Defining your requirements

If you are seriously interested in timber production for income then you need to do your homework on options, expected yields, opportunity costs, tax implications, market access and risks. Timber production from planting to harvesting involves long rotations so if you are able to achieve other values (such as shade or shelter) by varying your layout and management, why not do so? If you have started with this chapter first you should also read about how revegetation can provide other values before deciding on a final design.

If you have turned to this section as a secondary option you will have already identified the main reason why you want to grow trees. You may also have identified where they need to be planted, what mix of species is required and how the forest as a whole might be structured. You are now interested in whether these same trees might be able to provide a direct commercial product.

Irrespective of the reasons for being interested in timber production there are some clear design principles that can be used to help determine the most appropriate species and management regimes to meet your needs.

Timber options

There are many different timber product, tree species and timber management options. Financially, the options vary in:

- their costs;
- labour requirements;
- economies of scale;
- risks and uncertainty;
- ease of marketing.

Different options are available in different regions and product options and prices will invariably change over time. What is valuable today may be more or less so in the future.

The uncertainty of future markets can be seen as a positive reason for investing in tree-growing. Many growers look to decreasing supplies of timber from native forests worldwide and an increasing world population as a sign that timber prices will rise. Landowners should be wary of such predictions and first look to ensuring that the product they produce matches the highest quality requirements of their local and regional markets. If prices for timber do rise, only those landowners with access to the market and stands of sufficient size and quality will benefit. What may be profitable in one region may be unsaleable in another.
Growing good wood

The greater the quality of the wood grown the more valuable the trees will be to the processor and therefore the easier to sell for the farmer.

In forestry, quality depends on how well a stand of trees meets the needs of the buyers.

A high quality firewood stand is very different from a high quality sawn timber stand or a pulpwood stand. Whether you intend to sell trees, logs, processed timber or simply use the product yourself, tree and stand quality are critical to success. Because farmers generally grow trees to sell as logs (which may later be used as sawn timber or chips), we need to know how species, log dimensions and wood quality influence value. We also need to know what factors will affect harvesting, transportation and marketing costs.

With an understanding of the tree species and stand type we should aim for and a knowledge of management costs, it should be possible to design plantings that meet our immediate needs while remaining commercially viable. It is important to recognise that the most appropriate design for a particular landowner will be determined by the needs and resources of the landowner and the characteristics of the land itself, and may not be the optimum one for maximising wood value or return on investment.

Product options

Wood products can be classified into a number of types:

- sawn timber products;
- composite boards;
- paper and cardboard;
- posts and poles; and
- fuelwood.

In each case and for each situation there will be particular log specifications and factors which downgrade the value of the log.

Sawn products

Solid timber products are used for engineering and appearance, as construction timbers, for flooring and lining, and for joinery, furniture and craft purposes. The timber may be used green or dried, it may be seen as a commodity (such as house framing), or as a specialty product (such as kiln dried furniture timbers). Increasingly, mills are specialising in a limited range of species (maybe even only one) and aiming to service particular market sectors.
DESIGN PRINCIPLES FOR FARM FORESTRY

Trees for wood products

For a given species, factors that affect the value of a log to the mill include:

- diameter;
- straightness;
- log length;
- presence of defects; and
- growth stresses.

These will influence the percentage recovery and grade of the final product. In the hardwood industry, recovery of marketable grades of sawn timber from native logs can be as low as 10% or as high as 50%.

Hence the value of a ‘good’ log at the mill door is many times that of a ‘poor’ log and should be reflected in market interest and price.

Composite wood panels

Across Australia timber is used to manufacture a range of veneers, plywoods, particle boards, medium density fibre boards (MDF), chipboards, and other panel products. With the exception of the veneers and plywoods, manufacturing processes involve the reconstitution of wood fibres and generally begin with woodchips.

Many, if not most, of the raw woodchips for use in reconstituted boards are sourced from sawmill waste. More than 30% of a sawlog can end up as woodchips. Mills often prefer mill waste to logs as they are easier to handle and are often of higher quality than woodchips sourced from young, small diameter logs.

Plywood and laminated veneer lumber involve the ‘slicing’ or ‘peeling’ of thin veneers directly from the log and can be treated as a ‘sawn’ product. Veneer mills have very specific requirements for log dimension and quality which are easy to define. However, this is a relatively small market and difficult to predict. Fortunately, in most cases a good veneer log is also a good sawlog.

Woodchips, pulp and paper

Woodchip and pulp processing plants are invariably large scale operations influenced by world prices rather than local demand. There are paper mills and export wood facilities in most states, and within acceptable haulage distances (say 100 km) of these facilities there is interest in the establishment of plantations dedicated to the production of woodchips.

Log quality and stand specifications are as important, if not more so, for pulpwood than for any other timber product. Due to very tight economic margins many factors are critical, including:

- fibre quality;
- tree size;
- harvesting and transport costs;
- plantation area; and
- the uniformity of the stand.

Therefore, the degree to which the layout and management of an ‘ideal’ pulpwood plantation can be varied to suit other farming concerns (such as shade and shelter) while remaining commercially viable is questionable.

Posts and poles

In some regions there are attractive markets for posts and poles. Unfortunately, the specifications are extremely tight and it is unlikely that a great proportion of trees harvested at any time will meet the specification of the market. The markets themselves may be quite fickle. For example, the current expansion of vineyards has increased the demand for treated pine posts, but because of the automated harvesting systems used now in vineyards the posts must be just under 125 mm in diameter. From any single tree taken from a stand only one short post may meet this market need, while the market for posts of other sizes may be flat.
Fuelwood and extractives

Despite the fact that the greatest use of timber worldwide is as fuel, growing fuelwood for profit remains a specialised business. The major costs are associated with such factors as:
- felling;
- cutting;
- splitting;
- drying;
- stacking; and
- transporting.

Any design or management that can reduce these costs will improve returns.

Wood characteristics such as colour, density, ease of splitting and burning quality will influence acceptance in major markets and affect returns to growers. Some markets simply prefer a particular species.

The use of timber as an industrial fuel or source of extractives (ethanol or tannins) has possibilities although prices will vary depending on the cost of alternatives. Special purpose fuelwood or extractive plantations carry similar risks to pulpwood due to low margins and high processing costs.

What to grow

As small producers looking to take advantage of market opportunities, landowners should carefully consider their product options. Ask yourself “why should industry be interested in my trees?” and look to gain some advantage by good design or management. Some points to consider include:
- look at the trends in the local industry. Is the supply from large scale plantations and native forests increasing or decreasing? What will the industry look like in the future when you come to harvest?
- avoid locking into a product option for which there may be only one buyer, unless you agree on a price at the outset. Examine the trends in the market and aim to produce a product that has a number of market options;
- look to producing products that have a long standing life to avoid having to sell at a particular age or when the market is depressed. Many forest owners who adopted regimes that required commercial thinning to be done at a certain age have been forced to accept a low price or find that the entire program is jeopardised because they cannot secure a market at that time.
Trees for wood products

Log values

The price paid for a particular tree will depend on the mill door value to the buyer and competition within the industry. In most cases what is good for the processor will improve the value of the standing trees to the grower. Many factors influence price:

- costs of harvesting and delivering the timber to the processing plant are influenced by the scale of the operation, ease of access, site characteristics and transporting costs. Clearly, small areas of forest on steep land at the back of the farm will attract less interest than large uniform plantations on flat land close to roads;
- timber is a heavy product and transport costs can be as high as 10c per km per tonne. This suggests that logs close to the mill may be worth $10 per m³ more than logs sourced from over 100 km away;
- year-round access for harvesting can greatly increase the value of a stand. In most regions logging slows during the wet season. If your plantation is accessible all year round it will be easier to attract contractors and buyers;
- consistency and security of supply provides processors with long-term stability. Although most small growers will not be able to provide large volumes over long periods, collective marketing or entering into marketing agreements can improve the value of a stand.

As the sawmilling industry becomes more sophisticated and the quality of logs from native forests declines, the price differential between logs of differing quality appears to be increasing. Figure 2 illustrates some examples of the effect of log quality (as determined by log size and the presence of defects) on the value of standing logs in government forests. For small growers the differential might be expected to be greater as they may be less able to ‘encourage’ industry to accept lower value timber as part of a parcel of logs.

Where trees are being used to provide other benefits (such as shade and shelter) as well as for timber, financial returns may be compromised by the need to maintain or provide these other benefits. Although the landowner may have to accept a lower return than that being achieved by large scale commercial timber growers in the same area, this may be acceptable in the light of other values such as shade and shelter.

Manipulating a stand of trees to grow good wood

Silviculture is the manipulation of forest stands and the trees within them. Silviculture is the most powerful tool of the farm forester and the means by which ‘firewood’ might be turned into high value veneer or sawn timber.

Having selected a product, species and site, the silviculture (beginning with planting design and continuing until the time of ‘harvest’) will determine:

- the volume of timber in the stand as a whole;
- the volume per tree;
- the distribution of timber within the tree; and
- the quality of timber produced in each part of the tree.

Growing logs to match market specifications requires the determination of the target tree. The most important characteristics of the target tree will often be form, diameter and wood quality. Silvicultural regimes are developed to ensure that these needs are met. But before we can consider silviculture we need to understand how a tree grows.
Trees for wood products

Figure 2: Effect of log quality on value

The top part of the table shows log prices in $ per m³ as quality increases from top to bottom. These values are illustrated in the graph.

The lower part of the table shows the definition of each quality class for each product.

Information drawn from the average royalty values for a range of log quality grades sold from native forest and government plantations in Victoria and Western Australia in 1995.

<table>
<thead>
<tr>
<th>Quality rating</th>
<th>Pine (Vic)</th>
<th>Pine (WA)</th>
<th>Euc Vic (Ash)</th>
<th>Euc WA (jarrah)</th>
<th>Blackwood (Vic)</th>
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<tr>
<td>1</td>
<td>5</td>
<td></td>
<td>12</td>
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<td>2</td>
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<table>
<thead>
<tr>
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<th>Euc WA (jarrah)</th>
<th>Blackwood (Vic)</th>
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<tr>
<td>1</td>
<td>Pulpwood</td>
<td>Pulpwood</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Diam. &lt; 20 cm</td>
<td>Case logs</td>
<td>D grade</td>
<td>Third grade</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25 cm</td>
<td>Rough logs</td>
<td>C grade</td>
<td>Second grade</td>
<td>Inferior</td>
</tr>
<tr>
<td>4</td>
<td>35 cm</td>
<td>Over 20 cm</td>
<td>B grade</td>
<td>First grade</td>
<td>General</td>
</tr>
<tr>
<td>5</td>
<td>45 cm</td>
<td>Over 30 cm</td>
<td>A grade</td>
<td>Premium</td>
<td>Superior</td>
</tr>
<tr>
<td>6</td>
<td>Veneer grade</td>
<td>Veneer grade</td>
<td></td>
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</tbody>
</table>

Effect on log quality on price

Standing Value ($/m³)

Pine (Vic) - Pine (WA) - Euc Vic (Ash) - Euc WA (Jarrah) - Blackwood (Vic)

Pulpwood (small, defective) - Sawlog grades - Veneer (large, clean)
Tree growth and wood production

Trees essentially have two above-ground growing points. The most obvious is the leading shoots of the main stem and branches. At this point cell division leads to elongation and height growth or branch development. The second growing point is the cambium. The cambium is a layer of dividing cells found just below the bark on the main trunk and all branches. The cambium produces two types of growth:

- wood cells on the inside which not only help support the tree but also initially act to conduct water from the roots up to the leaves; and
- bark cells on the outside which initially perform a role in transporting sugars from the leaves down to the roots but then later die to form the protective bark.

When we manipulate the growth of a tree we do so by influencing the growth and development of these two growing points. Through management we are able to suppress or encourage elongation of the main stem and branches and vary the production of wood by the cambium.

Tree form, diameter and wood quality

Arguably the most important criterion of a target tree for timber production is form. For all harvesting and processing procedures, straight single-stemmed trees are easier to process and thus have a higher recovery in milling. Leaning or crooked trees may also induce the development of reaction wood (with a different cell structure) which can affect a log’s milling, drying and pulping qualities.

The early management of a timber stand should be focused on the development of well-formed trees which can be seen as a structure onto which good wood can be grown.

Techniques to induce good form include:

- high initial stocking rates;
- nurse crops;
- genetic selection;
- corrective pruning.

Once a tree is felled and cut into log lengths it is the diameter of the log, not the height of the original tree, that will influence log value.

Log diameter will often determine the harvest age and therefore increasing the rate of diameter growth can reduce rotation lengths.

Wood quality is influenced by many factors:

- The type of wood. There are two types of wood in the tree: heartwood and sapwood. In some species only the heartwood is of commercial value. For other purposes, such as chemical treatment, sapwood may be preferred.

Knots or branch stubs. A major defect in plantation timber is the presence of knots or branch stubs. Knots interfere with the grain of the timber and reduce its strength and appearance qualities. They may also become entry points for rot and discolouration that can spread through the tree. Generally the larger the knots the lower the value of the timber although the type of knot is also important. The size, type and location of knots in the log can be influenced by silvicultural regime.

Age. In many timber species wood density increases with age, thereby increasing the strength of sawn timber and the fibre yield of wood chips. For low density species (pines and some eucalypts) this may make young trees less valuable.
Site selection

Like all crops, site quality greatly influences tree growth and productivity. For trees we generally consider soil depth, texture and the degree of exposure as the most important criteria. Although irrigation of trees is being trialled, the costs involved are likely to be prohibitive unless the trees are seen as a sink for waste water.

The condition of the existing vegetation on a site (species composition, height, structure and productivity) is often a useful guide to site quality. Problems such as waterlogging, infertility and dry soils can be identified and possibly overcome by appropriate site preparation. Soil fertility can be enhanced by fertilisers and this has been demonstrated as viable on some highly leached infertile soils. Intensive soil preparation may also overcome soil structural problems such as impeding layers or surface waterlogging that may restrict growth.

In many cases you will have already identified where you wish to grow trees. In some cases these areas will also be of low productivity for trees, but this should not be seen as of great concern.

The important point is that in determining the appropriate silvicultural regime the productivity of the site and the likely returns have been considered.

Silvicultural regimes involving intensive tree management, long rotations or high costs are generally only viable on good quality sites. Where growth is likely to be slow or risks of fire, drought or disease are high, less intensive options might be considered to reduce the financial risks.

The silvicultural tools

Landowners can influence the form, diameter and wood quality of their trees by manipulating competition between trees (thinning) and by tree shaping (pruning). For a single species, plantation competition is determined largely by size and spacing of trees on the site.

By understanding how the stocking rate of a plantation affects the growth of individual trees and stand characteristics, managers are able to manipulate the stand and change the outcome. Figure 3 illustrates the powerful influence of inter-tree competition on tree diameter and stand volume. If the object is to maximise the volume of timber (as for pulpwood or fuelwood) then the higher the stocking rate the greater the yield. This is why pulpwood plantations are established at over 1,100 trees per hectare (3x3 m spacing) and left unthinned until final harvest.

If, however, the aim is to produce large diameter logs suited to milling for solid timber, the trees are planted at a lower initial stocking rate or thinned to maximise diameter growth. Although the total volume of production may be lower, the shorter time needed for the trees to reach the appropriate size and the higher value per tree can offset the loss of volume.

It is common in plantation forestry to plant more trees than are expected to be harvested. This not only provides mutual shelter for the young trees and helps control tree form and branch growth but also allows for a degree of selection so that all the final crop of trees are of high quality.

Genetic variation is very pronounced within trees grown from unselected seed lots, particularly in our native species. Genetic improvement of tree species may reduce this genetic variation although some allowance should be made for poor growth or form due to planting technique or damage from wind, snow, browsing or disease.
To increase diameter growth on selected trees the competition from adjacent trees must be reduced as the tree grows.

The difficulty for landowners is in determining how many trees to thin and when to begin. Thinning too few trees means that tree growth is not increased sufficiently, while thinning too heavily may encourage excessive branch growth and will reduce total yields.

Experience suggests that for plantations on well watered sites, if trees are to grow freely without competition they should be spaced at an average distance greater than 25 times the diameter of the largest trees.

For example, trees planted at 3 m spacings (1,100 trees per hectare) will begin to compete, and their diameter growth will be restricted, once the trees reach 12 cm diameter.

Where branches are controlled by pruning, thinning to 25 times the diameter can reduce the time taken to reach target log diameters without compromising log quality. Where competition is required to reduce knot size, thinning to 20 times the diameter may be advisable depending on the degree of self-pruning.

The temptation to postpone thinning until the trees are large enough to allow for a commercial thinning for posts or even small sawlogs is common but will slow the growth of the best trees, therefore postponing the lucrative final harvest.

This may be acceptable for landowners who are happy to wait or are unable to fund the costs of pruning or thinning to waste, but in most areas where the return for small wood is very low it is advisable to thin to waste.

Pruning for high quality timber

Branches on the trunk of the tree reduce the timber strength, pulping quality and appearance values of the tree. High value timber contains either very small knots or no knots at all. Knots larger than 5 or 6 cm in diameter result in timber being unsuitable for many structural grades and for most appearance grade timber. Trees need to be artificially pruned if knots are likely to become large or if clearwood is specified.

Large knots occur if the branches become large. Branches of many species grow large at low stocking rates, especially if the site is fertile.

In order to benefit from the increased diameters achieved at low stocking rates pruning is often essential.

A well pruned tree produces a log with a core of knotty timber containing the pruned stubs surrounded by a sheath of knot-free wood or clearwood. The production of a clearwood log requires careful management over a number of years.

Harvesting and marketing

The nature of the logs and their value dictate the type of harvesting equipment and the scale of operation required to make the sale of timber profitable. For a product like pulpwood, which has a low value to weight ratio (about $20/tonne) and is sold to large industrial wood processors, the minimum volume required for a sale may be over 2000 m³ or about 10 hectares of plantation. Because of the small size of the logs from young pulpwood plantations, automated harvesting equipment is required and clearfelling is recommended to keep logging costs down.

For high value sawlogs (over $50/tonne) the minimum lot size might be just one truckload delivered to the sawmill. Farm equipment (chainsaws and adapted tractors) is often adequate and the landowner can learn the skills or pay experienced fallers. Landowners interested in maintaining non-timber benefits may choose not to
clearfell large areas and accept the higher costs of selective or small scale logging.

**Joint ventures and lease arrangements**

Governments and plantation developers are offering joint ventures or land lease options to landowners for the development of commercial plantations. These should be seen simply as another option for landowners and can be assessed against the farmer's own design criteria for other values and his or her own financial needs.

In most cases the silvicultural regimes on offer will largely be fixed. The joint venture partner will have determined what species, planting pattern, management and products they are interested in. The landowner should be aware of the degree to which the design is flexible and can be varied either financially, legally or physically to better meet specific needs. Understanding the principles of silviculture and the needs of the industry partner will help in the negotiations.

### The most appropriate silvicultural regime for your farm

For sites where you need to plant trees for other benefits or for those sites you have identified as available for timber production, a silvicultural regime needs to be developed. The regime will specify:

- the expected target tree;
- stand characteristics;
- the species mix;
- initial stocking rates;
- thinning and pruning prescriptions; and
- other management requirements.

Questions will arise regarding markets, management options or simply species selection. In some cases the answers may be available from local research or experience but quite often you will need to make a judgement yourself. Where there is uncertainty you might choose to test a number of options, be they establishment methods, species or management. Unfortunately, the long rotations make it impossible to fully test the options on a small scale before you decide to go ahead, but you will learn from your own experience very quickly and be able to see what seems to work.

There is no best bet option suited to all landowners but by understanding the principles involved in timber production and by gaining direct experience you may be able to determine what is best for you.

### References / Further reading


The economic return from timber or wood products may offer the opportunity to achieve the scale of plantings needed to capture other major benefits such as water-table control and soil conservation. Shelter and, with careful planning, some nature conservation and scenic beauty objectives can also be captured.

### Capturing benefits in addition to wood products

<table>
<thead>
<tr>
<th>Other benefits to capture</th>
<th>Opportunity</th>
<th>Things to look out for</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salinity and waterlogging</strong></td>
<td>Belts of timber trees can be planted to intercept laterally moving groundwater and prevent waterlogging or salinity problems downslope.</td>
<td>Optimum location of trees for timber may not coincide with locations required for salinity management.</td>
</tr>
<tr>
<td></td>
<td>Plantations in recharge areas will reduce additions of water to the water-table.</td>
<td>Upland recharge sites often have poor soils.</td>
</tr>
<tr>
<td><strong>Soil conservation</strong></td>
<td>Belts of timber trees reduce effective slope length and drop litter which can reduce sheet and rill erosion.</td>
<td>Some species can make erosion worse by suppressing ground cover or reducing infiltration.</td>
</tr>
<tr>
<td></td>
<td>Timber trees reduce wind erosion.</td>
<td>Harvesting trees can cause erosion and remove nutrients.</td>
</tr>
<tr>
<td></td>
<td>Trees can cycle nutrients from subsoils.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trees can improve compacted subsoils by making root biopores.</td>
<td></td>
</tr>
<tr>
<td><strong>Shade and shelter</strong></td>
<td>Plantations make effective windbreaks for surrounding paddocks, and this can be improved with appropriate choice of plantation shape and location.</td>
<td>Square-shaped plantations give a small area of protection to pasture/crops relative to the number of trees planted.</td>
</tr>
<tr>
<td></td>
<td>Access to plantation for stock gives excellent shelter.</td>
<td></td>
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<tr>
<td><strong>Fodder</strong></td>
<td>Pasture in young plantation paddocks can be grazed once trees are large enough to withstand possible damage.</td>
<td>Browsing can have adverse effects on tree growth rates and form.</td>
</tr>
<tr>
<td></td>
<td>Some commercial tree species may yield livestock fodder.</td>
<td>Moderate to high tree densities will inhibit pasture production.</td>
</tr>
<tr>
<td><strong>Nature conservation</strong></td>
<td>Plantation trees can potentially provide useful food and nesting resources for some wildlife.</td>
<td>Requirements for uniform timber quality reduces structural diversity and hence reduces the habitat potential of plantations.</td>
</tr>
<tr>
<td></td>
<td>Plantations adjacent to remnant vegetation may buffer the remnant against extreme environmental conditions.</td>
<td>Large block plantings reduce patchiness in the landscape and hence reduce habitat diversity.</td>
</tr>
<tr>
<td></td>
<td>Plantations linking existing remnants may increase the chance of animals moving through the landscape.</td>
<td>Tree harvesting may cause resource shortages and hence population declines for some species.</td>
</tr>
<tr>
<td><strong>Scenic quality</strong></td>
<td>The need to manage scenic quality may require alternative and creative silvicultural and harvesting practices but these need not affect economic output.</td>
<td>Visual impacts of standard silvicultural prescriptions and harvest operations usually lower scenic quality.</td>
</tr>
</tbody>
</table>