



Processing Trees on farms

**A literature review for the
Rural Industries Research and Development Corporation
by
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"Processing Trees on Farms - A Literature Review"

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Foreword

Australia has a trade deficit in its forestry products industry with items imported being of higher value than those exported. These products come mainly from native and plantation forests.

It has been argued that farm forests could boost the industry's output and this report shows how they can be managed to maximise production of valuable lines.

The study examines forests and plantations generally as a resource and looks at the future availability of wood. It surveys the extent of farm forestry plantings and the economic benefits of farm forestry.

The report details processing of individual products such as sawn timber, posts, poles and piles, wood based panels, pulp, paper and paperbound and on-site timber processing.

It takes a close look at current and future markets for forest products, both in Australia and internationally and gives valuable insight into marketing processes.

The project is part of the Rural Industries Research and Development Corporation's Agroforestry and Farm Trees Program which encourages integration of sustainable and productive agroforestry within Australian farming systems.

Peter Core

Managing Director

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Executive Summary

Australia's 40.7 million hectares of native forests includes 11.3 million hectares of private forest. All of this forest is potentially available for timber production, although a number of constraints reduce the area that is actually available to approximately 7.6 million hectares.

The majority of Australia's 1.1 million hectares of plantation forests are publicly owned and managed by State and Territory forest agencies. There are, however, significant areas of privately owned plantations in a number of States. The owners of these plantations range from large forestry and investment companies to individuals such as farmers.

Wood from Australia's native forests and plantations is the raw material for a number of products - sawn timber, wood-based panels, pulp and paper, posts, poles and piles. Reference to Australia's trade figures reveals that the volume of imports of these forest products slightly exceeds that of exports. The situation is far less balanced, however, when the value of these imports and exports is considered. Higher value-added sawn timber and pulp and paper products constitute the majority of imports, while low-value pulpwood (predominantly woodchips) is the major export. The result is that Australia incurs a significant trade deficit in forest products.

It has been argued that timber from farm forests has the potential to supplement the products currently harvested from Australia's native and plantation forests, and to reduce the nation's current account deficit through import replacement and export. While the extent and nature of farm forest plantings in Australia is not well known, and their capacity to contribute to the expansion and diversification of the country's timber supplies is not well quantified, a number of recent surveys and analyses have thrown some light on the current state and future economic potential of farm forestry in this country.

Recent surveys have suggested that the majority of landholders planting trees are motivated by environmental concerns and not by a desire to produce timber. Many of those with such a desire, however, have experienced difficulties in finding markets for their timber. These difficulties relate to the relatively small size, poor quality and inaccessibility of many farm forest plantings, and the distance of these plantings to markets.

On-site processing has been suggested as a means of overcoming many of these marketing difficulties. Such processing has the potential to deal effectively with a current supply situation in which small, isolated forests have been unable to attract the interests of large-scale timber processors, and it has the potential to increase the returns to farm foresters by enabling them to provide a variety of value-added timber products to the wider community market. In these ways it negates, to an extent, the influence of size, inaccessibility and distance on the marketability of farm forest timber.

There are a number of portable sawmills, mobile debarkers and chippers, and relocatable drying kilns on the Australian market that permit the on-site processing of timber from farm forests. Portable sawmills and relocatable drying kilns can be used

to produce seasoned sawn timber for a variety of applications and markets. Mobile debarkers can be used to debark non-durable posts and poles prior to on-site treatment with preservatives or sale to preservation plants. Portable wood chippers may permit the sale of woodchips to wood-based panel processing plants, hardwood and softwood woodchip exporters or pulp and paper mills.

The steps involved in the manufacture of pulp and paper and wood-based panels, with the exception of debarking and chipping, are complex and require capital intensive processing facilities. Pulp and paper and wood-based panel manufacture is therefore beyond the reach of small-scale processors. These processors can, however, follow the processing stream for sawn timber and roundwood right up to final product stage because these products do not require industrial-scale processing facilities. This fact is of particular relevance to Australia because sawn timber dominates the wood product market in this country, in terms of volume of production, imports and consumption. There appears to be an opportunity for the replacement of Australia's substantial sawn timber imports with domestically produced sawn timber, including that produced by farm foresters utilising small-scale processing equipment.

Introduction

It is widely accepted that increased farm forestry activity over the last two decades has provided numerous environmental benefits, such as soil protection from wind and water erosion, salinity control and improved water quality. It has also lead to an increase in the size of the timber resource that is available to the wood processing industries. Problems relating to the marketing of timber from small, dispersed and species diverse forests, however, have meant that many landholders have had to look towards activities that increase the value, and therefore marketability, of their timber. Such activities encompass on-site processing and the sale of value-added timber products.

The aims of the following paper are four fold.

- (i) To present a review of the literature pertaining to;
 - (a) the existing area of native, plantation and farm forest in Australia and the amount of timber currently and expected to be produced from this resource;
 - (b) existing markets for native, plantation and farm forest wood-based products; and
 - (c) technical aspects of the primary processing of native, plantation and farm forest wood.
- (ii) To identify those activities within the primary processing stream that can be undertaken by small-scale wood processors.
- (iii) To present a review of available small-scale wood processing technologies.
- (iv) Identify potential markets for farm forest timber that has been processed on-site.

The Forest Resource

Native Forest

‘Forest’ will be defined for the purposes of this paper as:

‘including native forest with existing or potential stand height of 20 metres or more and cypress pine in commercial use regardless of stand height, but ... [not including] plantations’ (ABARE 1990a; as cited by RAC, 1992a).

This is the definition adopted by the Australian Bureau of Agriculture and Resource Economics (ABARE). It is a commercial definition and describes trees that are of sufficient stature to provide harvestable timber. It has been chosen because the paper is concerned primarily with wood production from Australia’s forest resources.

Based on this definition, the total area of native forest in Australia is estimated to be approximately 40.7 million hectares (as at 30 June, 1993). Of this, 29.4 million hectares (72%) are publicly owned and 11.3 million hectares (28%) are on private land (ABARE, 1995).

Of the publicly owned forest, 6.6 million hectares (22%¹) are in National Parks or World Heritage areas, 12.1 million hectares (41%) are managed by State forest authorities for various uses, including wood production and 10.7 million hectares (36%) are vacant or leasehold Crown land (as at 30 June 1993) (ABARE, 1995). Figure 1 shows the total area of native forest in each state and in each ownership category.

¹ Of the publicly owned forest

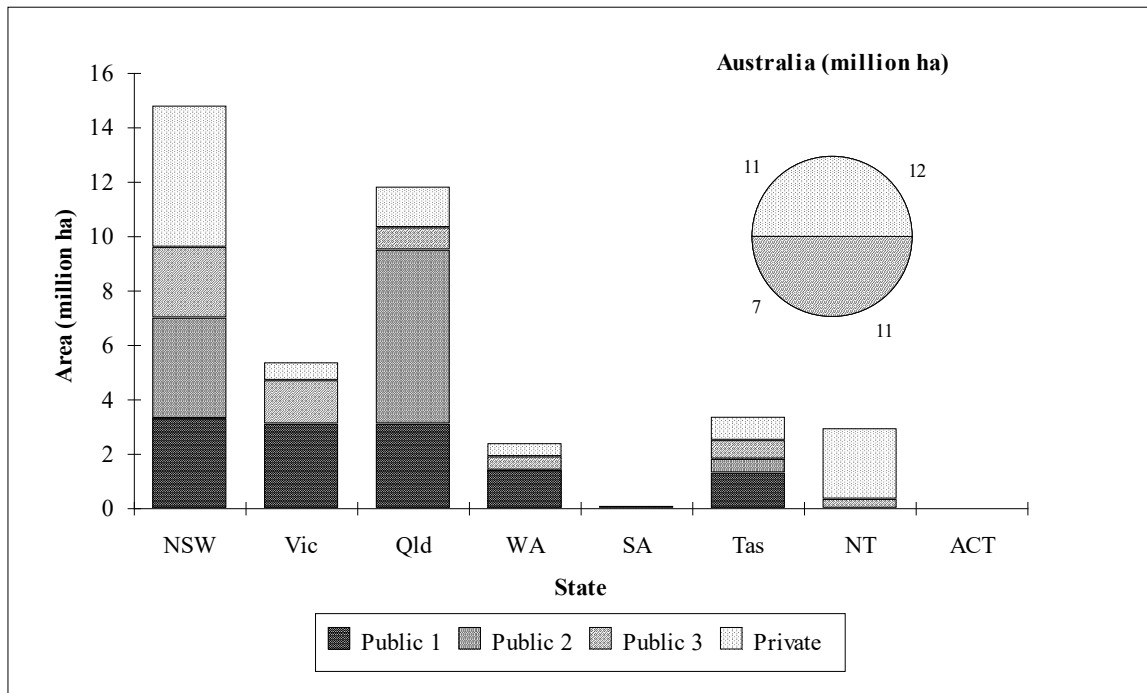


Figure 1: Native forest areas by ownership, as at 30 June 1993.

Note: Public 1 native forest is forest land managed for multiple use including wood production. Public 2 native forest is crown land either vacant or occupied under lease on which wood harvesting is carried out under government control but is not reserved and managed for that purpose. Public 3 native forest is land on which wood production is excluded (National Parks etc.) (Source: ABARE, 1995).

According to the Resource Assessment Commission (RAC) (1992a), the area of forested land held under state forest tenure has increased steadily since the 1940s in each state except Western Australia and Victoria, where reallocation of state forest to conservation reserves occurred during the 1970s and 1980s. As well as this, there has been an increase in the area of forest in conservation reserves in all states and territories (RAC, 1992a).

The increase in area of both state forest and conservation reserves was achieved in all states except Tasmania by reallocation of other crown land that is forested. The area of privately owned forest has changed little (RAC, 1992a).

The main native forest groups in Australia include rainforests and mangroves (8 per cent), *Eucalyptus* (60 per cent) and mixed woodland (the native pine and open forests) (33 per cent). The *Eucalyptus* resource in state forest is the principal source of raw material for the wood and wood products industry (RAC, 1992a).

All public native forest outside conservation reserves and all private forest is potentially available for timber production, although a number of constraints reduce the area of land that is actually available. For publicly owned forest, these constraints include the inaccessibility of the resource, the economic feasibility of timber extraction, and the setting aside of specified areas of production forest under management codes of practice. The availability of privately owned forest for timber production is also influenced by accessibility and financial considerations, and by the intentions of the landowner (RAC, 1992a).

The gross area of production forest in Australia is approximately 33.4 million hectares. The net available area (that is, excluding areas that are inaccessible, that are uneconomic to log, and that are excluded from logging by management codes of practice) is approximately 22 million hectares. It may therefore be said that approximately 65 per cent of the gross timber production resource is potentially available for timber production. This figure, however, is subject to qualification as it represents the average across state forest (62 per cent), other crown land (64 per cent) and private forest (67 per cent), even though not all the potentially available private forest is used for timber production. As well as this, according to the National Association of Forest Industries, Crown lands are mostly low productivity forests leased for cattle grazing and only approximately 5 per cent of annual log removals come from these forests (RAC, 1992a).

As previously stated, the major timber production tenure is state forest, and around 7.1 million hectares of state forest are available for logging (RAC, 1992a).

Plantations

Australia's plantation forests are generally confined to high rainfall areas along the eastern seaboard, the south-eastern region of South Australia and the south-western region of Western Australia, although some plantations have been established in highland and tableland regions of New South Wales and Victoria (Stephens *et al.*, 1993).

Australia had approximately 1.1 million hectares of plantations - 959,000 hectares of softwood and 146,000 hectares of hardwood species - as at 30th June 1993 (ABARE, 1995). Over the past three decades, Australia has experienced a significant increase in the area of its plantation forest estate. The 1960s and 1970s were major growth periods for plantations in this country. Public plantations increased by 113 per cent in the 1960s and by 68 per cent in the 1970s, and private plantations increased by 119 per cent and 82 per cent respectively. The Commonwealth and State governments have actively promoted plantation development, through such initiatives as the Softwood Forestry Agreement Acts (1967 and 1972) and, more recently, the National Afforestation Program (Stephens *et al.*, 1993).

In March, 1993, approximately 70 per cent of all plantation forests in Australia were publicly owned, representing 73 per cent of the softwood and 44 per cent of the hardwood plantation estate (ABARE, 1995). Figure 2 shows the area of plantation forests in each state in both public and private ownership.

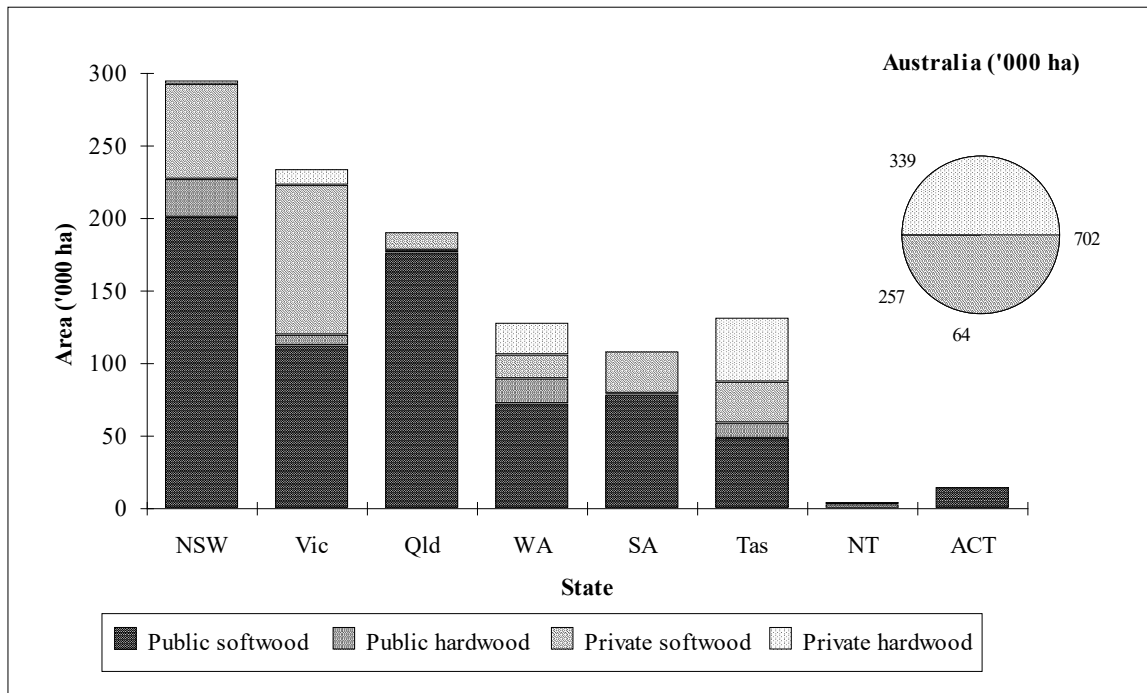


Figure 2: Softwood and hardwood plantation areas as at 31 March, 1993 (Source: ABARE, 1995)

Publicly owned plantations are predominantly managed by State and Territory forest agencies. The owners of private plantation forests range from large forestry and investment companies to individuals such as farmers (Stephens *et al.*, 1993).

Most of the softwood plantation resource owned by large forestry companies is in very significant areas, from around 4000 hectares to over 40,000. Investment company forests range from around 2500 hectares to nearly 20,000. Farm woodlot, pine-pasture, and agroforestry plantings are smaller and comprise the major part of the 22,000 hectares in holdings of 200 hectares or less (Sebire, 1984; as cited by Lewis and Ferguson, 1993). According to Hall (1990; as cited by Lewis and Ferguson, 1993), non-corporate private growers own some 17 per cent of the private area of plantation, or about 5 per cent of the total plantation area.

Softwood plantations were established at an average rate of approximately 27,000 hectares per year in the period 1987-88 to 1992-93. The rate of establishment has decreased from a high of 35,000 hectares per annum observed in 1988-89 to approximately 20,000 hectares per annum in 1992-93²(ABARE, 1995).

The predominant softwood plantation species is Radiata Pine (*Pinus radiata*). This species accounts for approximately 75 per cent of the total coniferous plantation area. Slash Pine (*P. elliottii*) and Caribbean Pine (*P. caribaea*) have also been extensively planted in subtropical regions of northern Australia (Stephens *et al.*, 1993). Figure 3 shows the areas that are occupied by different softwood species in each State.

² The last year for which figures are available for all Australian states

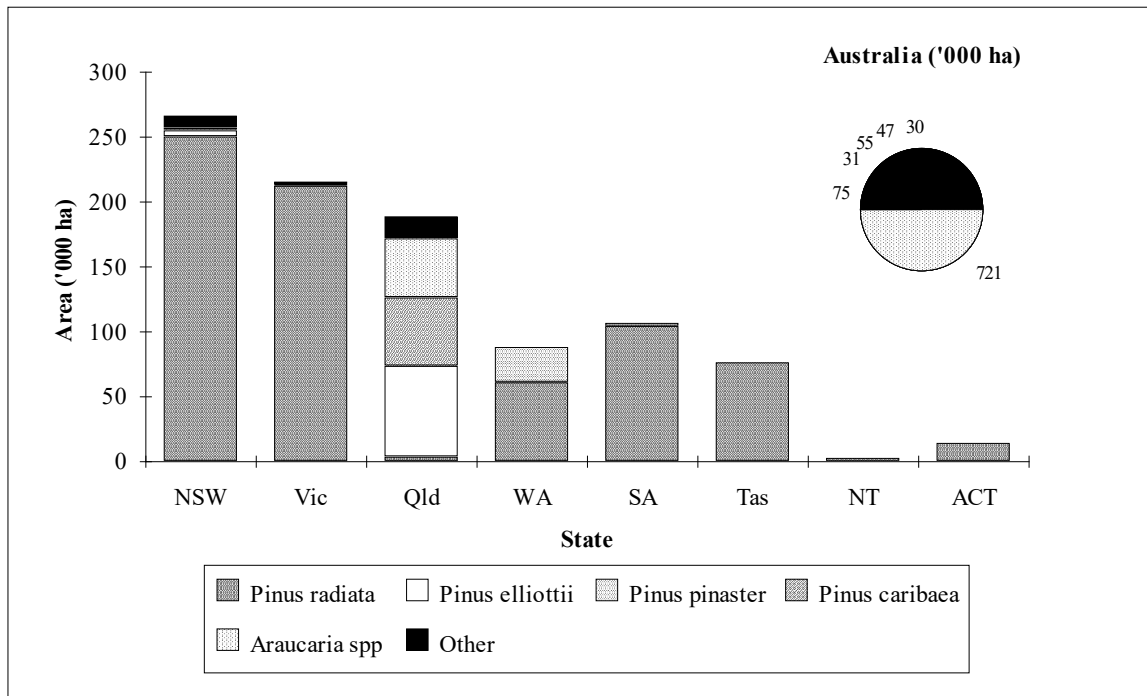


Figure 3: State softwood plantation areas, by species, as at 31 March 1993 (Source: ABARE, 1995).

The establishment of hardwood plantations has been slower than that of softwood plantations because of the abundance of native forest hardwoods and because of the rapid growth rates achieved by softwood plantation species. However, the rate of hardwood plantation establishment is increasing in view of the expansion programs of private forestry concerns and the uncertainty of guaranteeing long term supplies of pulpwood from publicly owned native forest (AFC, 1989).

The average annual rate of planting of hardwood plantations over the period 1987-88 to 1992-93 has been 9800 hectares. The rate of establishment reached a high of 14,000 hectares per year in 1992-93 (ABARE, 1995).

In general, hardwood plantations are based on eucalypts. The predominant species are Mountain Ash (*Eucalyptus regnans*), Tasmanian Blue Gum (*E. globulus*), Shining Gum (*E. nitens*), Flooded Gum (*E. grandis*), Blackbutt (*E. pilularis*) and Karri (*E. diversicolor*). Figure 4 shows the areas that are occupied by different hardwood species in each State.

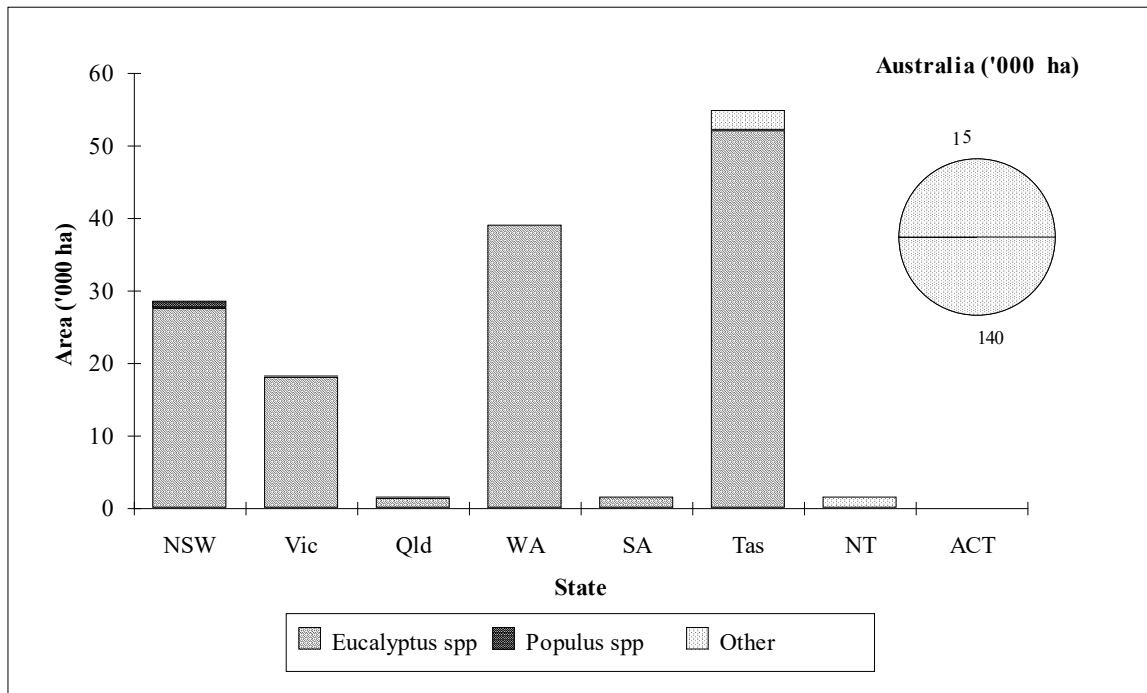


Figure 4: State hardwood plantation areas, by species, as at 31 March 1993 (Source: ABARE, 1995)

Production from the Resource

In 1994-95, removals of roundwood from Australian forests amounted to 19.1 million cubic metres. Of this, 9.6 million cubic metres was hardwood (which is sourced predominantly from native forests) and 9.5 million cubic metres was softwood (which is sourced predominantly from plantations) (ABARE, 1995). Figure 5 shows the removals of both hardwood and softwood roundwood from Australian forests during the period 1951-95. As can be seen, the volume of softwood roundwood removed has increased dramatically since 1951 so that it now compares favourably with the volume of hardwood roundwood removed. This is due to a number of factors, namely:

- an increase in the area of softwood plantations; and
- a decrease in the area of native forest available for timber production.

The importance of plantations can be appreciated when it is considered that, although the area under plantation forest was just over one million hectares in March 1991, or 3 per cent of forest area potentially available for wood production, approximately one third of the volume of domestic logs supplied to the processing sector originated from plantation forests (ABARE, 1992a; as cited by Stephens *et al.*, 1993).

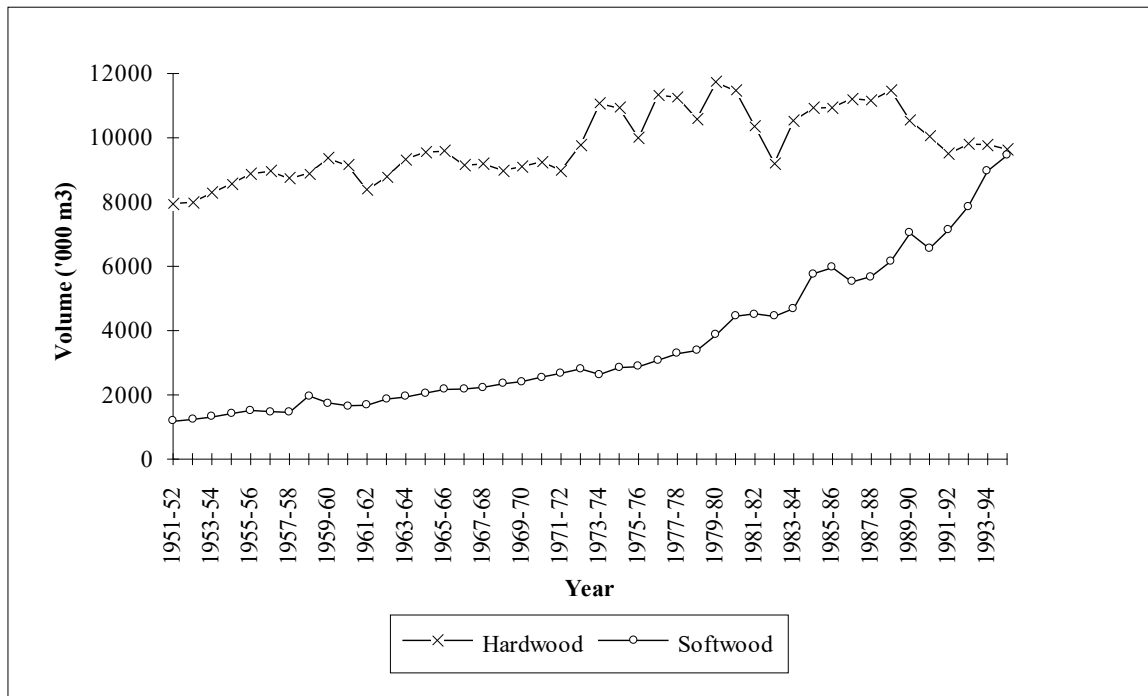


Figure 5: Hardwood and softwood roundwood removed from Australian forests during the period 1951-95.
(Source: ABARE, 1995)

The roundwood that is harvested from Australia's forests can be divided into a number of major product classes, namely:

- saw and veneer logs;
- sleeper logs;
- pulpwood (for wood-based panel products and paper and paperboard);
- fencing materials;
- mining materials;
- poles and piles; and
- other materials.

The proportion of roundwood harvested falling into each product class is given in figures 6 and 7.

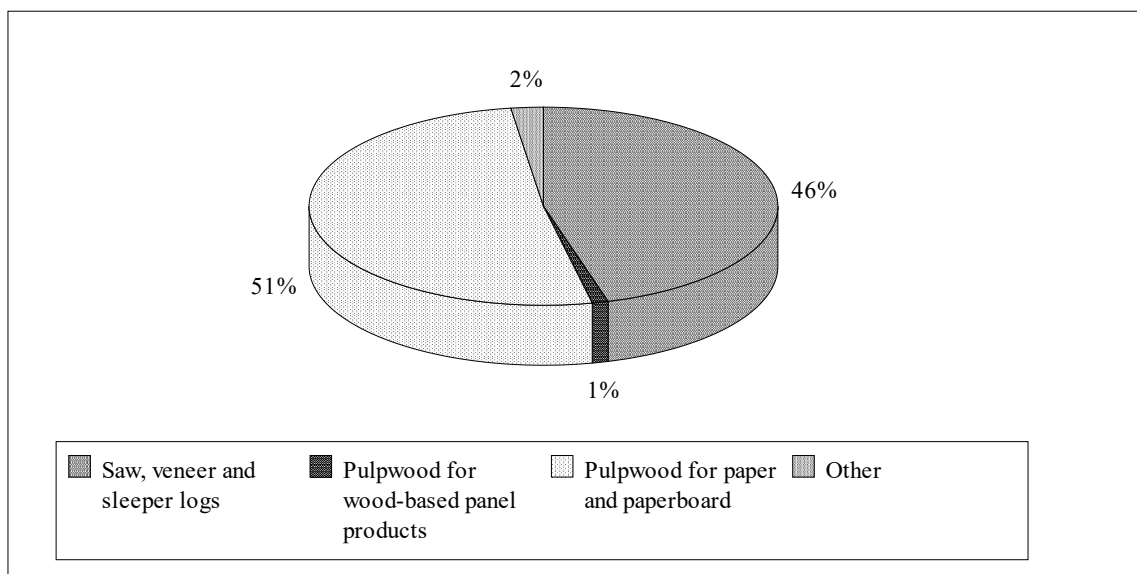


Figure 6: Hardwood roundwood harvested by product type, 1993-94

Note: 'Other' includes fencing materials, mining materials, and posts and piles. (Source: ABARE, 1995)

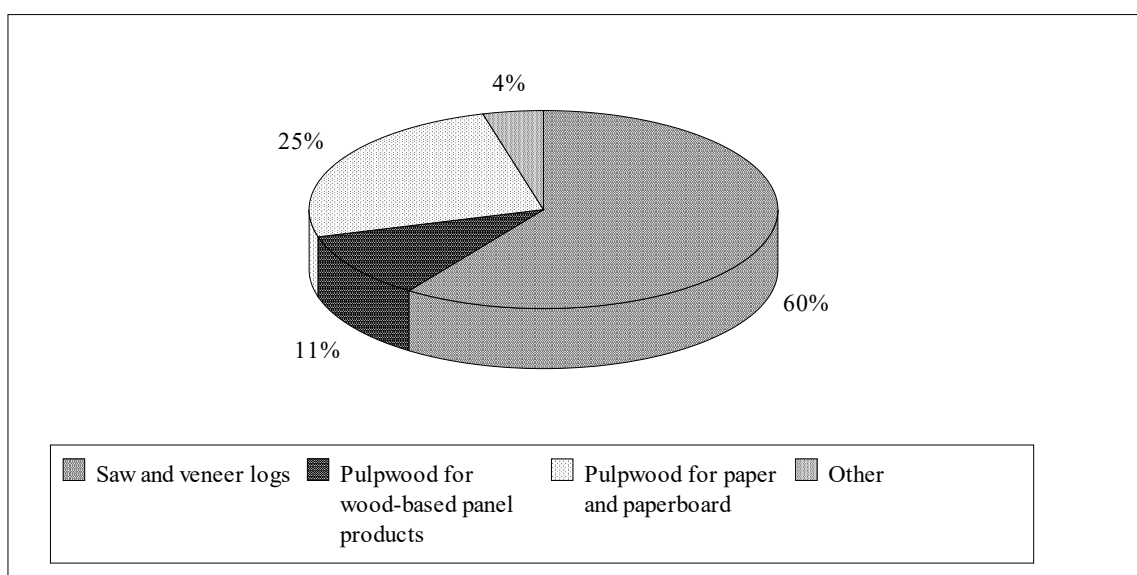


Figure 7: Softwood roundwood harvested by product type, 1993-94 (Source: ABARE, 1995)

Future Wood Availability

Numerous studies in recent years have dealt with the future availability of wood from Australia's forests. Summaries of these studies can be found in RAC (1992b) and in Cameron and Penna (1988). Most are based on the projections made by the Forest Resources Committee of the Australian Forestry Council in 1981 and revised by the same committee in 1989 (AIC, 1993).

In estimating future availability of logs, AFC (1989) assumed that current methods, rates, economics etc. of harvesting and utilisation would continue, that

planned rates of plantation establishment would be realised and that no further large tracts of native forests would be alienated from wood production.

AFC's (1989) estimates are given in Table 1.

Table 1: Estimates of future log availability ('000 m³)

<i>Year</i>	<i>1990</i>	<i>2000</i>	<i>2010</i>	<i>2020</i>	<i>2030</i>
Softwood					
Sawlogs	4,111	6,806	8,608	9,675	9,742
Other logs	4,953	5,076	5,159	5,393	5,404
Hardwood					
Sawlogs	4,061	5,327	3,514	3,626	3,494
Other logs	8,601	8,649	9,179	8,951	8,750
Totals					
Sawlogs	8,172	10,333	12,122	13,301	13,236
Other logs	13,554	13,725	14,338	14,344	14,154
Grand total	21,726	24,058	26,460	27,645	27,390

(Source: AFC, 1989)

As can be seen, the overall availability of sawlogs is expected to increase by about 60 per cent over the projection period, with availability of softwood sawlogs more than doubling and hardwood sawlogs declining by 12 per cent. The availability of pulp logs is estimated to remain more or less constant (AFC, 1989).

Farm Forestry in Australia

The Benefits of Farm Forestry

Before proceeding, it is pertinent to define what is meant by farm forestry. Inions' (1995) definition of farm forestry will be adopted for the purposes of this paper. According to Inions (1995) farm forestry is:

'the practice of establishing, tending and marketing forest products grown on cleared agricultural land in such a manner and in such configuration as to be complementary to traditional agriculture'.

Numerous authors attest to the potential benefits of farm forestry, to Australia in general and farmers and local communities in particular (for example, Gordon (1996) and Bird *et al.*, (1996)). Race and Curtis (1996a) state that:

"Farm forestry in Australia is increasingly promoted as a national strategy likely to deliver important benefits in terms of: expanding opportunities for commercial wood production, assisting the move to more sustainable agriculture and enhancing regional development"

According to Fargher (1996), farm forestry has the potential to:

- provide environmental services, such as improvements to water quality;
- diversify agricultural enterprises;

- enhance agricultural production by providing shade and shelter;
- increase the sustainability of land management practices;
- contribute to land rehabilitation;
- enhance habitats and biodiversity conservation; and
- enhance aesthetic values in the landscape.

Farm forestry could also contribute to the expansion and diversification of timber supplies and thereby reduce pressure on Australian and south-east Asian native forests (Race and Curtis, 1996b). Many authors make specific reference to the potential of farm forestry to supplement the products harvested from Australia's native forests (for example, Wilson *et al.* (1995)), while others stipulate that farm forestry can assist in reducing the nation's current account deficit through import replacement and export (for example, Race and Curtis (1996b) and Bird *et al.* (1996)). Fargher (1996) maintains that, once integrated into Australia's forest industries, farm forestry can reduce the need for industry capital to be locked up in land assets.

According to the Commonwealth Government's Wood and Paper Industry Strategy (Commonwealth Government, 1995), plantations and farm forestry represent the best sources for future growth in the wood and paper industry.

Inions (1995) lists five factors that he believes are responsible for the rapid escalation of farm forestry activity in Australia. These five factors are:

- environmental considerations;
- reduced agricultural returns;
- the stability of farm forestry returns;
- the need for the forest industry to find alternative land bases; and
- the availability of tax deductions.

Bird *et al.* (1996) outline the various factors that will influence the adoption of farm forestry in the future, and identify the current constraints to the adoption of farm forestry enterprises.

The Extent of Farm Forestry Plantings

Fargher (1996) states that the soils, climate and landscape of more than 18 million hectares of cleared agricultural land are suitable for farm forestry. Of this, 5 million hectares (27 per cent) is highly suitable.

There are no comprehensive statistics relating directly to the extent of farm forestry plantings in Australia. A number of recent surveys however provide a general picture of the state of farm forestry in Australia.

Native Forests

As previously mentioned, private forests account for 28 per cent of the total area of native forest in Australia. According to the Australian Bureau of Statistics (1987; as cited by Loane, 1990), there were 1.2 million hectares of bushland, scrub, native forest and hardwood plantations on Victorian farms in 1985-86. About half of the forested area was in the higher rainfall eastern districts and about a third was in the drier western zone (Dymovsky and Kennedy, 1983; as cited by Loane, 1990).

According to Wilson *et al.* (1995), approximately 81 per cent and 68 per cent of farms in the wheat-sheep and high rainfall zones³ of Australia respectively, have some areas of native forests or woodlands. The national average area per farm of these forests and woodlands was 348 hectares in the wheat-sheep zone and 163 hectares in the high rainfall zone. Few farmers listed the main function of the forests and woodlands as being for the production of pulpwood, sawlogs and non-timber products for sale (Wilson *et al.*, 1995).

Plantations

Farmers and other private owners not identified as industrial or investment companies accounted for 6 per cent of the softwood plantation area and 9 per cent of the hardwood plantation area in Australia in 1987 (AFC, 1989; as cited by Loane, 1990). According to Prinsley (1991) there were 60,000 hectares of private plantation on farms in 1991.

Agroforestry

The area under Agroforestry in Victoria in 1991 was approximately 570 hectares of which 78 per cent was hardwood and 22 per cent was softwood species. Of the total planted area, 20 per cent, 30 per cent, and 50 per cent respectively were for research, demonstration and production purposes (Wareing, 1991).

Timber belts totalled 8.6 kilometres. Seventy-five per cent of their length consisted of hardwood species and 25 per cent consisted of softwood species. Their main purposes were for research and demonstration (Wareing, 1991). By the year 2020 it is estimated that up to 30,000 hectares of farmland could be planted to agroforestry in Victoria (0.3 per cent of agricultural land) (JAMC, 1991).

A survey of 260 South Australian farmers active in tree planting in 1988 found that the average area planted was 6 hectares (about 1 per cent of the average property area of about 630 hectares). An average of 8 hectares was regenerated by other means and there was, on average, 61 hectares of native vegetation per property (Loane, 1990). The most common purpose of tree establishment was the provision of shelter. Other purposes included aesthetics, conservation, and erosion and salinity control. Wood production accounted for only 7 per cent of the total number of purposes reported (Howett and Lothian, 1988; as cited by Loane, 1990).

³ Refer to Wilson *et al.* (1995) for definitions of these two agricultural zones.

A 1989-90 survey (Prinsley, 1991) of farmer organisations, Landcare groups, and farm-tree groups revealed that approximately 26 per cent of Australian farmers had planted trees in the preceding two years. Most of these farmers were in Victoria and Western Australia. However, tree plantings were undertaken primarily for reasons other than timber production, such as the provision of shade and shelter. Only 5.8% of farmers were planting trees for pulpwood and sawlog production. This percentage, however, rose to 13.7% of farmers in areas which receive more than 650 mm rainfall per annum (Prinsley, 1991).

ABARE's 1990-91 survey of land management practices indicated that 44 per cent of all broadacre and dairy farmers planted trees on their farms in that year (ABARE, 1992; as cited by Wilson *et al.*, 1995). This survey revealed that farmers primarily planted trees for stock shelter and that a relatively small portion of farmers planted trees that year exclusively for wood production.

ABARE's 1994 survey of trees on Australian farms found that as of 30 June, 1994, 35 per cent of broadacre and dairy farmers had planted tree belts and corridors, 14 per cent had planted tree blocks, 6 per cent had planted alley belts and 6 per cent had planted widely spaced trees. The average area of these plantings was 5 hectares for tree belts and corridors, 12 hectares for tree blocks and 10 hectares for alley belts. An average of 406 widely spaced trees were planted (Wilson *et al.*, 1995).

Planting trees to produce timber or non-timber products for sale was of relatively minor importance except in the high rainfall zones of Queensland and South Australia, where there were frequent plantings for the production of sawlogs, and Western Australia and Tasmania, where there were numerous plantations for pulpwood production. Twenty six per cent of farmers in Victoria's high rainfall zone planted trees for the sale or on-farm use of other wood products (Wilson *et al.*, 1995).

Nationally, 35 per cent of farmers planted at least 20 trees in the three years preceding the survey (1991-92 to 1993-94). This recent tree planting activity has been concentrated in Western Australia and Victoria. Tree belts and corridors have been the most common planting pattern (63 per cent), with an average of 657 trees per planting. Twenty per cent of recent plantings were in tree blocks, with an average area of 5.1 hectares per planting, while alley belts and widely spaced trees averaged between 3.8 and 5.7 hectares per planting and accounted for only 8 and 9 per cent of the plantings respectively (Wilson *et al.*, 1995).

The provision of shade and shelter was the most common purpose of recent plantings. The next most common reason was to rehabilitate or protect degraded land. Less than 2 per cent of farmers, in both the wheat-sheep and high rainfall zones, listed the production of timber and non-timber products as the main function of tree plantings. This finding is further reinforced by the modest percentage of farmers in these two zones planning to harvest their most recently established stand of trees (Wilson *et al.*, 1995).

Nationally, the proportion of farmers who harvested trees during the period 1991-92 to 1993-94 was only 3 per cent (Wilson *et al.*, 1995).

General plantings

The number of trees planted in 1988 in Victoria was estimated to be 411,000 for farmers, Farm Tree groups, and Landcare groups out of the total of 24 million (Loane, 1990).

The Economic Benefits of Farm Forestry

Calculations made by the Centre for International Economics indicate that once farm forestry reaches sustainable harvest levels the annual contribution to Australia is potentially in the order of \$3.1 billion a year, including \$2.5 billion worth of increased crop yields and \$363 million in non-market community benefits. If all the shelterbelts responsible for these benefits to farmers and the community were harvested and the wood sold, the annual supply of hardwood sawlogs would triple and that of softwood pulplogs would increase by a factor of six. After 40 years, given the same input requirements for the different processing activities, the processed wood would be worth approximately \$20 billion (Gordon, 1996).

The value of timber obtained from the 30,000 hectares of agroforests expected to be planted in Victoria by the year 2020 was estimated in 1991 to be approximately \$9 million per annum. This equates to a wood volume of 0.47 million cubic metres per annum and an average timber value of \$18.40 per cubic metre (JAMC, 1991). It is assumed that this figure represents the value of the standing tree. It is a relatively low figure - comparable to the prices received for small diameter softwood sawlogs⁴ (\$17-20/m³), D grade hardwood sawlogs (\$15/m³) and softwood and hardwood pulpwood (\$7-17/m³ and \$8-15/m³ respectively). It contrasts with the prices received for larger diameter softwood sawlogs⁵ (\$23-63/m³), A to C grade hardwood sawlogs (\$30-50/m³) and various speciality timbers (\$40-400/m³) (Loane, 1993). Prices received for processed timber are even further removed. Green sawn hardwood can fetch between \$350 and \$450 per cubic metre, and kiln-dried sawn hardwood retails for between \$1100 and \$3000 per cubic metre (Race, 1994). A price range of between \$300 and \$600 has been quoted for farm sawn timber of various species in north east Victoria (Anon., 1993).

There are clear opportunities for landholders to increase the value of their timber by engaging in on-site processing. This subject, as well as the general processes involved in the manufacture of a range of forest products, will be covered in the following section.

Wood Processing

The aim of the following section is to present a brief overview of the Australian forest products industry and the processes involved in the production of sawn timber, wood-based panels and paper products. This will be done with a view to

⁴15-20 cm

⁵ > 20 cm

identifying those steps in the manufacturing process that can be undertaken by farmers and small-scale processors.

The Australian Forest Products Industries

The key forest product industries in Australia are:

- the roundwood and sawn timber industries, which produce sawn wood products and round and hewn timbers of all kinds;
- the wood-based panels industry, which produces veneer and veneer products, plywood, and particle and fibreboards; and
- the pulp and paper manufacturing industries, which produce wood pulps, and paper and paperboards of all kinds.

These industries acquire wood from a variety of public and private sources (public old growth and new growth forests, public and private plantations, and private property primarily used for agricultural purposes). The present industry structures are characterised by extensive vertical integration (primarily in the pulp and paper sector) and a degree of horizontal integration by the larger sawn timber producers. In general, output from each forest products industry is dominated by a small number of relatively large producers (AIC, 1993).

Sawn Timber Production

The Australian Sawn Timber Industry

The sawn timber (sawmilling) industry has two components, traditionally referred to as the log sawmilling sector and the re-sawing sector. The latter may be referred to more accurately nowadays as the sawn import sector.

The sawmilling industry is the largest and most geographically dispersed processor of wood in Australia. There are approximately 1070 hardwood and 235 softwood sawmills in operation (RAC, 1992a; Commonwealth Government, 1995).

Hardwood Sawmilling

Hardwood sawmilling is the major exception to the concentration of production generally seen in the forest products industry. Although there are some large companies involved - such as Boral and Bunnings - hardwood sawmilling is fragmented and the average scale of production is small. Most hardwood sawmills are labour intensive and independently owned. According to the Australian Industry Commission (AIC, 1993) there have been significant reductions in the number of hardwood sawmills in recent years. For example, Victorian sawmill numbers have fallen by 80 per cent over the last 20 years. In 1992-93, approximately 67 per cent of Australian hardwood sawmills had an annual log intake of less than 3000 cubic metres (ABARE, 1995). Table 2 categorises sawmills on the basis of annual log intake.

Table 2: Number of sawmills, by log intake.

<i>Cubic metres per year</i>	<i>Hardwood</i>		<i>Softwood</i>		<i>Total</i>	
	<i>1992-93</i>	<i>1993-94p</i>	<i>1992-93p</i>	<i>1993-94p</i>	<i>1992-93</i>	<i>1993-94p</i>
< 3,000	791	735	91	98	882	833
3,000 - < 15,000	285	247	68	77	353	324
15,000 - < 45,000	88	71	37	34	125	105
45,000 - < 75,000	11	11	5	8	16	19
75,000 - < 100,000	3	3	6	4	9	7
> 100,000	2	6	18	14	20	20
Total	1,180	1,073	225	235	1,405	1,308

Note: p = preliminary
(Source: ABARE, 1995)

Variations in the physical dimensions and in the quality of Australian hardwoods have complicated the adoption of automated processing and contributed to fragmentation within the hardwood sawmilling industry. Other factors (for example, log allocation procedures and the availability of suitable logs) are also believed to have delayed rationalisation (AIC, 1993).

Softwood Sawmilling

Softwood sawmilling establishments are considerably larger, on average, than hardwood sawmills. In general, softwood mills are capital intensive and technologically advanced (RAC, 1992a). A small number of large producers, namely CSR, Boral, Brown and Dureau (owned by AMCOR), Australian Forest Industries (owned by Bowater Industries), SEAS Sapfor and plants owned and operated by the South Australian Government in the Mount Gambier region account for the bulk of Australian production (AIC, 1993).

Sawmilling

The basic steps involved in the production of seasoned sawn timber are outlined in Figure 11. Sawmills are characterised by the timber resource they cut, their size, the type of machinery used to break down the logs, and their degree of automation (Walker, 1993). As such, minor variations to the following order of operations do exist. Shaded boxes in Figure 8 represent those processes that lend themselves to on-site timber processing.

Debarking

Debarking prior to sawing is often a necessity as bark can pick up sand and dirt during logging, transportation and handling in the mill yard. Its removal reduces saw tooth damage and wear. A reduction in wear results in longer time intervals between saw sharpening and consequently, higher rates of production, as well as reduced saw sharpening costs. It also allows better exposure of the log shape and any defects that may be present. The miller is in a better position to make decisions that lead to better sawlog conversion and grade recovery (FAO, 1981, Walker, 1993).

Materials are more easily handled with reduced fouling of saws and transfer systems and clean, bark-free chips (from sawmill residues) and slab wood command a better price (Walker, 1993).

Debarking can be carried out in the forest (in the stand itself or at log landings) or at the sawmill. One of the advantages of debarking in the forest is that the weight and volume of the timber is reduced for transport over land (Staaf and Wiksten, 1984). Debarking of logs at the mill also has its advantages, however. It can be easily integrated into what are often highly automated facilities and the bark can also be used as a fuel or sold for some other purpose. If there is no market for the bark, however, taking it to the mill simply increases transport costs and creates disposal problems (Wingate-Hill and MacArthur, 1991).

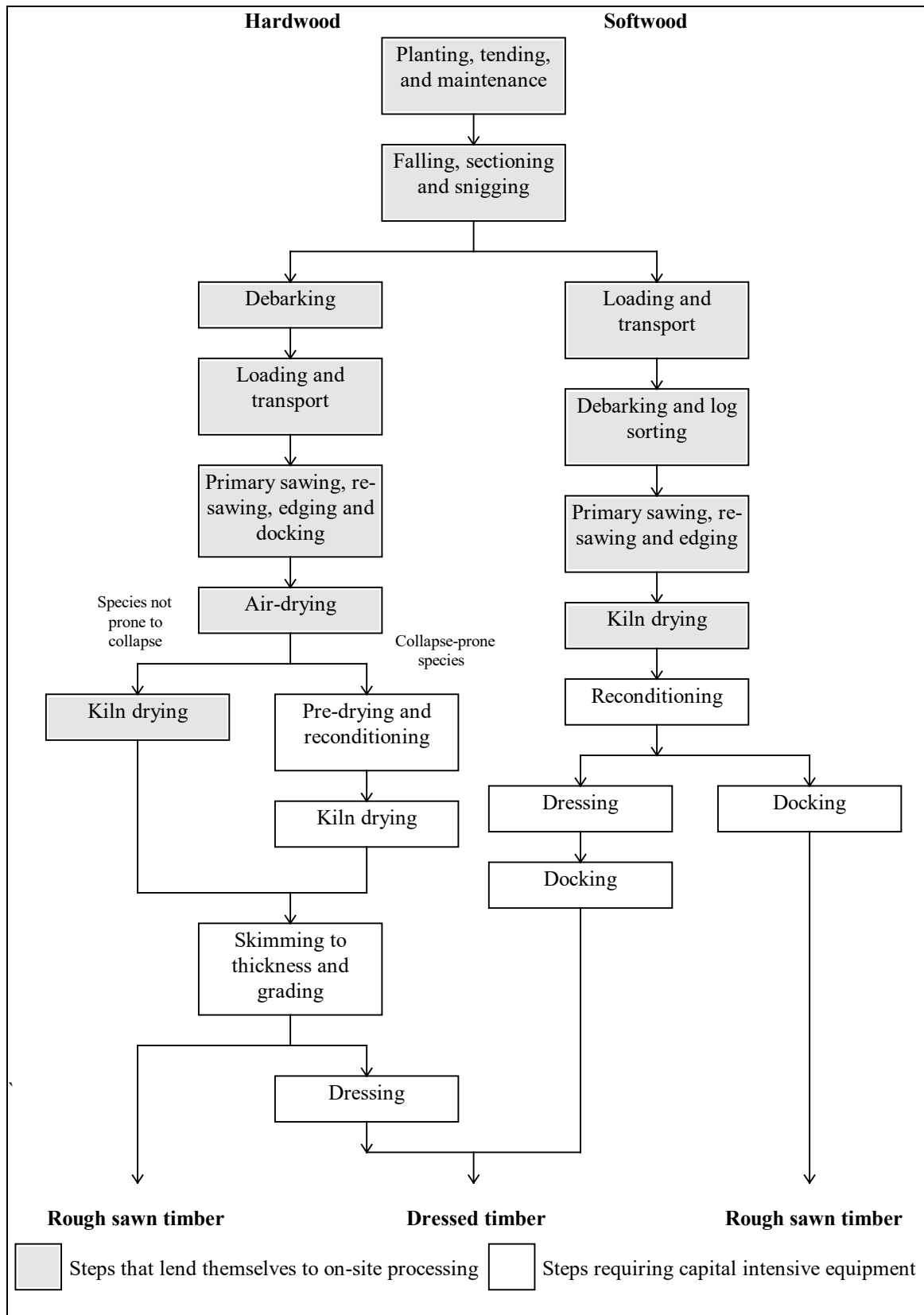


Figure 8: Steps involved in the manufacture of hardwood and softwood sawn timber (Adapted from Thurlow, 1988).

Staaf and Wiksten (1984) recognise three types of debarker, based on the technical means employed in debarking and describe the characteristics of each. These debarkers include knife, cutter and ring (rotor) debarkers (commonly employed

in softwood sawmills). They also describe trough debarkers, in which friction is used to separate the bark from the wood. Wingate-Hill and MacArthur (1991) investigated the use of various types of debarker for debarking small diameter eucalypts in the stand, at the log landing and at the processing plant, including compression, water hydraulic, drum, trough and chain flail debarkers.

Primary Sawing, Re-sawing, Edging and Docking

Primary sawing, re-sawing, edging and docking are processes enabling the progressive breakdown of logs into boards or larger dimension timber. The saws used include circular saws, bandsaws, frame or gang saws and chipper canterers. The headrig, which is responsible for primary sawing, can consist of either a single or double arbor circular saw, a single or double edged bandsaw, a frame or gang saw, or a chipper canter. The choice of saw depends primarily on the size and uniformity of the logs being processed. Resaws, edgers and docking saws are commonly circular saws as these saws are cheaper and more robust than other alternatives (Walker, 1993).

The cutting pattern employed in primary sawing is determined by the available saws, the log quality and size, market demand, and the skills of the sawyer. Three basic sawing patterns are recognised: live sawing ('sawing through and through'), sawing around and cant-sawing. These patterns are represented in Figure 9.

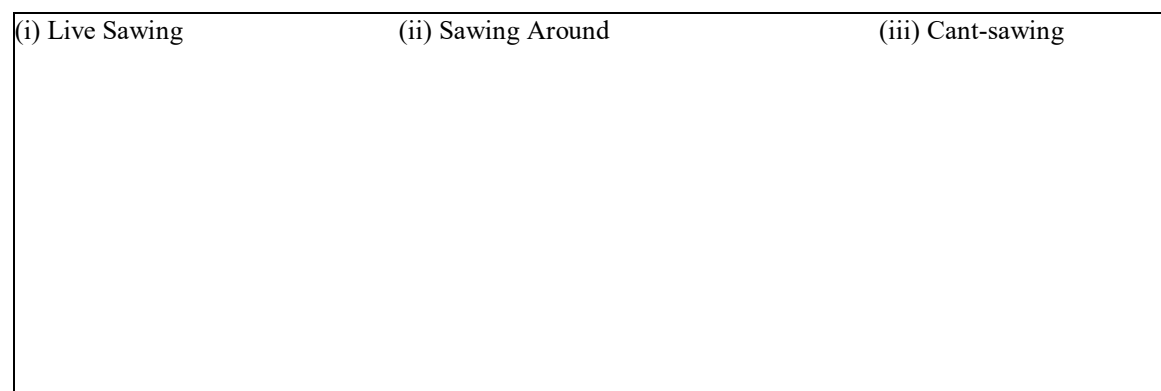


Figure 9: Live sawing, sawing around, and cant sawing (Source: Walker, 1993).

Live sawing involves cutting a small amount off one side to provide a level base for the log and then, after turning it onto this base, making a series of parallel cuts without any further turning of the log. This is the common method for large scale production utilising small sized logs of good form and few defects. It is not suited to the processing of defective logs and the production of varied sizes and qualities as a mixture of grain directions is obtained, resulting in a large amount of seasoning degrade (Bootle, 1983), and there is an increased incidence of large spike knots which lower the recovery of higher grades, particularly in softwoods (Walker, 1993).

Sawing around involves altering the position of the log during sawing in order to avoid any major defects (Bootle, 1983). It is only suitable for large logs (>500 mm) (Walker, 1993), and, according to Bootle (1983) can involve back-sawing or quarter-sawing. Back-sawing aims for the production of boards with faces roughly tangential to the annual growth rings and at right angles to the rays. Such a sawing method

enables a greater speed of production, simpler milling (than quarter-sawing) and higher grade timber to be recovered from faulty logs (Bootle, 1983).

Quarter sawing involves cutting as many boards as possible with their faces parallel to the rays. A minimum log diameter of approximately 450 mm small-end diameter is often required for quarter sawing (Waugh and Rozsa, 1991).

Sawing can involve split-taper, which involves sawing parallel to the central axis of the log, and full-taper, involving sawing that is parallel to the cambium. The merits of each method are outline in Walker (1993).

Drying and reconditioning

Proper drying is a prerequisite for the efficient and economic utilisation of timber. It is carried out in order to:

- minimise degrade and problems such as staining, warping, cellular collapse, case hardening, honeycombing and checking;
- ensure that all shrinkage has occurred before the timber is used;
- obtain a better surface finish before gluing, painting, or polishing;
- make it less susceptible to decay;
- facilitate impregnation with preservatives;
- reduce transport costs; and
- encourage more efficient burning (dry wood is a much better fuel) (Walker, 1993; Groves, 1990; Bootle, 1983).

There are two ways of drying timber - air-drying and kiln-drying. Air-drying involves the stacking of timber under shelter and allowing the timber to dry slowly, to a moisture content that is in equilibrium with the surrounding atmosphere (which can be as high as 20 per cent and as low as 6 per cent). This particular drying method suits many impermeable or collapse-prone species, larger sized timber members and items for exterior use which do not require a low moisture content (Thurlow, 1988). Air-drying is often required because kiln-drying of green, impermeable hardwoods takes too long and is uneconomic. In such cases, timber is first air dried to around the fibre saturation point⁶ before being kiln dried (Walker, 1993).

Predrying enables some control over the drying elements (relative humidity, air temperature, and the flow of air across the timber surface) and thereby decreases overall drying times (predrying times can be reduced by a factor of four or more compared to air-drying). Predriers usually consist of a large enclosure containing a number of parallel lines of timber stacks. They are provided with a fan and a source of heat which is provided on a continual basis (Bootle, 1983).

Kiln-drying requires greater technical skill than air-drying and involves higher capital investment. It is, however, much faster than air-drying and accurate control of the drying elements reduces the amount of degrade in the stack. Many hardwoods can be dried in three weeks or less (although some must be partially air-dried to fibre

⁶Fibre saturation point is defined as the moisture content at which all the water in the cell lumen and intercellular spaces has been removed but at which the cell walls are still fully saturated (Walker, 1993)

saturation point (25-30 per cent moisture content) beforehand) and most softwoods can be kiln-dried in less than a week (some in a few hours). Softwoods can be economically kiln-dried immediately after sawing (Bootle, 1983). Kiln-drying is essential if drying to low moisture contents (<18 per cent). Usually timber is dried to a moisture content of 10-15 per cent for high quality end uses (Howell, 1993).

Folkema (1995) recognises four types of kiln:

- conventional steam kilns, which are the standard kilns for the drying of softwood;
- dehumidification kilns;
- solar kilns; and
- vacuum kilns.

There are also high temperature kilns, for the drying of plantation softwoods (especially thinnings), and microwave kilns.

Steam reconditioning of both hardwoods and softwoods is carried out to remove some of the loss of cross section in boards due to collapse (an excessive form of shrinkage) (Rozsa, 1993).

Post, Pole and Pile Production

The steps involved in the production of posts, poles and piles are outlined in Figure 10.

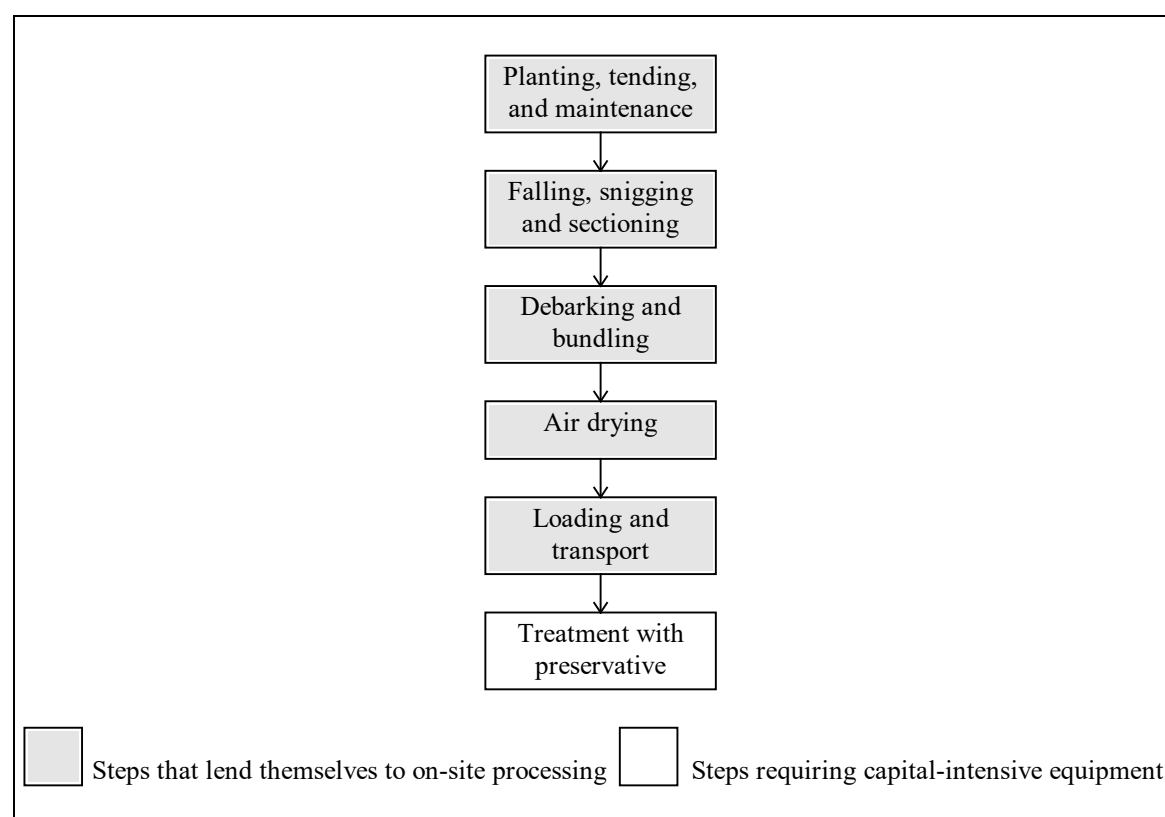


Figure 10: Steps involved in the manufacture of treated posts, poles and piles.

Preservation

Not all posts, poles or piles need to be treated with preservatives. Preservation is often required because the wood of various species can be destroyed by decay and insect attack. For example, radiata pine thinnings are the major raw material of the treated post and pole industry. These thinnings often consist almost entirely of non-durable sapwood (Jolliffe, 1967). The various wood preservatives are classified into three main groups, as a function of the liquid phase in which they are carried into the wood:

- oil borne preservatives, such as creosote, pigment emulsified creosote (PEC) and pentachlorophenol (PCP);
- water borne preservatives, such as copper chrome arsenate (CCA), borates and fluorides; and
- organic solvent based preservatives (light organic solvent preservatives or LOSPs) (Greaves, 1989a).

According to Groves (1990), LOSPs, water borne and PEC are the three main types of preservative used in Australia. Various wood preservation processes are outlined by Greaves (1989b). These processes include;

- vacuum pressure processes (vacuum impregnation processes or VIPs), including full- and empty-cell processes;
- passive treatment processes which do not require capital intensive VIP plants and include spraying, dipping, brushing and immersion (for example, the hot-and-cold tank process); and
- remedial preservation processes involving the *in situ* application of preservative to timber in which decay and/or insect attack must be eliminated (Greaves, 1989b).

The Treated Post, Pole and Pile Industry

The majority of Australia's treatment plants operate CCA VIP processes and their treatment schedules vary between full- and empty-cell depending on the timber being treated (Greaves, 1984). Full-cell schedules are used to treat dense timbers for poles and sleepers with creosote and radiata pine posts and poles with CCA (Greaves, 1989b). The hot-and-cold bath is the most commonly used passive method (Greaves, 1984).

There were 12 LOSP plants in operation in Australia in 1990, treating an average of 10,000 cubic metres of softwood and hardwood timber per annum. As well as this, there were 130 CCA VIP treatment plants in operation with an annual throughput of 300 000 cubic metres, 26 water-soluble boron and 18 water-soluble fluorine plants (Groves, 1990).

Wood-based Panels Production

The basic steps involved in the manufacture of various wood-based panel products are outlined in Figure 11. The manufacture of these products involves complex processing and, with the exception of debarking and wood chipping, this

processing is beyond the technical reach of small-scale timber processors, the likes of which are the focus of this report. They will not, therefore, be discussed in detail.

The production of low density fibreboard follows many of the steps for hardboard except that softwood is used and the fibres are felted together but not consolidated by heat and pressure. Medium density fibreboard manufacture also follows that of hardboard but bonding is achieved by the addition of synthetic resin adhesives which are cured under heat and pressure (Bootle, 1983).

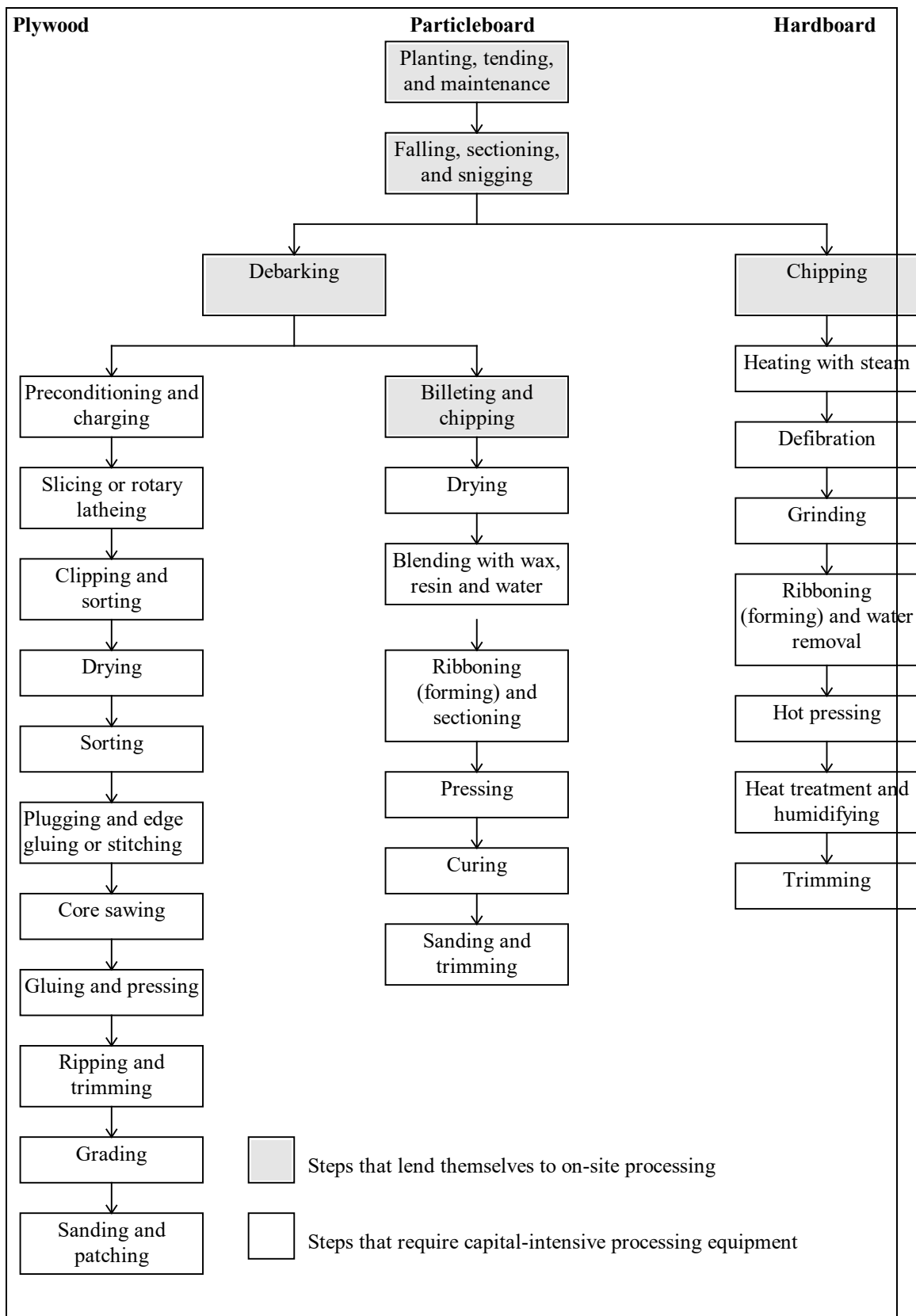


Figure 11: Steps involved in the manufacture of wood-based panels (Derived from Walker, 1993; Bootle, 1983).

Chipping

Chippers vary in size from huge, whole-log chippers down to very small units used for the chipping of sawmill waste (Williston, 1988). Staaf and Wiksten (1984) recognise two main types of chippers: those equipped with cutting knives and those equipped with slashing knives. They go on to further divide cutting knife chippers into disc, drum and V-form chippers. Disc chippers are ideally suited to the production of high quality industrial chips. Chips obtained from drum chippers on the other hand are generally of a low quality. They make suitable portable machines because of their light weight and wide feeding spout (Staaf and Wiksten, 1984).

The Wood-based Panels Industry

The wood-based panels industry consists of 37 mills (Commonwealth Government, 1995). CSR, the South Australian Government, ACI, Westralian Forest Industries, ANM, and APPM, a subsidiary company of North Broken Hill-Peko, are among the larger companies engaged in the production of wood-based panels (AIC, 1993).

Pulp, Paper and Paperboard Production

As is the case with wood-based panels, the manufacture of paper and paperboard is complex and only possible in capital-intensive processing facilities. The steps involved are outlined in Figure 12.

The Pulp, Paper and Paperboard Industry

The pulp, paper and paperboard industry is a highly geographically concentrated and capital-intensive sector. There is considerable vertical integration within the sector, with the result that most of the major paper manufacturers produce woodchips for internal use (AIC, 1993).

In 1993 there were nine major hardwood woodchip exporters, of which the largest were APPM, Forest Resources (owned by Boral), Harris-Daishowa and West Australian Chip and Pulp (part of the Bunnings Group). There were also three softwood woodchip exporters (AIC, 1993).

Five major companies - Australian Paper Manufacturers (APM) (part of the AMCOR Group), ANM, Kimberly-Clark, Bowater and Visy Board (a Pratt Group company) - operate 22 pulp and paper mills across Australia and produce virtually all of the paper products manufactured in this country (AIC, 1993, Anon, 1995). Companies owned by AMCOR and the Pratt Group produce the vast majority of Australia's corrugated packaging and folding carton needs (AIC, 1993).

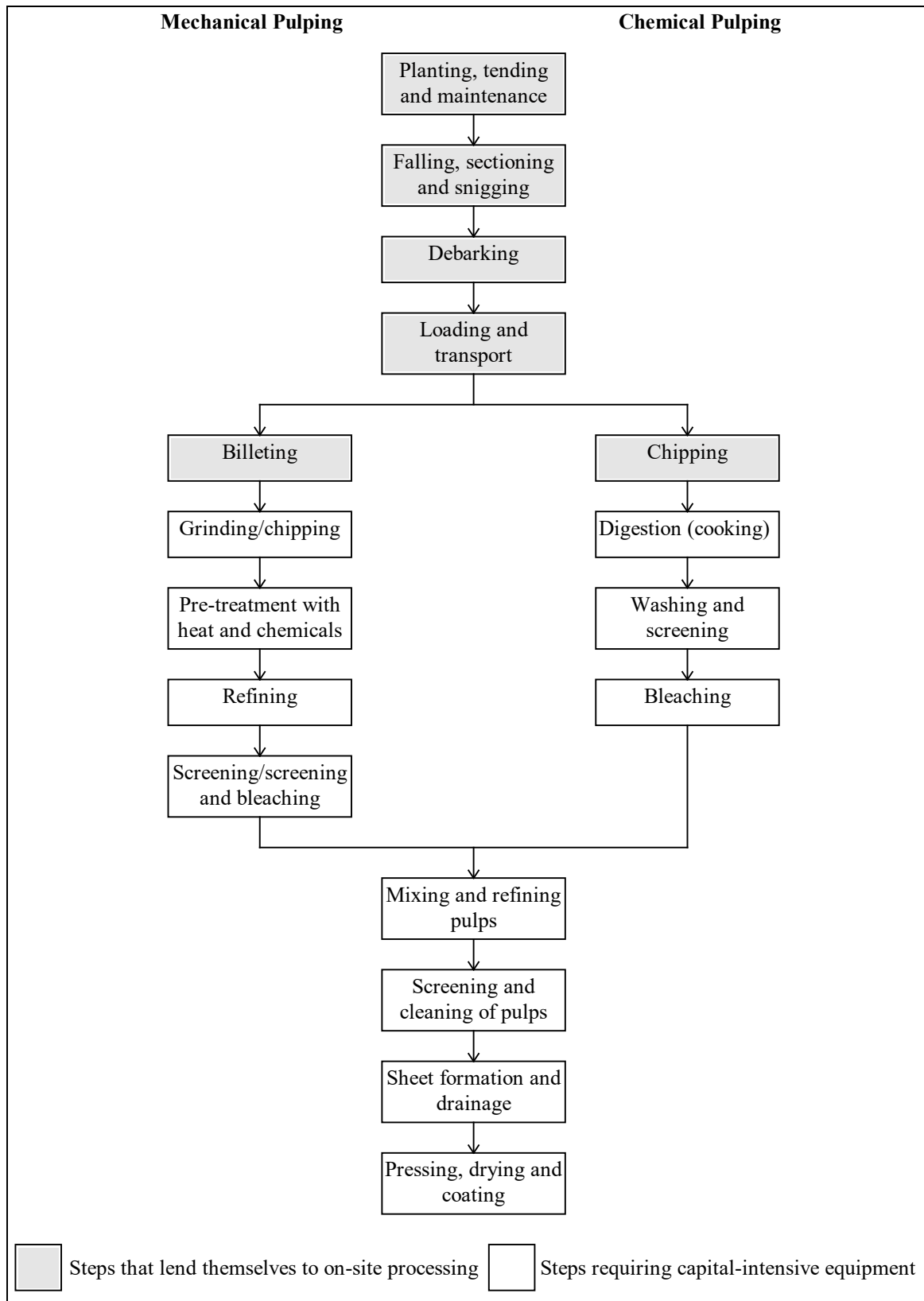


Figure 12: Steps involved in the manufacture of pulp and paper (Derived from Walker, 1993; Bootle, 1983).

On-site Timber Processing

As indicated in figures 8 and 10 to 12, small-scale processors can engage in the following processing activities using currently available technologies:

- debarking;
- chipping;
- sawmilling;
- air- and kiln-drying; and
- preservation.

Debarking and Chipping

As previously mentioned, the benefits to industry of on-site debarking include a reduction in the weight of wood that has to be transported over land, and this results in a decrease in the cost of transporting this wood. If the wood is air dried on site (as is often the case with post, pole and pile production), the weight is reduced even further.

Mobile debarkers and chippers of the type that can be used by small-scale processors are often mounted on tractors, trucks or trailers. The units are therefore very easy to move and they can be transferred between several work locations in a single season or year at reasonable cost (Staaf and Wiksten, 1984).

Mobile debarkers include:

- Debarkers mounted on or behind standard agricultural tractors. The tractor is also the power source for the debarker. Infeed and outfeed are manual and a crew of three is usually required. Production per shift, according to Staaf and Wiksten (1984) is approximately 130 cubic metres of piled wood. This figure is yet to be verified and appears at this stage to be very high. The cost of labour is estimated to be about 75 per cent of the total cost of debarking, while machine costs amount to approximately 25 per cent. The use of one such debarker for debarking eucalypts was investigated by Wingate-Hill and MacArthur (1991) and it was found that it did not satisfactorily debark stringy bark eucalypts and performed erratically when debarking *Eucalyptus regnans*. Its potential productivity was considered high, however (if used on easy debarking species and if logs can be fed into and removed from the machine with sufficient speed).
- Tractor/trailer mounted debarkers. Timber infeed and outfeed is carried out with the assistance of a hydraulic crane which is mounted on the tractor or trailer. Three operators are the norm and a production rate of approximately 170 cubic metres of piled wood per shift is feasible, according to Staaf and Wiksten (1984). Machine costs account for 50 per cent of the total cost of debarking, with the remaining 50 per cent attributed to labour costs.
- Flatbed or specially built trailer mounted debarker. The timber is handled by means of a hydraulic crane. It is anticipated that a three person crew can debark approximately 200 cubic metres of timber per shift. Such debarkers see a division of costs between labour and capital in the ratio of 1:3 (i.e. labour costs and machine costs are 25 and 75 per cent of the total debarking costs respectively) (Staaf and Wiksten, 1984).

Portable wood chippers include:

- Those mounted on or behind standard agricultural tractors. The tractor is also the power source for the chipper.
- Those consisting of a tractor or truck as a base machine, a chipper mounted in front and a hopper behind the operators cabin (Staaf and Wiksten, 1984).

Table 3 gives some specifications for a currently available mobile debarker, while Table 4 does the same for a number of portable wood chippers.

Table 3: Cundey mobile debarker.

<i>Debarker</i>	<i>Power Source</i>	<i>Debarking Mechanism</i>	<i>Capacity (timber diameter)</i>	<i>Output (m³/hr)</i>
Cundey '15 ERC/TRC/20 MBRC'	15 hp 1500 rpm diesel engine/tractor PTO/20 hp electric motor	6 planar type knives on disc mounting	50 mm - 250 mm	2.5

Table 4: Portable wood chippers.

<i>Chipper</i>	<i>Power Source</i>	<i>Chipping Mechanism</i>	<i>Capacity (timber diameter) (mm)</i>	<i>Chip Size (mm)</i>	<i>Infeed</i>
Macquarrie Model 15	Diesel engine/tractor PTO/20 hp electric motor	-	Up to 250	-	Manual
Macquarrie Model 20	Diesel engine/tractor PTO/60 hp electric motor	-	Up to 350	-	Manual
Patu DC 40	Tractor PTO (15-35 hp)	3 Knives	Up to 100	4 - 12	Manual
Patu DC 65	Tractor PTO (20-45 hp)	4 Knives	Up to 170	6 - 8	Manual or hydraulic
Patu DC 100	Tractor PTO (30 - 75 hp)	4 Knives	Up to 250	5 - 18	Manual or hydraulic

Sawmilling

There are a number relatively inexpensive purpose-built mobile sawmills on the Australian market. These range from lightweight frames to which a chainsaw can be mounted through to horizontal bandmills and sophisticated band and circular saw mill assemblies (Orr, 1992).

The chainsaw mill is typically a low cost (\$500 plus chainsaw), highly portable but labour intensive alternative, suitable for small timber volumes. The wide kerf of the chainsaw results in substantial sawdust losses which can be of considerable

concern when milling smaller dimension timber. Horizontal bandmills are a better option for milling higher value speciality timbers where minimising wastage is of particular importance. Sophisticated band and circular sawmill assemblies have the ability to efficiently move, rotate, and cut logs in a manner that approaches that found in conventional sawmills (Orr, 1992).

Jowett (1993) and Waugh (1996) summarise the characteristics of a range of portable sawmilling systems including chainsaw, horizontal, single and twin circular and bench sawmills. Table 5 provides details for a number of portable sawmills, as provided by Waugh (1996).

An important consideration when processing logs using portable sawmills is the fact that peripheral growth stresses in small-diameter eucalypts are the same as in large logs (Archer, 1986; as cited by Walker, 1993), so the internal stress gradient is more severe in small logs as the forces are distributed over a smaller radius (Walker, 1993), and this may lead to distortion and splitting during sawing and greater difficulties in sizing products (NPAC, 1991).

Increased farm forestry activities in recent years have given rise to a new small diameter timber resource and a new wood that requires specialised handling and processing systems. According to Waugh (1996), the log handling systems that can prevent growth-stress splitting and drying degrade, and the sawing systems and strategies necessary to ensure sawing accuracy and a minimisation of product distortion will only be provided by specialised sawmills handling in the order of 30,000-40,000 cubic metres of logs per year and with a minimum capital infrastructure of around \$25 million. This is well beyond the scope and skills which can be developed with on-site processing.

Table 5: Portable sawmills

<i>Travelling Head Units</i>						
<i>Sawing System</i>	<i>Mobility, Set-up Time</i>	<i>Resource</i>	<i>Productivity</i>	<i>Product</i>	<i>Strength</i>	<i>Weakness</i>
Chainsaw (e.g. Stihl)	Truck or 4WD. Set-up in less than 1 hr.	Wide range of log sizes	Very low (approx. 2m ³ /day sawn)	Slabs require resawing	Versatile, low cost	Small logs, large kerf, poor accuracy
Horizontal bandsaw (Laidlaw)	Truck or 4WD. Set-up in 1 - 2 hrs.	Best on large logs	Low-medium, 4 - 6 m ³ /day sawn	Slabs require resawing (can be done with unit)	Narrow kerf, low cost, accurate sawing	Sawing high density wood and small eucalypts
Singular circular saw units (Lewisaw)	Truck or 4WD. Set-up in 1 - 2 hrs.	Best on large logs	Low-medium, 4 - 6 m ³ /day sawn	Flitches and final product sizes off saw	Final product cut without further handling	Wide kerf, handling small eucalypts
Twin circular saw units (Forestmil)	Truck or 4WD. Set-up in 2 - 3 hrs.	Capable of handling very large logs	Medium, 6 - 12 m ³ /day sawn	Flitches and final product sizes off saw	Handling large logs. Final product cut without further handling, ruggedness	Wide kerf, handling small eucalypts, saw cut stability
<i>Bench-type Units</i>						
<i>Sawing System</i>	<i>Mobility, Set-up Time</i>	<i>Resource</i>	<i>Productivity</i>	<i>Product</i>	<i>Strength</i>	<i>Weakness</i>
One-man unit (Kara mill)	Truck or 4WD. Set up in 2 - 3 hrs.	Flitches and small logs	Medium to high, 10-15 m ³ /day sawn. Two man crew	Flitches and final product sizes off saw	Good productivity and log and product handling capability, accurate sawing	Expensive and least mobile, external power requirement
Proprietary	Truck. Up to 2 days to set up	User requirements	Medium to high. Up to 20 m ³ /day sawn. Three to four-man crew	Variety of accurate final products	Good productivity, similar to conventional sawmilling	Expensive, larger crew required, ruggedness and lack of technical support

(Source: Waugh, 1996)

Drying

The most common form of on-site timber drying is air-drying. However, for softwoods and the final drying of hardwoods there is usually the need for some form

of controlled drying to produce wood with a moisture content that meets market specifications. While they are still in an early stage of development, there are a number of relocatable dehumidifier/heat pump units available which are adequate for most needs (Race, 1994; Anon., 1995; Waugh, 1996). Alternatively, there are a number of different solar kilns, including greenhouse and external collector type kilns, although the use of these is restricted to the hottest five months of the year. Sattar (1993) provides a review of the use of solar kilns in the drying of timber. Most dehumidifier/heat pump and solar kilns are expensive, costing several times more than the sawing system (Waugh, 1996).

Dehydration Kilns Australia Pty Ltd manufacture a portable kiln that has been successful in drying the following timbers:

- Blackwood (*Acacia melanoxylon*)
- Myrtle Beech (*Nothofagus cunninghamii*)
- River Red Gum (*Eucalyptus camaldulensis*)
- Red Stringybark (*E. macrorhyncha*)
- Alpine Ash (*E. delagatensis*)
- Sydney Blue Gum (*E. saligna*)
- White Cypress Pine (*Callitris glauca*)
- Black Cypress Pine (*C. endlicheri*).

The kilns are capable of drying up to 12 cubic metres of timber per session, and cost between \$24,000 and \$34,000 (Brown, pers. comm.)

Preservation

Passive treatment processes - spraying, painting and the like - provide the most practical option for landholders wishing to treat posts, poles and piles on-site, as these methods are relatively straight forward and do not rely on capital-intensive processing facilities. The hot-and-cold tank process, for example, involves immersing green timber in a tank with preservative and heating to 95°C for up to four hours. The timber is then allowed to cool to about 60°C in the preservative before being removed and air dried (Greaves, 1989b). Passive treatment processes do not permit the efficient production of large volumes of treated timber.

Timber that has been processed on-site can be used on the property or sold. The following section will provide an outline of the markets available for forest products and the existing and potential markets for timber that has been processed on-site.

Markets for Forest Produce

International Markets

Some 3.5 billion tonnes of wood per annum are used world wide, with some 50 per cent as industrial roundwood and the balance as fuelwood. The major softwood exporting countries of the northern hemisphere (USA, Russia and Canada) effectively

shape the world trade in forest products. According to Steers (1994; as cited by Dunchue and Sinclair, 1994), one fifth of the worlds forest resource is coniferous, supplying 70 per cent of the worlds industrial roundwood. Hardwood species on the other hand are the major source of fuelwood (AIC, 1993). Total world production of industrial roundwood and fuelwood for 1994 is given in Table 6. Industrial roundwood is the basic input for the forest products industries and is used in the production of posts, poles and piles, sawn wood, wood-based panels and pulp, paper and paperboard. World production figures for these products are given in Table 7.

Table 6: 1994 world production of industrial roundwood and fuel wood..

<i>Product</i>	<i>Production (million m³)</i>	
	<i>Softwood</i>	<i>Hardwood</i>
Sawlogs and veneer logs	601	294
Pulpwood	263	151
Other industrial roundwood	60	98
Fuelwood	187	1,549

(Source: FAO, 1995)

Table 7: 1994 world production of forest products.

<i>Product</i>	<i>Unit</i>	<i>Production</i>
Posts, poles and piles (sw/hw)	mill m ³	na
Sawn wood (sw/hw)	mill m ³	304/109
Plywood	mill m ³	49
Particle board	mill m ³	52
Fibreboard	mill m ³	20
Veneer sheets	mill m ³	21
Pulp	mill t	172
Newsprint	mill t	34
Printing and writing paper	mill t	82
Household and sanitary paper	mill t	16
Packaging and industrial paper	mill t	116

(Source: FAO, 1995)

Note: na = not available, sw = softwood, hw = hardwood

Table 8 provides estimates of the future world availability of industrial roundwood, fuelwood and charcoal.

Table 8: Estimated world availability of industrial roundwood, fuelwood and charcoal (million m³ under bark).

	<i>Availability (mill m³)</i>	
	<i>2010</i>	<i>2020</i>
Industrial roundwood	1495-1954	1665-2128
Fuelwood and charcoal	2265-2426	2607

(Source: Nilsson, 1996)

The future global demand for industrial roundwood has been the focus of a number of analyses in recent years. Nilsson (1996) presents the results of some of these analyses. The results of analyses pertaining to the future global demand for fuelwood and charcoal are also presented. The demand situation for industrial roundwood, fuelwood and charcoal is summarised in Table 9.

Table 9: Projected global demand for industrial roundwood, fuelwood and charcoal.

	<i>Demand (mill m³)</i>	
	<i>2010</i>	<i>2020</i>
Industrial roundwood	2100	2400
Fuelwood and charcoal	3800	4250

(Source: Nilsson, 1996)

According to Wright (1994), all recent studies of world wood markets have predicted large and growing deficits in international wood supply. For example, a report by Resource Economics Incorporated and D. A. Neilson and Associates, and referred to in Ryan (1994), indicates that the Pacific Rim faces a major shortfall in wood supply over the 10 years from 1993. Overall industrial wood consumption in 22 Pacific Rim countries was expected to increase by 252 million cubic metres to a total of 1.5 billion cubic metres by the year 2001. It was predicted that the theoretical wood deficit would be almost 180 million cubic metres by 1996 and more than 325 million cubic metres by 2001.

Much of this deficit was attributed to increasing demand for industrial wood and fuelwood (especially in developing countries), restrictions on supply due to environmental considerations, and a lack of sufficient fast growing plantations. It is believed by Ryan (1994), however, that adjustments to a supply deficit situation will occur in the form of increased prices, and that these adjustments will encourage greater investment in resource expansion on the one hand, and substitution by non-wood products and economies in use on the other.

Nilsson (1996) foresees a total shortage of 300 million cubic metres of industrial roundwood in the year 2010 and a shortage of 800-900 million cubic metres in 2020.

Waugh (1996) contends that environmental considerations could lead to a 50 per cent reduction in wood flows from tropical forests by early in the next decade, principally of higher quality hardwood appearance sawn and veneer products. Even assuming no market growth, and based on a potential 50 per cent substitution of this with eucalypt products, Waugh (1996) believes that there is a potential market for alternate sawn and veneer hardwood products in the order of ten million cubic metres of sawn product and five million cubic metres of veneer product per year. He therefore argues that the greatest opportunities on international markets in the future will lie with hardwood appearance products.

Australia's Domestic Markets

Australia consumed 19.6 million cubic metres of roundwood in 1994-95, in the form of various forest products (ABARE, 1996). The production and consumption of these products in 1994-95 is shown in Figure 13. As can be seen, imports account for a significant proportion of total forest products consumed in Australia.

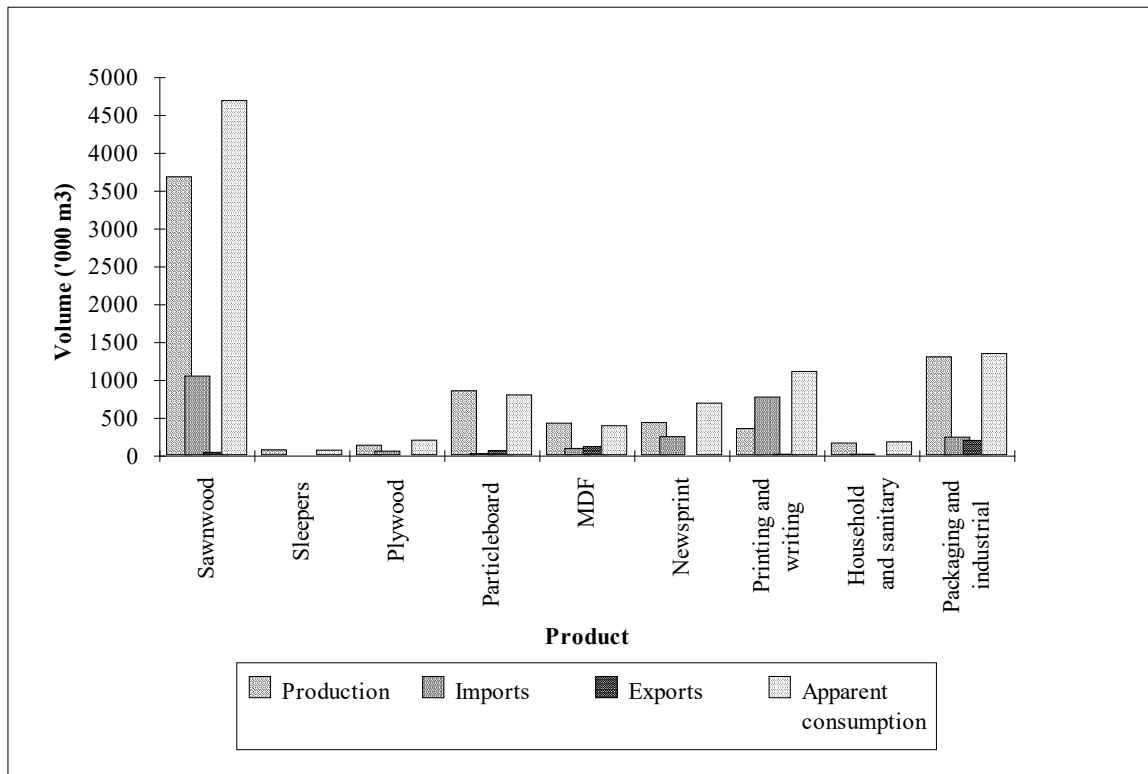


Figure 13: Production, consumption, imports and exports of various forest products in 1994-95.
Note: Apparent consumption is production plus imports minus exports. (Source: ABARE, 1996)

Figure 14 shows the volume of Australian forest products imports and exports for 1994-95, while Figure 15 shows the value of these imports and exports. Australia exported 6.8 million cubic metres of wood products in 1994-95 (in roundwood equivalent terms), while imports were slightly higher at 7.6 million cubic metres. As can be seen, however, higher value-added sawn wood and pulp and paper products constitute the majority of imports, while low-value pulpwood (predominantly woodchips) is the major export. The result is that Australia possessed a trade deficit in forest products of almost \$2 billion in 1994-95 (Neck *et al.*, 1996).

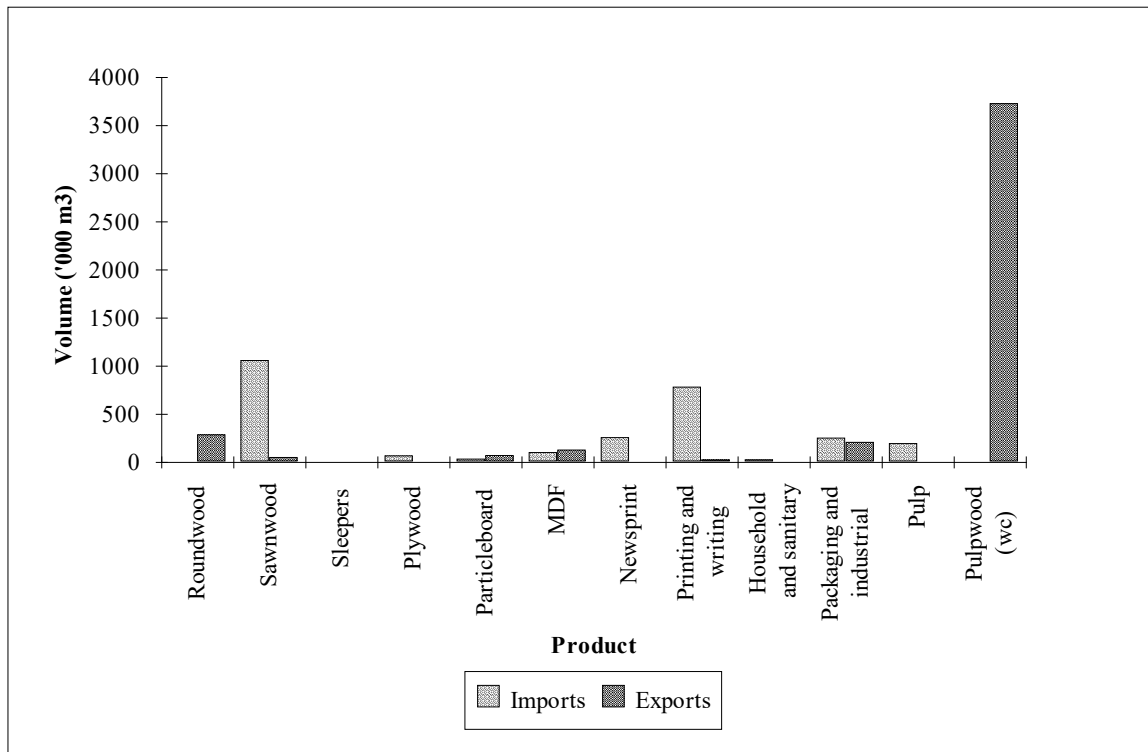


Figure 14: Volume of Australian imports and exports, 1994-95 (Source: ABARE, 1996)

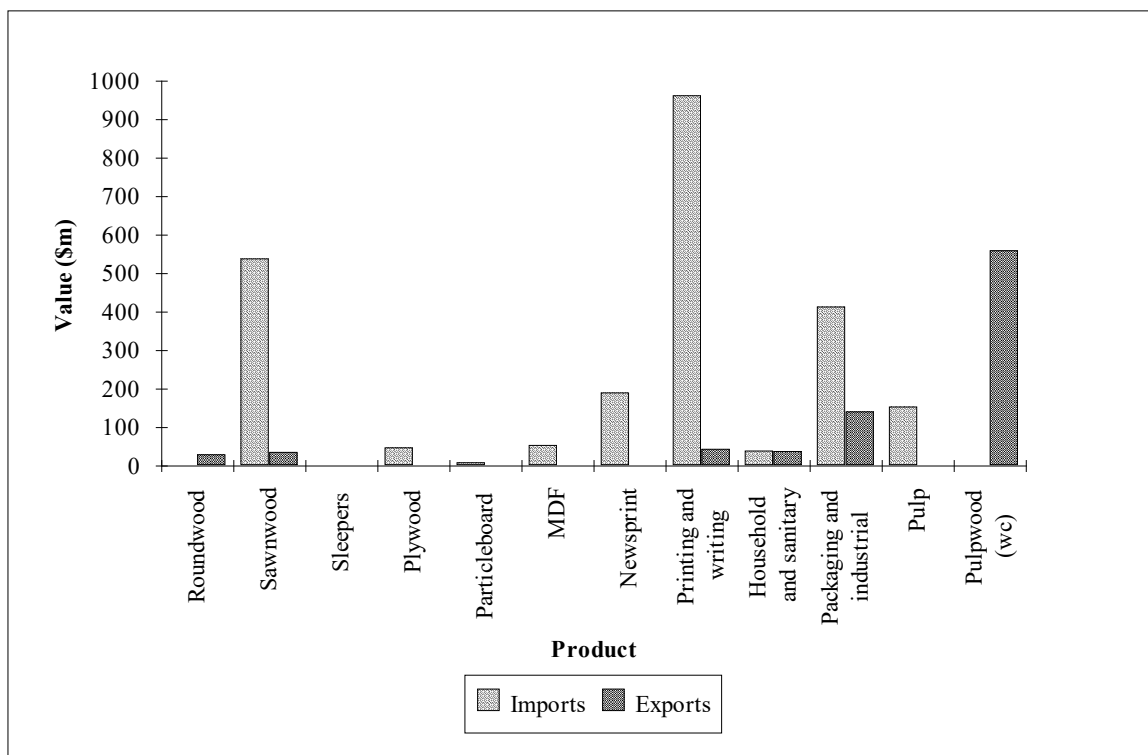


Figure 15: Value of forest product imports and exports, 1994-95 (Source: ABARE, 1996)

As was shown in figures 6 and 7, the sawn wood industry is the largest user of wood in Australia, with over 47 per cent of all logs harvested in 1993-94 processed at sawmills for the production of sawn timber (Sar *et al.*, 1994).

Sawn Timber

Of the 3.7 million cubic metres of sawn wood produced in Australia in 1994-95, approximately 43 per cent (1.6 million cubic metres) was hardwood and 57 per cent (2.1 million cubic metres) was softwood (ABARE, 1996).

The 4.7 million cubic metres of sawn wood consumed in Australia in 1994-95 consisted of 1.7 million cubic metres (36 per cent) of hardwood and 3 million cubic metres (64 per cent) of softwood (ABARE, 1996). Sawn timber consumption beyond 1996-97 is projected to increase by an average 1% a year, reaching 4.3 million cubic metres in 2000-01 (Neck *et al.*, 1996). According to Neck *et al.* (1996), consumption of softwood sawn timber is projected to increase to around 70% of total Australian consumption of sawn timber by 2000-01.

Sawn wood products cover the range from construction timbers through claddings, mouldings and fixings to joinery and furniture timbers, stacking and packaging timbers, and stock for manufacture of various small articles of wood (Lewis and Ferguson, 1993; Brabin, 1981). The major markets for sawn wood in Australia include the metropolitan areas and the more closely settled rural districts (Lewis and Ferguson, 1993). The major factor affecting these markets is the cyclical nature of new house construction activity (Neck *et al.*, 1996). The dwellings market for sawn wood has been steadily eroded over the last 10-20 years, with other materials (concrete, bricks, aluminium and steel) replacing timber in various applications. Roof framing so far has remained a sawn wood market in various forms - over 90 per cent of the market in all States. It is anticipated that new houses will absorb around 40 per cent of domestic log production over the next 40 years (Lewis and Ferguson, 1993).

Wood is still in strong demand for interior fittings and fixings, and for partitions and furniture in commercial buildings. Most of these applications utilise plantation softwoods for utilitarian purposes. Mature native or imported hardwoods are more favoured for decorative purposes (Lewis and Ferguson, 1993).

Sawn hardwood retains a place for heavy duty constructional purposes, but treated softwood is being used increasingly for such purposes in both domestic and commercial building. Softwood laminated and enclosed beams and engineered trusses and frames are widely used for roofing and wall timbers where wide spans or some degree of decorative appearance are required (Lewis and Ferguson, 1993).

Waugh (1996), Wright (1994) and Ford (1992) all make reference to the substitution of hardwood sawn timber with softwood (predominantly radiata pine) sawn timber in many structural applications. The increasing level of substitution is the result of:

- the increased availability of softwood sawn timber and its consequent lower price;
- aggressive marketing by softwood sawn timber producers
- the stability and ease with which softwood sawn timber can be used;
- a decrease in the availability of hardwood sawlogs due to environmental concerns (Neck *et al.*, 1996; Ford, 1992; TIC, 1988).

Waugh (1996) argues that, while good opportunities do exist for larger engineering products, best opportunities for hardwoods do not lie in trying to compete with softwoods for domestic framing timbers, for the reasons just outlined. Ford (1992) believes that the hardwood products for which there is likely to be less substitution by softwood represent a higher level of value-adding than those that are being replaced by softwood. Hardwood has strong comparative advantages for high value uses. It is stronger, more stable and more impact resistant than softwood. Marketing opportunities therefore exist in high value applications such as furniture manufacture.

The Australian furniture market is of particular relevance to small-scale processors of farm forest timber, as the industry, at least in Victoria, experiences difficulty obtaining locally produced furniture grade material (TIC, 1988). The industry has a turnover of approximately \$2.7 billion and relies heavily on imported wood, as finished product or for manufacture in Australia (Bird *et al.*, 1996). The market offers potential for hardwood species which have special colour and grain characteristics (Ford, 1992).

Reference to Figure 13 clearly shows that sawn timber dominates the wood product market in Australia. The production of such timber is the activity most readily undertaken using on-site processing technologies, as was shown in Figure 8. There is clearly an opportunity for the replacement of Australia's substantial sawn timber imports with domestically produced sawn timber, including that produced by small-scale processors. According to Ford (1992), prospects for hardwood import replacement in high-value applications are good, particularly for products such as furniture beams, window frames and mouldings.

Exports of sawn wood, as previously mentioned, are small, relative to imports. This is particularly the case for appearance grade material. All material exported from Victoria to foreign markets is select and is used for furniture manufacture, higher grade joinery, wall panelling, flooring and mouldings (TIC, 1988). Wright (1994) believes that Australia will possess an exportable surplus of sawn timber in the next 10 to 15 years.

Joiners, staircase manufacturers, moulding manufacturers and numerous other users of small volumes of high-value timber offer niche market opportunities which could be important for individual sawmillers (Ford, 1992).

Wood-based Panels

Australian particle board industry is based on utilisation of the coniferous plantation resource and at present supplies practically all the Australian market. Its capacity - installed and potential - is seen as more than able to meet any likely future domestic market demands (Lewis and Ferguson, 1993). As such, Australia is a net exporter of wood-based panels. Export markets include Indonesia, Japan, Singapore and Taiwan (ABARE, 1996).

The main production is of plain particle boards, although fine-surfaced board and boards with special surfacings or veneers are being manufactured in increasing

volumes. As well as this, high quality oriented strand board panels are being manufactured in southern New South Wales (Lewis and Ferguson, 1993).

Markets are primarily industrial usage. Approximately 90 per cent of the usage of these boards is in furniture, shop and office fittings, cabinets, built-ins, and packaging. (Lewis and Ferguson, 1993).

Hardboard from indigenous species and medium density fibreboard are used mainly for interior and furniture panelling, while softboard is employed as wall panelling, partitioning and acoustic panels. It is, however, no longer produced in Australia (RAC, 1991; as cited by Lewis and Ferguson, 1993).

Laminated veneer lumber is manufactured at Mount Gambier and in Sydney (RAC, 1991; as cited by Lewis and Ferguson, 1993) and is used mainly for wide span beams, trusses, and columns. Oriented strand board manufacture is carried out in southern New South Wales and uses radiata pine smallwood. SCRIMBER is used for long length and deep section structural uses (Lewis and Ferguson, 1993).

There are two categories of plywood, viz. thin plywoods (up to 5.5 mm thickness) and thick plywoods (over 5.5 mm thick). There is a large Australian market for both. The demand for plywood in Australia is not met by domestic production, as can be seen from Figure 9. Imports accounted for 32 per cent of domestic consumption in 1994-95 (ABARE, 1996). The majority of thin plywood is imported, but thick plywood imports are relatively low.

Consumption of wood based panels is projected to increase by an average 3.5% a year until the year 2000-01 (Neck *et al.*, 1996).

Roundwood and Railway Sleepers

The consumption of posts, poles, and other round timbers is low relative to that of sawlog products, but stable. The market, in plantation regions, is expected to continue moving towards preservative-treated pine. Interstate trade is considerable but overseas trading is negligible (Lewis and Ferguson, 1993).

Piles are seen as remaining a speciality product of the appropriate native species. Quantities produced, however, are small (Lewis and Ferguson, 1993).

Timber railway sleeper usage is also small in volume relative to that of sawlog products. Present production is wholly from native forests. Interstate trade in hardwood sleepers is considerable on the mainland, but exports based on Jarrah sleepers was greatly reduced over the five years to 1993 (Lewis and Ferguson, 1993).

Pulp, Paper and Paperboard

Demand currently exceeds production capacity for all paper and paperboard products with the result that imported paper and paperboard form the majority of Australia's imports of forest products (ABARE, 1996; Bull and Hemery,

1995). Net imports of printing and writing papers may decline over the medium term, however, as domestic production of printing and writing paper increases, displacing some imports (Neck *et al.*, 1996).

Australia has a significant trade surplus in woodchips. Those chips not used in Australia are exported, primarily to Japan (RAC, 1992a).

Over the medium term, paper and paperboard consumption is projected to increase by 3.5% a year on average (Neck *et al.*, 1996).

The Marketing of Farm Forestry Produce

Markets for Traditional Farm Forest Timber Products

Traditional farm forest timber products have included the following:

- veneer logs for use in the manufacture of plywood;
- sawlogs (including those from speciality tree species) for use in sawn and board products such as house frames, weatherboards, linings, mouldings, furniture, laminated beams and table tops (Oates and Clarke, 1987);
- pulpwood for conversion into woodchips and subsequent processing into particleboard or pulp and paper;
- fencing material including posts, rails, strainers, stays and droppers;
- poles, such as shed, telephone and electricity poles;
- firewood.

Wright (1994) believes there will be a strong future market for the aforementioned timber products in Australia. Pulpwood, and more particularly sawlogs, will be in increasing demand in future: Firstly, as a supplement to the wood currently supplied from State and industrial forests to satisfy an increasing Australian demand; secondly, as a replacement for increasingly scarce and increasingly costly imported wood or wood products; and thirdly, as exports contributing to increasingly supply-deficient overseas markets, especially Asia and the Pacific Rim region.

Fargher (1996) states that export and domestic market potential exists for commercial farm foresters to:

- aggregate softwood and hardwood resources through marketing co-operatives to internalise the costs of fragmentation and provide a united supply for industry;
- intensively manage softwood plantings to produce high value sawlogs and peeler logs;
- produce thinnings and short rotation forest products to supply resources to pulp, paper and composite product industries; and
- produce thinnings and short rotation forest products to supply resources to post and pole industries.

The market niche for products from farm forestry is also extremely diverse and has great potential (Fargher, 1996).

According to Waugh (1996), it is anticipated that opportunities for farmers to grow hardwoods and attract a realistic return for the products they produce will dramatically increase by the year 2020.

Farm forest timber products may be sold in a regional, state-wide, national or international market, or they may simply be used on the farm (Fitzpatrick, 1994). Regional markets include other farms, country centres and local processing industries such as sawmills and pulpmills.

Current marketing arrangements for farm forest timber products are outlined by Dunchue and Sinclair (1994) and include:

- Individual parcel sales in which the forest owner approaches a mill and is paid on the timber removed. This is the most common approach.
- Marketing forward selling agreements which commit industry to purchase the future produce from a plantation. Most agreements base the price on the ruling market price at the time of harvest. There are some marketing agreements, however, which use an index price based on CPI increases.
- Marketing co-operatives. Co-ops require a substantial timber resource and a large number of growers to establish but they work well when marketing a combination of many small parcels of low value products. Their advantages accrue because economies of scale give individual growers greater bargaining power when negotiating with industries and industries benefit because they do not have to negotiate with individuals. They are also advantageous in that they enable greater efficiency in harvesting and transport.
- Tendering, according to Dunchue and Sinclair (1994) is the most sensible way of marketing high value products. The product is usually parcelled into lots in order to attract the highest number of tenderers.

Marketing Problems Faced by Farm Foresters

The problems encountered by farm foresters wishing to sell timber relate to the size, quality and accessibility of the resource, the distance to markets, and consequently, the price received for the timber.

Cooper and Jamieson (1996) outline the problems faced by forest growers with respect to the marketing of forest produce in the Canberra Region. These problems are faced by farm foresters throughout Australia and include, among other things:

- The fact that plantation areas are invariably small in size (10 hectares or less) which leads to a higher cost of logging for every tonne of logs carted to the mills. This is due to the high cost of logging machinery, the high cost of moving such machinery, and the low total yield from these small areas.
- The fact that most of the plantations currently standing have received little or no management. The plantations are usually standing at their initial stocking and any thinning required is well overdue. This means that the plantation could have almost stopped growing. The problem is then two fold: firstly, no market currently exists for the pulpwood that has to be removed and secondly, the stand could become unstable if thinned.

- Some form of production thinning may have already taken place but without qualified supervision, with the result that the larger trees have been removed leaving trees of variable quality.
- Private plantations are often established with no thought as to how the timber will be extracted at time of clearfall. The roading then has to be brought up to the standard required for log trucks which can cost more than the returns expected from the plantation.
- The plantation may also have been established with no thought as to where the eventual points of sale or markets were going to be. This has led to many plantations being too far from markets to attract a return (after deducting logging and transport costs) at clear fall. To be commercially attractive, these local plantations should be placed within 100 km of a mill on accessible roads for large logging trucks. Any plantation located over 150 km from a mill will provide only marginal returns, particularly if there is no market for pulp logs.

The bottom line for commercial farm forestry is the sale of the product at a net profit (Wright, 1994), and this depends on the price received for the product. The price received can be the stumpage price or the royalty price. Stumpage is the value of timber in standing trees. Farm foresters often have to negotiate a stumpage price with processors. The haulage distance, harvesting difficulty, resource accessibility, log size and quality, and volume of supply (and hence economies of scale) all affect the stumpage price. Farm foresters may be offered a lower price than the State royalty, for example, if they have a small volume and there is only one major buyer in the district (they may, however, be able to negotiate a better price for products for which demand is exceeding supply) (Loane, 1993).

Royalty prices are similar to stumpage prices except that they are determined under a system of royalty equation under which the sum of royalty and the transport costs involved in placing a base grade of sawn timber on a specified market will be the same for all operations with access to that market (enabling all sawmillers supplying that market to compete on an equal basis, regardless of location). Sales of logs are therefore at administered prices rather than those set by market forces (Kennedy, 1980). Many argue that royalty prices have been less than the prices that would have been obtained in a competitive market (O'Regan and Bhati, 1991). Industrial processors have no need to and will not pay above forest service prices. However, many processors almost always pay less to the private grower (Flannery, 1988), and this of course impacts on the ability of the grower to make a profit. Royalties for softwood and hardwood logs are given in Table 10, while royalties for some speciality timbers are given in Table 11.

Table 10: Royalties for Victorian timber (1992)

<i>Softwood</i>		<i>Hardwood</i>	
Sawlogs		Sawlogs	
Log diameter class (cm)	\$/m ³	Log grade	\$/m ³
15-20	17-20	D	15
20-25	23-27	C	30
25-30	31-35	B	45
30-35	39-42	A	50

35-40	46-50	
40-45	53-60	
>45	60-63	
Pulpwood	7-17	Pulpwood 8-15
Includes roading and Timber Promotion Council Levy		

(Source: DCNR Commerce Branch and Victorian Association of Forest Industries; as cited by Loane, 1993)

Table 11: Royalties for selected speciality timbers.

<i>Tree Species</i>	<i>Sawlog Royalty (\$/m³)</i>
Cypress (clearwood)	40-60
Blackwood	70-150
Radiata pine (clearwood)	50
Walnut	100-400
Douglas fir (oregon)	50
Eucalypt (ash)	40

(Source: Lyons, 1991; as cited by Loane, 1993)

Yet another price to be considered is the residual stumpage price. The maximum price that buyers are willing to pay would be the value of the sawn timber product minus the total costs incurred between stump and sale (Loane, 1993).

As well as the afore mentioned considerations, the state forest services, as the major supplier of wood to industry, attain a monopolistic position which is frequently very much to the detriment of the private grower, particularly where the available resource exceeds industry's processing capability. Where there is an excess timber supply the forest products industries find it more convenient and profitable to take their pick from the State resources, to the exclusion of the private grower (Flannery, 1988).

Potential Farm Forest Timber Products

A possible solution to many of the problems outlined in the previous section is the on-site processing of farm forestry timber. On-site processing enables forest growers to provide products to the broader community market, and gives them access to added value at the point of sale (Dawson, 1992). As well as this, on-site processing is ideally suited to woodlots that are too small to attract the interests of large-scale timber processors. It can provide a means of avoiding the minimum standards for sawlogs and the like imposed by large-scale timber processors (see, for example, Hall, 1990). It may even have a role to play in rapid salvage operations following wildfire.

The timber products that could be produced by utilising on-site processing technologies include:

- air or kiln dried sawn timber for a variety of applications;
- debarked and chipped pulplogs; and
- debarked and preservative treated posts, poles and piles.

Sawn Timber

As mentioned in Section 5, sawn timber can be produced on-site using a variety of portable sawmills. The timber can be air dried or dried in portable kilns.

The advantages of on-farm sawmilling are well recognised. Returns to landholders can be greatly improved if they mill their own timber using a small mill. As well as this, landholders handle their own timber, ensuring that the property is not damaged. They can also work in their own time, enabling the economic handling of small volumes of timber (Fitzpatrick, 1994). Lang (1989) outlines the many benefits of on-farm milling, including the relatively low cost of the equipment, the many uses to which the timber can be put, both on the farm and in the district, and the high returns that can be expected from the sawntimber (relative to timber sold on the stump or as sawlogs).

Alexandra and Youl (1991) argue that centralisation and the increasing scale of industrial sawmilling has reduced the number of mills throughout the country, making local timber less readily available. As well as this, big mills are losing their ability to service niche markets in their attempts to reduce unit costs through mass production. On-farm milling enables landholders to take advantage of such niche markets.

Structural change in the sawmill industry was one of the reasons offered by Risberg (1991) to explain the slow but steady increase in the use of portable sawmills in Sweden. These structural changes have resulted in a few big and highly productive sawmills producing standard assortments.

Waugh (1996) believes that there are opportunities for on-farm processing of wood harvested from existing slow growing mature trees on farms, especially where there is a need to salvage dying trees or to thin overstocked stands to improve the growth and vigour of remaining trees. These opportunities will be particularly manifest in regions where forest industries are not developed and the resource is scattered.

Risberg (1988) identifies three tasks for which portable sawmills can be put to good use:

- domestic sawing (sawing for on-farm construction);
- custom sawing (sawing for other landholders); and
- sawing and processing for sales (selling to timber merchants, other farmers etc.).

Examples of impressive on-farm construction using farm-milled timber can be found in Risberg (1988) and Andrews (1990).

Custom sawing is advantageous in that there is no cost and loss of time associated with obtaining the raw material and assistance from the customer is often provided free of charge. High utilisation of the saw can be realised, which is of particular importance to users who have only recently taken delivery of their sawmill (Risberg, 1988).

Sawing for sales can be undertaken with a view to selling the sawn timber to other woodlot owners and farmers, local timber merchants and the like. Increasingly farmers are looking to on-farm sawn timber to provide a source of income. How to

handle the wood and how to market it then becomes a problem. The small quantity and irregular flow of wood often makes it hard to develop a stable market and develop contacts with further processors (Waugh, 1996). The basic strategy in sawing for sales must be to serve the local market and to find niches where the sawmill industry cannot compete. Production of timber from certain species for special use may be one such niche, special qualities, dimensions and lengths may be others. Sawing can also be integrated with further processing such as kiln drying (Risberg, 1991).

Debarked and Chipped Pulplogs

Pulplogs and small diameter roundwood are the primary raw materials of wood-based panels and paper and paperboard products. The processes involved in the manufacture of these products are complex and require capital-intensive facilities. As such their production is beyond the technical reach of farmers and small-scale processors. Some of the preliminary processing, however, can be undertaken using a variety of mobile debarkers and portable wood chippers. The debarked pulplogs and woodchips can then be sold to one of the 37 wood-based panel processing plants, one of 12 hardwood and softwood chip exporters, or to one of the 22 pulp and paper mills throughout Australia.

Debarked and Preservative Treated Posts, Poles and Piles

Small diameter logs, particularly those resulting from first thinnings may be debarked on-site, air dried, and, if of non-durable species, sold to one of the 186 preservative treatment plants in operation throughout Australia. Alternatively, debarked roundwood can be treated on-site and sold directly to other farmers, timber merchants or rural stockists.

In conclusion, on-site processing has the potential to:

- deal effectively with a current supply situation (take advantage of a current supply opportunity) in which small forests have been unable to attract the interests of large-scale timber processors;
- provide value-added timber products to Australia's domestic markets;
- increase the returns to farm foresters and thereby encourage further expansion of the farm forestry resource;
- enable farm foresters to avoid the minimum specifications imposed by large-scale timber processors; and
- provide a means of dealing with large timber volumes resulting from salvage operations.

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