Using Pine Timber

by G. R. Siemon

Report No 7
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Wood Utilisation Research Centre

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ABSTRACT

It is an advantage to the pine grower or the agroforester to understand about wood properties. These properties are influenced by the way the forest stand is managed and in turn influence the way in which timber produced can be used efficiently. This publication provides information on wood properties and utilisation so that the grower is better able to produce timber for specific uses.

GROWING PINES FOR COMMERCIAL USE

Growing pine in conventional stands and in agroforestry is basically different.

The term 'agroforestry' covers a wide range of approaches for integrating trees and farming. Types of agroforestry range from the fully integrated system of grazing under widely spaced trees to growing shelterbelts. Briefly, the objectives of growing trees on farms include timber production, salinity control, erosion control and shelter for stock. Small woodlots can supply farm timber requirements, such as fence posts, stock yard material, fuel etc.

Research to date has concentrated on efficient growing of pine and assessment of wood quality, particularly *Pinus radiata* and to a lesser extent *P. pinaster*. The major advantage of pines is their fast growth rate, especially *P. radiata*. This species is recommended for the south-west of the State, on fertile soils and rainfall greater than 700 mm, but not for areas north of Moore River. (See CALM Information Sheet No.2-87 'Pine trees for timber under W.A. conditions'.) *Pinus pinaster* is the more drought resistant species, and better suited for lower rainfall areas and lighter soils. However, in the South Coast region growing *P. radiata* is a possibility because low evaporation rates partly compensate for lower rainfall.

The Forests Department (which was incorporated into the Department of Conservation and Land Management (CALM) on 22 March 1985), had produced several publications on agroforestry. These included some of the Tree Care Series:

'Agroforestry - the integration of trees and farming'

'Pines for private investors'

'Pines for farms'

'Farm windbreaks'.

The publications are available from Departmental offices. They give details of types of agroforestry, the economics of growing trees on farms, and management methods (including fertilising, pruning and thinning requirements). Information on standard forestry practices is also available.

MARKETS

'Pines for private investors' has relevant information on current markets for pine products for growers whose main objective is timber production, and is useful also to growers whose major aim is salinity control, erosion control, or providing shelter for stock. The maximum economically viable distance from a market is about 70-100 km. The current products and markets are:

Small round pine logs, pressure treated with preservative, have several uses. The trees thinned from the stand, leaving the better ones as crop trees, could be sold to treatment plants. Each plant has its own standards for acceptable material or the quality required in the logs.

Particleboard logs are a limited market for private growers, as the State Government has agreements regarding sales to the Dardanup factory for thinnings from the State plantations. The volume of small round logs required by the factory could decrease with time as increasing quantities of cheaper sawmill residues, become available. Thinning is usually undertaken at about 11 years.

Case logs, as the name implies, originally referred to small logs sawn to make packing cases. Although most of this market has gone, the logs are used for pallet material.

Mill logs produce quality sawn timber. These larger logs thinned at 18 years plus or from clearfellings give better recoveries to the sawmiller, and are therefore more valuable than the smaller case logs. The return in royalties from mill logs ($\$/m^3$) is about twice that of case logs and four times that of particleboard logs.

The decreasing supplies of durable hardwood will provide opportunities to expand in these and pine woodchips is a potential market for thinned trees which are unsatisfactory as sawlogs.

The apparent lack of processing plants in some localities is due to the shortage of log resources. The Department's estimation is that processing plants will develop along with the growing resource. The States's increasing populations and demand for timber, combined with the diminishing availability of indigenous hardwoods, should ensure an expanding market. A small pine sawmill requires at least 10 000 m^3 of logs each year, from within about a 70 km radius to avoid excessive transport costs. This would require a resource of about 700 ha to 1000 ha being available for harvesting each year.

Utilisation of timber grown privately has not been discussed to any extent in previous publications on agroforestry. This report provides information on wood properties and utilisation to the grower.

WOOD PROPERTIES OF PINES

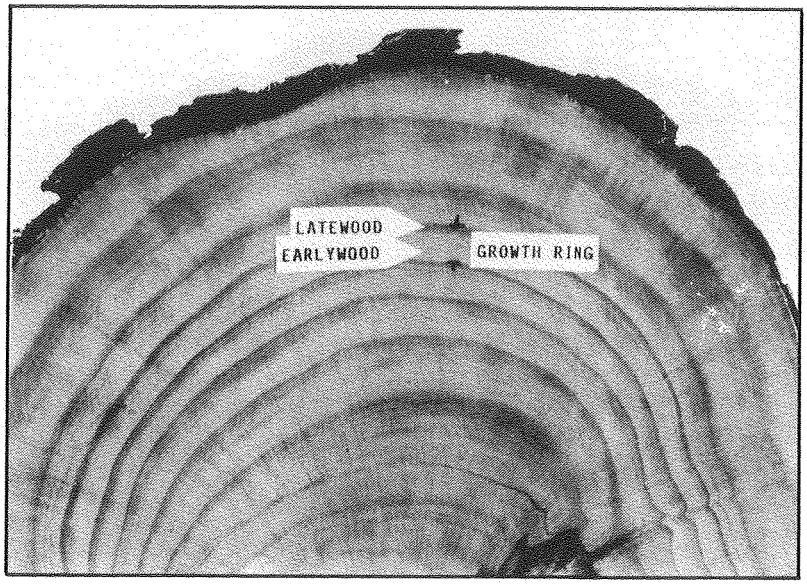
Pinus radiata and *P. pinaster* are both medium density softwoods. They are comparatively easy to work, are light, and have a wide range of uses . The use of any timber for a particular purpose depends on the types of cells in the wood and their relative proportions and arrangement. The age of the tree and the growing conditions also affect the wood properties.

Growth Rings

Wood cells are produced by the cambium, which is a continuous layer of cells around the circumference of the stem. The cells in the cambium continually divide to produce wood on the inside, and bark on the outside. A sheath of wood is therefore produced each year around the circumference (i.e. the outer edge) as the tree increases in height and diameter.

Pines have characteristic annual growth rings. The band of light coloured wood is composed of 'earlywood' cells, formed in the spring. These cells are mainly a type of fibre, called tracheids, with a large diameter and thin walls. Their main purpose is to conduct water and nutrients from the roots to the crown. The band of dark coloured wood is mainly 'latewood' cells, formed in the summer, which are tracheids with smaller diameter and thicker walls. These provide strength for the tree.

Both earlywood and latewood contain storage cells called parenchyma. Rays run radially from the circumference to the pith (the soft centre of the stem) and include parenchyma and tracheids. Specialised resin canals (oriented vertically in the stem), which are surrounded by a layer or two of parenchyma cells, produce resin.



Growth rings in radiata pine, showing early wood and latewood.

Juvenile Wood

Juvenile wood is produced in the first ten to twelve years of growth, after which a similar type of wood is produced in the stem in the area of the crown. This crown-formed wood differs from normal juvenile wood in microscopic details only.

Juvenile wood contains a lot more earlywood than latewood, so has low density. In addition, its tracheids are arranged at an angle to the length of the stem, which results in spiral grain. These two factors result in juvenile wood having lower strength than mature wood (which forms below the crown, after age 12 years). The spiral grain also affects the drying behaviour of sawn timber, making it more difficult to season without twisting. This problem can be overcome by using the correct method of seasoning.

'Heart-in' pine, which is sold commercially, is defined by grading rules as the timber from within a 50 mm radius of the pith (the soft centre of the stem). That is, it contains all juvenile wood.

Mature wood is formed after 12 years, below the crown on the outside of the tree. This is the densest and strongest wood in the tree. With increasing age, the base of the green crown moves upward as branches die (or are pruned) and the ratio of mature wood to juvenile wood increases continually.

Heartwood Formation

When first formed, wood cells are live and conduct moisture and nutrients. In this form the wood is termed sapwood. At about 14 years, heartwood formation begins at the base of the stem, at the pith. The cells near the centre start to die, and lose moisture which is replaced by large quantities of resin (sapwood contains much less resin). The rate of heartwood formation is variable, and so there are often more than 14 rings of sapwood surrounding the heartwood, giving a wide sapwood band. Even with the increased amounts of resin in pine heartwood, it is not very resistant to fungal and insect attack .

Strength Properties of Pine

Strength tests carried out by the former Forests Department in co-operation with the Department of Civil Engineering, WAIT, (now Curtin University of Technology) showed that on average *P. pinaster* has strength properties of clear wood at least equal to those of *P. radiata*. *P. radiata* had been extensively tested by the CSIRO Division of Building Research in Melbourne in the mid 1970s.

Mature wood of *P. pinaster* has higher density than that of *P. radiata* because it has a higher proportion of latewood, and therefore has greater strength.

As mentioned previously a major feature of pine is its large sapwood band, which is much wider than the sapwood in eucalypts. The sapwood contains living cells, including the parenchyma cells which store starch, sugars and minerals, and it is also relatively free of toxic or unpalatable deposits. The wood can therefore be rapidly attacked by sapstaining fungi after the tree is felled, and after timber is sawn. The most common sapstaining fungi are those which cause bluestain. These fungi feed on the cell contents, and do not attack cell walls. The appearance of the timber is affected, but not the general strength properties. Control of bluestain will be discussed later.

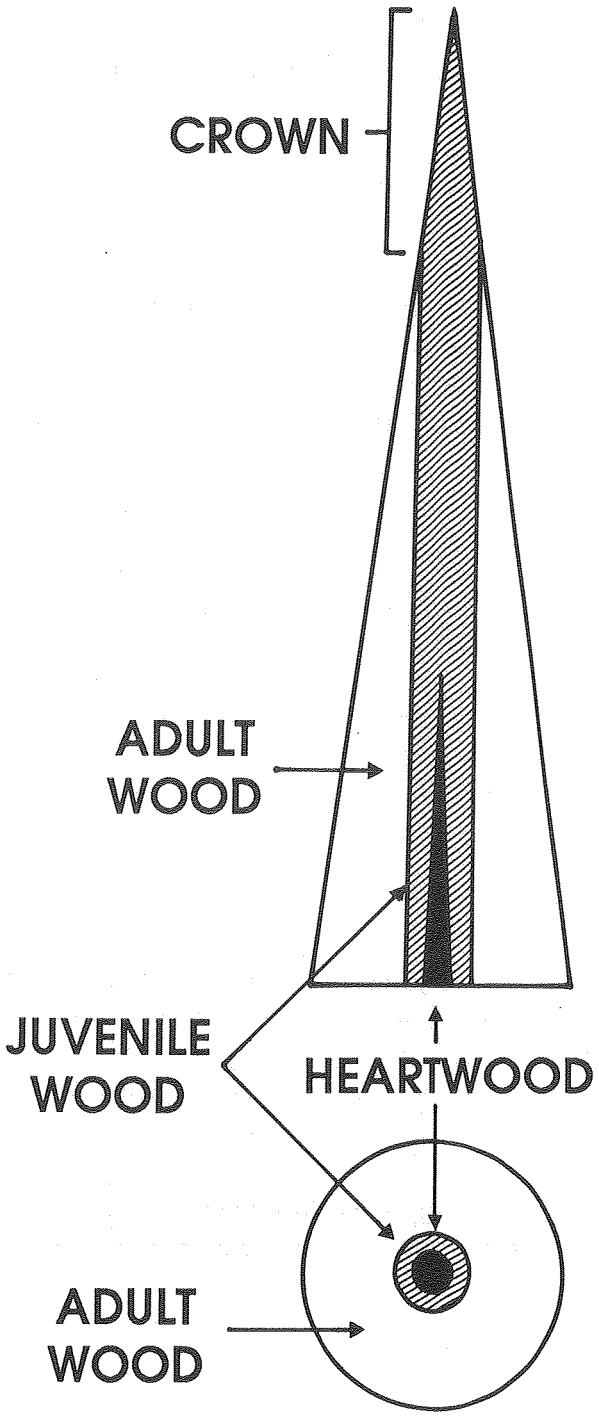


Diagram of heartwood formation in pine

EFFECT OF MANAGING PINES ON WOOD QUALITY

Wood quality of pines is reduced by factors such as spiral grain, low density and knots. The grower cannot do much about spiral grain, which is the responsibility of the tree-breeder. However, he can significantly influence wood density and knot size, by controlling spacing, fertilisation, pruning and thinning. Specific details regarding these factors are given in the publications referred to earlier.

Spacing

The management techniques in conventional forestry include control of spacing of the trees (distance apart of the rows, and distance between trees within the row). Over a range of spacings, total growth per hectare is similar where the trees make full use of the site. Close spacing means that the volume increment on an individual tree is reduced. However, close spacing generally means smaller branches, hence smaller knots. In most agroforestry, however, trees are planted at wider spacings to allow pasture development under the trees, and knot size is controlled by pruning the trees.

Fertilising

Faster growth caused by fertiliser applications may result in lower density and hence lower strength, if the ratio of earlywood to latewood width is increased. This occurs if most of the increased growth takes place in the spring when the earlywood is formed. When sufficient moisture is available it is possible for increased growth to continue in the summer, so that the earlywood/latewood ratio remains constant, and density remains constant. Even if the density is reduced, the increased volume growth from fertilising more than compensates for this reduction.

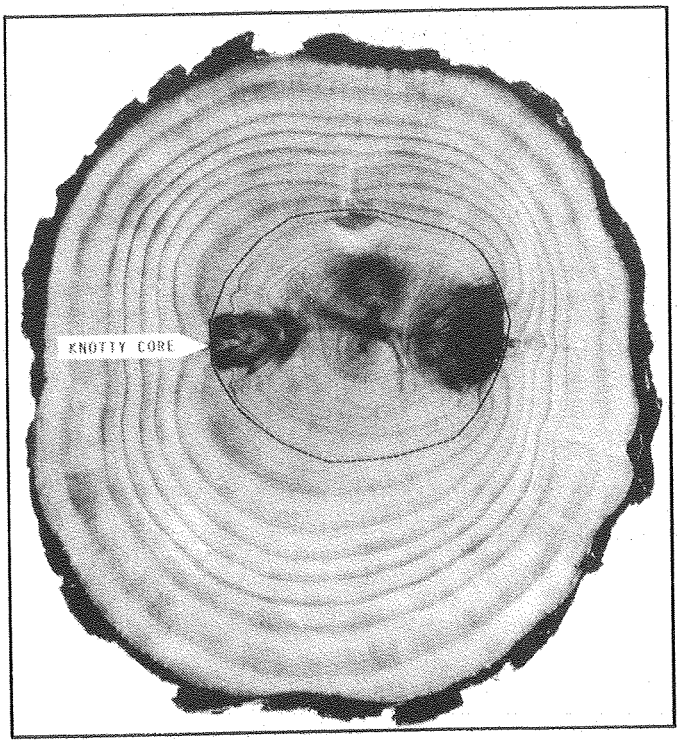
Pruning

Knots are the major defect reducing the strength of timber, which is caused by the grain sloping around the knot. The larger the knot, the greater is the angle of the grain around it. Pruning branches off the lower stem has the advantage of allowing clear and straight-grained wood to be formed. The tree consequently has a small 'knotty core' of juvenile wood in the centre. Clear wood is much more valuable for structural purposes than wood with knots, and should bring higher prices. Some knots may be an advantage in furniture and panelling for aesthetic reasons.

Thinning

An average area of *P. radiata* forest in Western Australia produces about 15 m^3/ha of wood each year. The corresponding figure for *P. pinaster* is about 8 m^3/ha.

Although *P. pinaster* is slower growing, it grows better than *P. radiata* on low rainfall areas (700 mm/year) and poor sandy soils. This applies over a wide range of tree densities. If there are 50 trees per hectare on average, each one will produce several times the volume produced per tree than if there were 500 trees per hectare. That is, thinning to remove the poorer trees concentrates the growth on the better ones remaining, because the competition for water, nutrients and sunlight has been reduced many times. Thinning to waste, if there are no markets for small trees, may be a matter of concern for some growers. However, the advantages are considerable from the long-term point of view, because crop trees reach sawlog size much faster, and the revenue more than compensates for the cost of thinning. Fast grown trees have a large proportion of juvenile wood, but the mature wood formed in the outer rings is a quality product. The sawn recoveries at sawmills increase, and the cost per cubic metre of production decreases, with increasing log size.



Knotty core development after pruning of radiata pine

GENERAL USES OF PINES

Uses of sawn pine include the following:

- *engineering uses eg. industrial building;*
- *house framing;*
- *formwork, retaining walls, cooling towers;*
- *moulding architraves, doors, shelves;*
- *joinery and turnery;*
- *beehives, boxes, pallets;*
- *decorative panelling;*
- *sleepers (preservative treated).*

Other uses are:

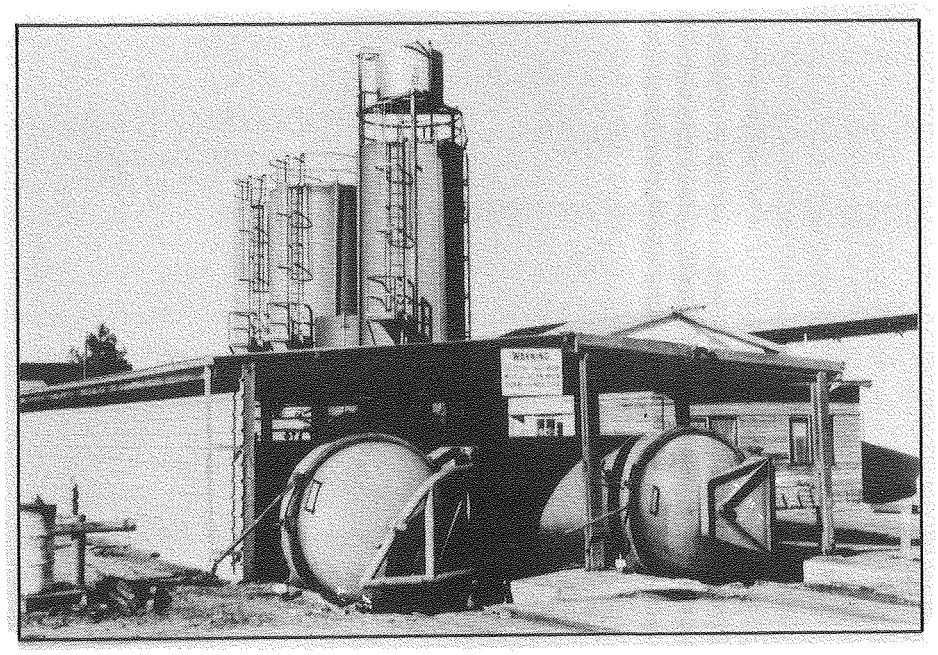
- *furniture;*
- *poles, fence posts (preservative treated);*
- *construction plywood;*
- *sliced veneer as facing for particleboard;*
- *particleboard and other panel products;*
- *pulp and paper.*

The properties of pine make it easy to machine, finger-joint, glue-laminate, nail, and apply finish to. In general, pine is a very versatile timber.

USE OF ROUND TIMBER

For the use of round timber on the ground (eg. fence posts, children's playground equipment) durability becomes more important than strength. Pines belong to durability class 4, which means that timber is regarded as non-durable, and very susceptible to insect or fungal attack. Its heartwood would last from one to eight years in the ground. (The classification system of 1-4 was developed by the former CSIRO Division of Forest Products about thirty years ago.) The sapwood of any species is susceptible to attack because the starch, sugars and minerals stored make it attractive to insects and fungi.

Treatment with preservatives is essential for pine timber in contact with the ground to prevent insect or fungal attack. Treatment by dipping will not produce satisfactory results. It is therefore recommended that treatment is done by a member of the Timber Preservers Association of Australia, who currently have treatment plants at Bridgetown, Bunbury and Mundijong. The method used is to dry the timber to 30 per cent moisture content, when it is placed in a large airtight steel cylinder. A vacuum is drawn, preservative is flooded in, and pressure of about 1 400 kPa (200 p.s.i.) is applied. A final vacuum is used to remove excess preservative.



A typical plant for preservative treatment of timber

The preservative used generally is copper-chrome-arsenic (C.C.A.), which is a 'water-borne' preservative i.e. the chemicals are dissolved in water. The copper is a fungicide, the arsenic is an insecticide, and the chromium fixes the other two elements in the wood. The treatment results in the characteristic green colour of C.C.A.

An alternative preservative is creosote, which comes from tar oils. Creosote treatment is not recommended because it bleeds, which can burn skin and make clothes dirty. However, a new 'clean' formulation to overcome this problem should soon be available commercially. Pressure treatment is also needed to get good penetration of oil based chemicals into the wood.

Because a large volume of C.C.A. preservative solution is taken up, the weight of the post can double. It takes about three weeks for water based chemicals to fix in the wood, after which they cannot be leached out. The treated timber is drying continuously in the meantime.

The white powder which forms on the surface of C.C.A. timber as it dries sometimes causes concern. It is sodium sulphate, which is not harmful. It can be removed easily by hosing down or wiping with a damp cloth if this is considered necessary.

Using the C.C.A. treated timber is more effective if ends do not need trimming, because this removes part of the protective envelope which pressure treatment provides.

It is important that any off-cuts of C.C.A. treated timber are not burnt, because the ash and smoke are toxic. In summary, C.C.A. treatment gives a long working life. It is not dangerous as the chemicals are fixed in the wood, the powder on the surface is not harmful, and the only possible hazard is from burning.

Because of its much wider sapwood band, pine is more effectively treated than hardwoods in a commercial pressure treatment plant, using C.C.A. preservative. For in-ground service the comparatively high cost of treatment is compensated for by the greatly increased life in service. For uses in semi-sheltered or protected situations a coating of a chemical with water repellent properties should be adequate.

USE OF SAWN TIMBER

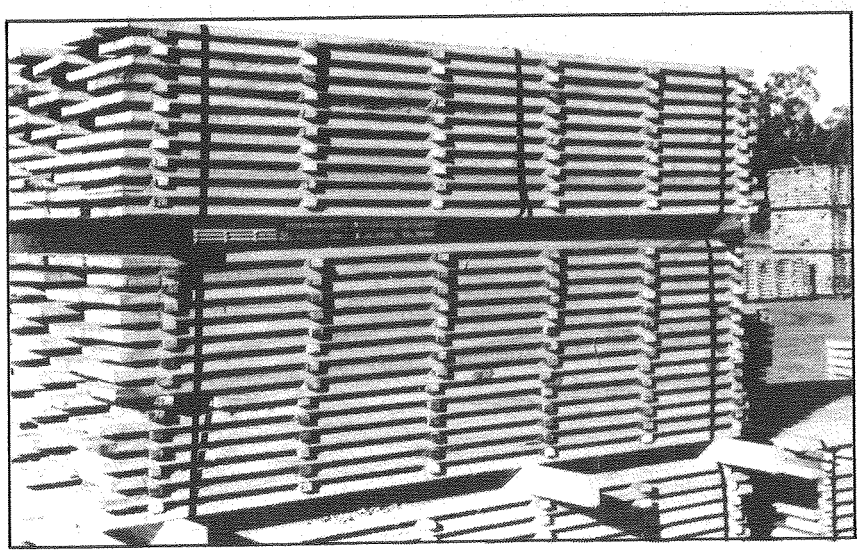
The grower has two main options when sawlogs are produced; sell them to a sawmill, or process them for his own use. For the latter, a 'spot' mill can be set up adjacent to the forested area. Baulks (i.e. squared sections) could be transported to larger sawmills for further processing. The saving in transport costs would more than cover the spot milling costs.

In the discussion on wood quality, it was pointed out that juvenile wood of pines has different characteristics to mature wood. Because drying of juvenile wood is difficult, the process can involve some waste from twisting. A permanent sawmill is likely to have drying kilns, which permit more efficient drying of timber. It is recommended therefore that pine is sold to an established sawmill where possible.

A mill log is generally one with a small end diameter, under bark, of not less than 20 cm, as shown in the Table on markets on page 3. Logs should be sawn within a few days to avoid sapstain attack.

Boards or structural sized pieces can be cut. As pine is generally used in the seasoned condition, the pieces are cut oversize to allow for shrinkage while drying and for planing to size. An allowance of 10 mm is needed for the width, and about 7 mm for the thickness.

To prevent attack by sapstaining fungi, recommended chemicals for dipping pine to prevent sapstain attack include Benlate, Koppers NP-1, and Busan 1009. (Dipping in sodium pentachlorophenate or captafol was common practice to protect the wood as it dried from sapstain attack. However, these latter chemicals are suspected of being carcinogenic.) In commercial practice where timber kilns are used, dipping for sapstain control is not necessary when seasoning is done within a few days of milling.



A well constructed stack of pine timber

Timber is best stacked on a firm base, 250 mm clear of the ground on a weed free area to allow air circulation and reduce the chance of fungal attack. 'Strip' stacking involves separating each layer of timber of strips (stickers) of dry timber 25 mm square, spaced about 450 mm apart. Air circulates over both faces. It is important for the stickers to have uniform thickness and then to be lined up vertically in the stack, and for pieces of timber for drying to have uniform thickness. Stacks should be generally about 1.5-1.8 m wide. Weights equivalent to a load of 1 tonne /m^2 could help to restrict any twisting of 'heart-in' wood.

The time taken for pine to dry varies with the season and board thickness, but will be at least two months (moisture moves through pine much more easily than it does in eucalypts).

In general, *P. pinaster* and *P. radiata* are interchangeable for structural uses, while the latter is preferred for general purpose uses.

GENERAL

The pine grown on farms can either be sold to a sawmill or treatment plant, or perhaps used by the grower. It is important that round timber is pressure treated commercially with preservative to make it durable for use in the ground and exposed positions.

Sawmilling by spot mills can produce quality timber, but dipping to prevent sapstaining is necessary unless the timber can be kiln seasoned in a few days. The grower should remember that it is the properties of the juvenile wood in pines which make it difficult to season, and juvenile wood has lower strength than mature wood.

The major advantage of pines (particularly *P. radiata*) over hardwoods is their very fast growth rates, and hence a large volume production over comparatively short rotations of about 25-30 years. This growth advantage more than compensates for the minor problems described. As stated previously, *P. radiata* is not recommended for areas north of Perth, and is best suited for fertile soils in areas with rainfall above 700 mm. *Pinus pinaster* can be grown on better quality soils in drier areas, although it has a slower growth rate than *P. radiata.*

Further information on the use of pine is produced by the Radiata Pine Association of Australia. The R.P.A.A. has technical publications and codes of practice for milling and using *P. radiata*, which are available from the Department of CALM's timber advisory service at Como (09 3670333).