim of producing sawlog for sale to local processors.
Stumpage	Stumpage is revenue received by the grower after deduction from the Mill Door Price of the costs of harvesting the trees, transporting the logs to the processor, harvesting supervision and harvesting management. Depending on specific sale arrangements, cost of on-farm roading may or may not be taken into account in the stumpage.