

# Sawn timber from 10-year-old pruned *Eucalyptus nitens* (Deane & Maiden) grown in an agricultural riparian buffer

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## Reference:

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**Summary:** A 10-year-old mixed species native riparian buffer strip established and managed for timber, wildlife, shelter and soils erosion control was selectively logged to assess the viability of producing high value appearance grade sawn timber. The trees had a mean diameter at breast height of 39.3cm, a mean height of 22.7m and were pruned to an average height of 6.5m. The total underbark tree volume was estimated as 8.15m<sup>3</sup> with a pruned log volume of 4.99m<sup>3</sup> or 61% of the total tree volume. On milling 4.66m<sup>3</sup> of prepared log yielded 1.89m<sup>3</sup> of back-sawn boards; a green recovery of 41%. Visual grading, prior to drying, estimated that 45% of the sawn product was select grade or better. Following kiln drying, reconditioning and four-sided dressing a sample of the larger dimension (100x38mm) boards of select grade or better (graded green) were re-graded. Fifty-two percent were subsequently downgraded due to drying related defects including surface checking (25%), stain (13%), undersizing (8%) and spring (6%).

The viability of timber production from eucalypts grown on such sites may depend on the potential to grow large diameter (over 55cm) pruned butt-logs that can be harvested at a reasonable cost without greatly impacting on the environmental or social values. Drying degrade remains a real concern for some species although larger diameter logs could be quarter sawn to reduce the likelihood of surface checking. Un-pruned or small diameter eucalypt logs (less than 40cm diameter) appear to be unviable to harvest for sawn timber.

## THE MAIN POINTS OF THIS PAPER

- Riparian buffers strips on farmland are critical areas for revegetation for on-farm and off-farm environmental values but are costly to fence and revegetate. High quality timber production from multipurpose riparian belts may offer farmers an incentive to establish and manage native vegetation.
- This trial demonstrates that it is possible to selectively harvest high quality appearance grade timber from young eucalypts grown in a riparian buffer strip
- The viability of small scale eucalypt sawlog production appears to depend on achieving a large log diameter (over 55cm) and access to appropriate drying facilities to avoid excessive drying degrade. Eucalypt species that are not as susceptible to drying degrade may be preferable.

## 1. INTRODUCTION

### 1.1 Riparian belts as a timber production zone

Revegetation of riparian zones in agricultural areas is commonly advocated as an important means of controlling land degradation and improving water quality (Abel et al. 1997). However, in addition to the high opportunity cost associated with excluding grazing or cropping from productive land, fencing waterways can be very expensive due to the irregular patterns and may create weed and vermin control problems. The fences are also susceptible to damage during floods. While many of the benefits of riparian vegetation fall downstream it is the landholders who carry much of the cost.

Where salinity or water logging do not threaten tree growth riparian areas are often the most productive forestland in the agricultural landscape. Deep alluvium soil profiles, high availability of water and a low position in the landscape mean that tree growth rates and the choice of potential species may be greater than on the adjacent slopes. However, timber production from riparian areas faces many practical, political and economic constraints.

Because riparian vegetation projects are commonly focused on providing conservation benefits the planting design and management (including any harvesting) must not critically compromise the primary values. Where the intent is to control land degradation or trap nutrients many conventional plantation establishment and harvesting options, such

as deep ripping, broad-scale herbicide application and clearfelling, may be unacceptable. If the farmer is interested in maintaining a mixed species plantation for wildlife habitat, shelter or the aesthetics this will impose additional constraints. For commercial timber harvesting to be viable the returns must not only cover costs but also adequately compensate farmers and the downstream community for the loss of non-wood values (Dole 1993).

There are also very real productivity concerns associated with harvesting and marketing small volumes from irregular plantations. Riparian buffers are, almost by definition, linear corridors of vegetation flanked by agricultural crops or pastures. The viability of any timber harvesting operation is likely to be reduced when the total volume extracted is low, the forest is spread over a large area, or the logs must be extracted over waterways and drainage lines. Being close to waterways may also increase the costs of complying with planning guidelines and codes of practice for harvesting. As a result, the costs of harvesting and marketing logs from riparian forests are likely to be greater than that from large-scale monoculture plantations

### 1.2 The Plantation

The plantation site, Bamba Agroforestry Farm, is a 42-hectare private property in the Otway Ranges of southwest Victoria that was purchased by the current owners in 1987. The small creek that dissects the farm was actively eroding, fouled by stock and largely devoid of native vegetation (Figure 1). Rainfall is approximately 800mm although higher rainfall totals in the upper catchment can contribute to high water flows and occasional flooding.



**Figure 1.** The unfenced creek in January 1987 showing evidence of flooding and bank erosion

The indigenous vegetation along the valley floor was probably a tall (approximately 30 m) forest of *E. viminalis* with *Acacia melanoxylon*. The new landowners applied for, and received, state government funding for fencing and tree planting

along both sides of 400 m of creek. An electric stock exclusion fence was established that allowed the planting to follow the meandering creek; the distance fenced out varying (from 2 to 10m) with the risk of bank erosion and rate of runoff from adjacent slopes.

### 1.3 Establishment and management

The aim of the revegetation project was to produce quality timber within the constraints set by the primary needs of soil protection, enhanced water quality, wildlife habitat and landscape aesthetics. The species selected initially included local native understorey shrubs, regional selections of blackwood (*A. melanoxylon*) for cabinet timber, and a number of eucalypts (primarily *E. regnans* and *E. globulus*) for sawlogs. Site preparation involved spot application of herbicides (Glyphosate and Simazine) and there was no soil disturbance or watering and no fertilizer application. The first trees were planted by hand in spring 1987. The buffer planting was interplanted with *E. nitens* seedlings in spring 1988 increasing the stocking to approximately 1000 eucalypt stems per hectare inside the fenced strip (Figure 2a).



**Figure 2.** (a) Left: The riparian buffer at age six years showing the pruned *E. nitens*. (b) Right: The hand pruning technique employed.

Over the subsequent years the better performing trees were pruned (Figure 2b). Pruning was done in winter each year using hand tools (loppers and saws) and ladders. All branches were removed from the bole of selected trees up to a stem diameter of 10 cm; pre-emptive pruning above this was used to correct for form. Most trees were pruned to a height of just over 6.5m to allow for a butt log of 6.1m. Pruning, of the selected trees, was largely completed by age 6 years. Poorly formed trees that were competing with the pruned stems were thinned to waste each year following pruning. Tree diameter growth was regularly monitored using 7 circular plots located along the riparian belt.

Sheep were totally excluded from the belt except for opportunistic summer grazing for fire and weed control or the occasional rouges. The planted and

naturally regenerating understorey was encouraged while any willows causing concern were controlled using the stem injection of herbicide. All debris from thinning and pruning were left to decompose on site.

## 2. METHODS

### 2.1 Tree selection and measurement

In January 1999, nine *E. nitens* trees were selected for harvesting on the basis of form, size and proximity to other trees. The aim was to select individuals that were over 35cm in diameter at breast height (DBH), of good form, pruned to at least 5m, and close enough to other trees of good form to warrant thinning to reduce competition. The trees were all growing on alluvial soil within 10m of the creek bank. In most cases, harvesting simply required dropping of the electric wires from the fences and hand-felling out into the adjacent cleared paddock. Once on the ground the full tree length was measured along with the residual stump to give a total tree height. The pruned section of the tree was then separated from the top and cut into two shorter logs (except for tree 2) and the log ends sealed with a proprietary brand sealer to reduce drying rates.

The pruned logs were then numbered and transported to a log pile using the 42 hp farm tractor fitted with a front-end loader. The logs were stored under a water spray for two weeks before loading onto a tray truck for transporting to the mill at Creswick (approximately 100km) where they were held under water spray for another 4 weeks prior to debarking and milling.

Following de-barking the log length and underbark diameters were measured to assess log volume. The logs were sawn with a conventional back-sawing strategy at the Timber Industry Training Centre at Creswick, Victoria on a line-bar-carriage equipped with a band head saw (Figure 3). Resawing was conducted on a conventional saw-bench into the final product dimensions (mostly 38mm by 100mm). The sawn timber was immediately visually graded using the CSIRO Appearance Grading Criteria (Waugh and Rozsa 1991). A sample of boards were block stacked for transport to CSIRO in Clayton where it was stickered for air drying. A year later the timber was kiln-dried, reconditioned and dressed. Any boards graded as “select” or better when green were visually re-graded to assess the extent of degrade due to drying.



Figure 3. The milling of one of the 19 logs

## 3. RESULTS AND DISCUSSION

### 3.1 Tree Growth

Although the better performing *E. nitens* had reached diameters of over 40cm at breast height by age 10 years, annual growth data collected from plot measurements suggested that diameter increments were declining due to increasing competition (Figure 4). The dimensions of the nine trees selected for harvest are shown in Table 1.

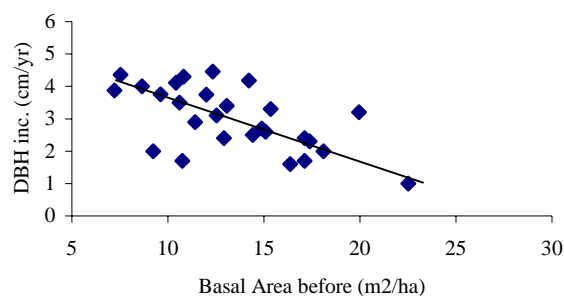


Figure 4. Relationship between plot Basal Area and subsequent annual Diameter Increment of selected plot trees between 1995 and 1998.  $R^2 = 0.38$ .

Table 1. Tree dimensions

Tree No	Diam. Breast Ht (DBH) (cm)	Tree Height (m)	Pruned height (m)	Overbark volume of standing trees (m <sup>3</sup> )	Overbark sawlog volume (m <sup>3</sup> )
1	41.0	21.1	6.4	1.12	0.67
2	38.0	21.4	5.4	0.98	0.62
3	40.8	25.0	7.0	1.13	0.72
4	36.5	25.4	6.3	1.21	0.65
5	42.6	22.7	6.7	1.23	0.78
6	38.1	20.8	6.3	1.06	0.63
7	37.5	22.3	6.4	0.99	0.59
8	38.9	23.2	6.8	1.11	0.63
9	40.0	22.4	6.5	1.14	0.69
<b>Mean</b>	<b>39.3</b>	<b>22.7</b>	<b>6.4</b>	<b>1.11</b>	<b>0.67</b>
<b>Total</b>				<b>9.97</b>	<b>5.99</b>

The total volume of the nine standing trees was estimated to be 10.0m<sup>3</sup> with 0.5m<sup>3</sup> of this remaining in the stump. Given that the over-bark volume of the pruned logs amounted to an estimated 6.0m<sup>3</sup> the pruned log volume was 60% of the total volume felled despite representing only 26% of the total tree height. The stump and unpruned section was left on site. Following debarking and log preparation a total of 4.7m<sup>3</sup> of sawlog was available for milling.

### 3.2 Recovery of green timber

The CSIRO Appearance Grading Criteria has 9 grades suitable for different applications in the production of appearance products. The three highest grades (Polishing, Moulding and Select) are considered the most valuable appearance products. These products are almost defect free on the graded faces and edges and they are grouped as “Select or better” in the analysis below. To achieve a select grade the product must be a minimum of 2.4 m in length and is graded on one face and two edges. As the aim of pruning was to obtain high quality products, the recovery products of select grade or better was considered to be the critical recovery to calculate.

Table 2 gives the recovery of all green products and the recovery of select grade and better for each individual log, the means for the bottom and top logs and for all logs.

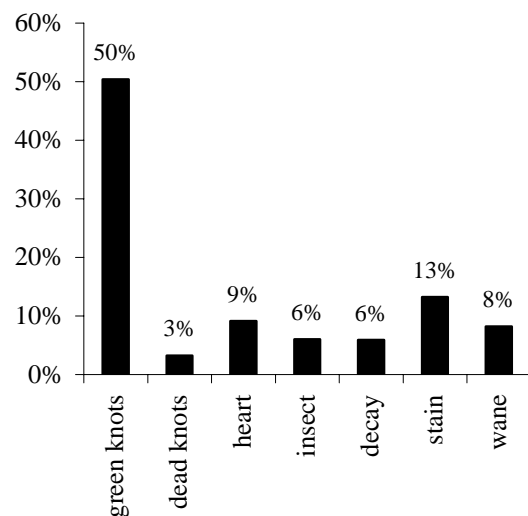
**Table 2.** The green sawn timber recoveries (Rec.) of Select and better (S&B) sawn timber grades

Log	Log Vol.	Total Sawn Rec.	Vol. S&B	Rec. S&B	% boards S&B
Bottom logs	(m <sup>3</sup> )	(%)	(m <sup>3</sup> )	(%)	(%)
1A	0.31	42	0.10	32	77
3A	0.37	32	0.09	23	74
4A	0.32	42	0.04	12	29
5A	0.35	45	0.09	24	53
6A	0.29	38	0.07	23	60
7A	0.33	35	0.07	21	60
8A	0.25	48	0.08	33	70
9A	0.30	43	0.10	31	73
<b>Total</b>	<b>2.52</b>		<b>0.62</b>		
<b>Mean</b>	<b>0.32</b>	<b>41</b>		<b>25</b>	<b>62</b>
Top log					
1B	0.23	44	0.02	10	23
3B	0.23	43	0.02	10	24
4B	0.24	36	0.01	5	14
5B	0.23	43	0.04	17	40
6B	0.19	48	0.02	8	17
7B	0.19	40	0.03	15	38
8B	0.18	36	0.02	11	29
9B	0.21	39	0.01	5	12
<b>Total</b>	<b>1.71</b>		<b>0.17</b>		
<b>Mean</b>	<b>0.21</b>	<b>41</b>		<b>10</b>	<b>25</b>

Tree 2	0.43	40	0.06	14	36
<b>Total</b>	<b>4.66</b>		<b>0.86</b>		
<b>Mean</b>		<b>41</b>		<b>18</b>	<b>44</b>

Sawn recovery was 41% for both the bottom and top logs. Sixty-two percent of the boards sawn from the bottom logs were graded green as select or better representing 25% of the saw log volume whereas only 25% of the boards from the smaller diameter top logs were of high grade representing just 10% of log volume

The major grade-limiting defect, affecting 50% of the boards, was green knots (Figure 5). Since the logs were pruned the green knots were often associated with pruned stubs and mostly located on the back face of boards from the inner heartwood. Decay was evident in some of the pruning stubs but was in itself only a minor (6%) grade-limiting defect. Decay was also associated with the damage caused by wood moths, in which case, the decay was often located in the clearwood zone. Stain was noted as a grade-limiting defect (13%) and possibly an indication that decay might have become more prevalent in future years had the trees not been harvested.

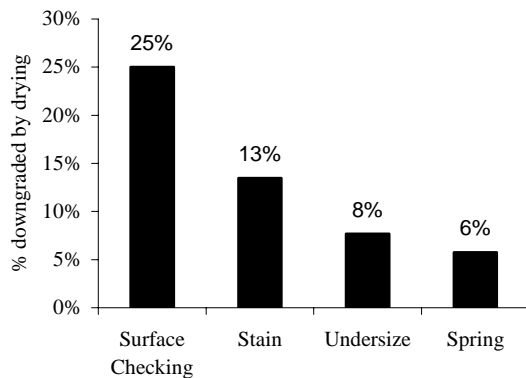


**Figure 5.** The causes of degrade of green boards

All 38mm thick boards assessed as select grade or better when green were re-graded following drying and dressing. In all fifty-two 38mm-thick boards were regraded and of these 25 (or 48%) remained as select grade or better. The main drying related causes of downgrading were surface checking (25%), stain (13%), under sizing (8%) and spring (6%) (Figure 6).

While pruning may be effective in increasing the recovery of high quality green products, this level of drying degrade would need to be reduced to maximise the return from pruning. The potential to apply quarter sawing as a means of reducing drying degrade may be increased by growing large diameter logs. More sophisticated drying strategies involving

Careful early drying may also be effective in reducing, or even eliminating, surface checking.



**Figure 6.** The causes of drying degrade in a sample of 52, 38mm thick boards

#### 4. FINANCIAL CONSIDERATIONS

The viability of timber production from riparian buffer strips will largely depend on the value of the individual standing trees. While the trees are performing a useful function harvesting for timber is unlikely unless the landholder is assured of a reasonable return (such as \$50 per pruned tree).

The highest value sawn products, as a group, are the dried timbers of select grade and better. The production of dried undressed timber from relatively young eucalypt plantations might expect to attract a wholesale price of at least \$1000/m<sup>3</sup> (Adams Timber Pers. Comm.). Lesser grades might sell for half this price or around \$500/m.

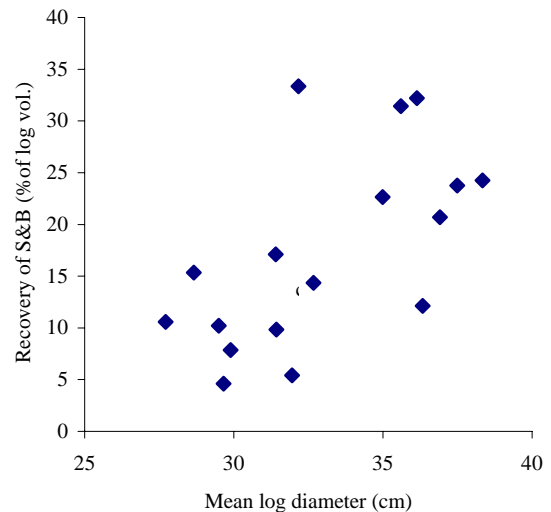
The nine trees milled in the trial produced a total of 1.90m<sup>3</sup> of sawn timber of which 0.86m<sup>3</sup> (45%) was graded (when green) as select grade or better with 0.46m<sup>3</sup> (24%) graded as “standard”, “utility” or “cover” grade (still suitable for appearance use or as structural components in furniture). The remaining 0.58m<sup>3</sup> (31%) was “case” grade or worse and might end up as woodchips at a value of around \$10/m<sup>3</sup>. Sawn recovery was 41% suggesting that at least 50% of the log volume (a total of 2.3m<sup>3</sup>) would also be chipped bringing the total volume of woodchips to 2.9m<sup>3</sup>.

Disregarding, for the moment, the degrade associated with drying suggests that the 0.86m<sup>3</sup> of select grade and better timber produced from the 9 trees might be worth in the order of \$860 (at \$1000/m<sup>3</sup>) and the lower grade timber worth \$230 (at \$500/m<sup>3</sup>). Residue products amount to a total of \$29 (at \$10/m<sup>3</sup>). This suggests that a total product value in the order of \$1120.

If it is assumed that the total harvesting and transporting costs for 5m<sup>3</sup> of sawlog is \$250 (or

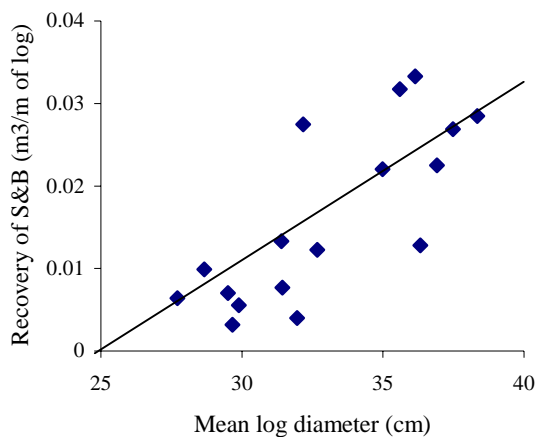
\$50/m<sup>3</sup> of log) and that the processing costs (including drying) for 2m<sup>3</sup> of sawn timber is \$934 (\$237/m<sup>3</sup> of sawn timber for milling and \$230/m<sup>3</sup> for drying (Leggate et al 2000)) then the total harvesting and processing costs come to \$1184. This suggests there is little value in harvesting logs of this size even if the drying degrade could be avoided.

To be viable, under these assumptions, the recovery of appearance grade timber would need to represent more than 20% of log volume or 50% of the sawn product. Because the main grade-limiting factor was green knots the recovery of appearance grade products from pruned trees is expected to increase with log diameter. Over the range of logs milled in this trial, the recovery of select or better timber increased with diameter suggesting that logs with a mean diameter of 40cm or more may be profitable (Figure 7).



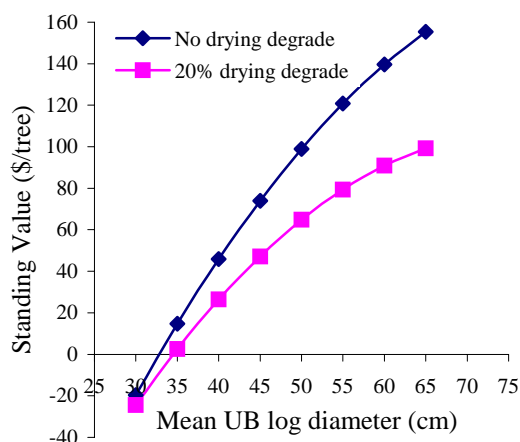
**Figure 7.** Recovery of select grade or better boards from logs of different average under-bark diameters.

Figure 8 presents the same data to show the real recovery of select and better timber per metre of log length against log diameter. If the same trees were grown to a diameter of 55cm DBH the 6.5m pruned section might provide two 3m logs with a total underbark volume of 0.97m<sup>3</sup> (mean diameter underbark of 45cm and length of 6.1m). From the regression shown in Figure 8 this would provide 0.044m<sup>3</sup> of select and better timber per meter of log or 0.268m<sup>3</sup> in total (28% of log volume). At \$1000/m<sup>3</sup> this would represent \$268 of value. Given a sawn timber recovery of 40% and a balance between lower grade and waste there might also be \$30 worth of low grade sawn timber and a total of \$5.50 of chip. This suggests a total product value of \$303 for a total cost of \$230 (\$50 harvesting and \$180 milling and drying): a return to the grower of \$73 for the tree



**Figure 8.** Volume of select grade or better boards per meter of log length from logs of different average under-bark diameters.  $Y=0.0024x-0.064$ ,  $R^2=0.61$ .

If drying problems downgraded 20% of the better grades the product value per tree would drop to \$276 leaving \$46/tree for the grower. The influence of mean log diameter and drying degrade on the predicted standing value of a 6.1m pruned log is shown in Figure 9.



**Figure 9.** Predicted standing value per tree against mean underbark log diameter assuming a 40% sawn timber recovery and 6.1m log length.

In a riparian buffer strip established and maintained for multiple values the only additional costs associated with the production of high value sawlogs will be the pruning and thinning. It has been estimated (Reid and Stewart 1994) that the time required to produce one final crop tree from a group of four is less than 30 minutes or around \$10 depending on how a landowner values labour. Wider tree spacings increase the return on pruning costs due to increased diameter increments (Reid 1999) and the viability of understory vegetation required for environmental and aesthetic values.

Although individual *E. nitens* trees growing on this site have reached 55cm DBH (underbark mean log diameter of approximately 45cm) by age 13 years it may be more realistic to expect an average rotation of 20 years. Assuming a total early timber management cost for the forest of \$10 per each harvested tree a return of \$46/tree in 20 years represents an Internal Rate of Return of over 7%.

## 5. CONCLUSIONS

The research suggests that small scale harvesting of eucalypts from multipurpose farm plantings may be viable if pruned trees are grown to a mean underbark log diameter of more than 40cm and drying degrade can be reduced to less than 20% of sawn output.

Diameter growth on this site was suppressed by competition suggesting that wider tree spacings (basal areas of less than 10m<sup>2</sup>/ha for most of the rotation) may allow farmers to harvest trees of 60cm DBH in less than 20 years. This would require a stocking rate of less than 100 trees per hectare and represents an average spacing between the trees of more than 10m. At this spacing sawn timber production is unlikely to recover the full cost of dedicating productive land to trees. However, if farmers were establishing trees for other values careful harvesting of widely spaced, large diameter high pruned trees of suitable species may provide an attractive return on the additional costs of silvicultural management (thinning and pruning) in multipurpose farm forests.

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## Personal Communication

Adam's Timber, Coldstream Victoria

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