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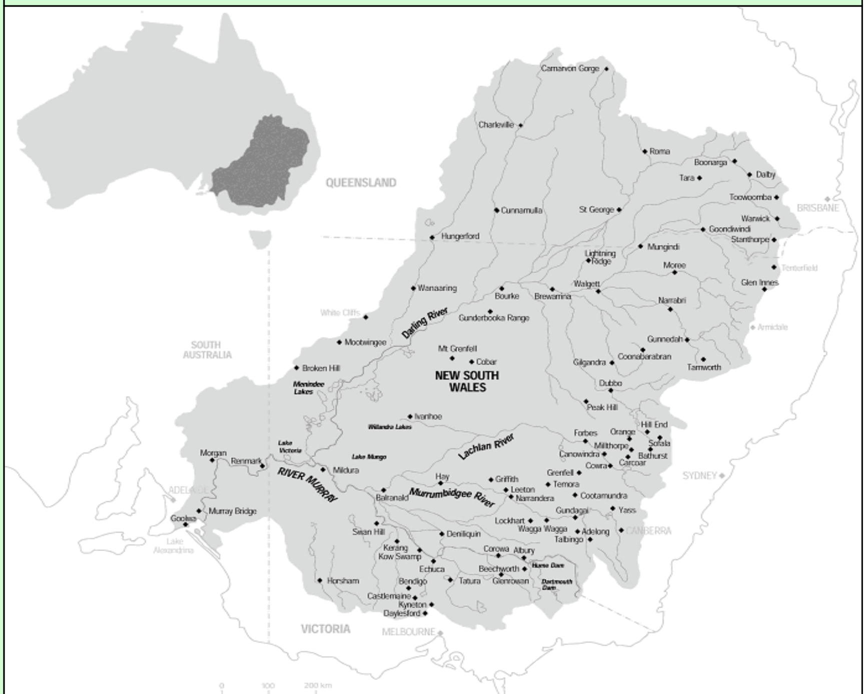

Schools of Economics and Political Science
University of Queensland
Brisbane, 4072
rsmg@uq.edu.au

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

Portable Sawmilling Costs for Landholders in Western Queensland

Tyron J. Venn[1], Robbie L. McGavin[2] and William W. Leggate[2]

[1] Risk and Sustainable Management Group, School of Economics, The University of Queensland, Brisbane Qld 4072, Australia.

[2] Horticulture and Forestry Sciences, Queensland Department of Primary Industries and Fisheries, Brisbane Qld 4068, Australia.

Portable sawmilling trials with *Acacia aneura* (mulga) and *A. cambagei* (gidgee) have been undertaken to estimate the private landholder costs associated with small-scale timber production from woodlands in western Queensland, Australia. A time study of harvesting and milling operations facilitated estimation of landholder labour input requirements. The scarcity and small size of millable logs, coupled with the prevalence of timber defects, make harvesting and portable sawmilling of western Queensland acacias an expensive undertaking for landholders. The cost of producing sawn timber that meets the High Feature (HF) grade of Australian Standard *AS2796* is estimated at between A\$3,000/m^3 and A\$3,400/m^3 of HF timber.

Keywords: Acacia timbers, farm forestry, portable sawmills, sawmilling costs.

INTRODUCTION

The woodlands of western Queensland, Australia, contain a substantial timber resource that has been traditionally viewed as an impediment to agricultural (predominantly pastoral) development. Lack of information about the wood properties of the resource, the scarcity of straight-boled trees, their typically small stem diameters, the prevalence of timber defects, remoteness from major timber markets, and the availability of high-quality cabinet timbers and construction hardwoods from eastern Queensland, have led to low private landholder valuation of these woodlands. As landholders have strived to increase the productivity of their pastoral holdings, much of the resource has been pulled (with bulldozer and chain) windrowed and burnt, a management practice that was encouraged by the State Government until the mid-1980s (Rolfe 2000). By 1997, approximately 24 M ha (23%) of Queensland's *Acacia* and *Eucalyptus* woodlands had been cleared (National Land and Water Resources Audit 2001).

Low commodity prices and drought, particularly throughout much of the late 1980s and 1990s, resulted in many western Queensland landholders experiencing financial difficulties. During this time, the unique timber properties of several western Queensland hardwoods, particularly *Acacia* species, became better appreciated in Australia and, to a limited extent, overseas. Small volumes have reportedly been utilised in specialty applications where high timber prices were obtained (Venn and Whittaker 2003). This has led some landholders to change long-held attitudes; woodlands are being seen less as an impediment to their enterprises and more as an economic opportunity.

Timber production potentially offers a relatively stable and drought-proof income stream to traditional western Queensland graziers. Western hardwoods can also be considered a form of liquid asset, which could be tapped when cash is required. Timber production in western Queensland could generate considerable economic benefits in rural communities, including employment creation, local skill development, income diversification and attraction of tourism. However, there is a lack of information about the utilisation of western Queensland hardwoods and potential markets (Venn *et al.* 2002).

In the mid-1990s, the Queensland Forestry Research Institute (QFRI)[1] identified demand from western Queensland landholders for a private financial analysis of small-scale timber production from natural woodlands in western Queensland. Preliminary investigations highlighted that research into timber utilisation has been performed in other Australian semi-arid woodland types, notably in the Western Australian Goldfields (Brennan and Newby 1992; Siemon and Kealley 1999); however, similarities between the Goldfields *Eucalyptus* woodland resources and the *Acacia* woodlands of western Queensland are limited to the arid climate and remoteness from markets. QFRI undertook a broad research project that included determination of the geographical distribution, merchantable wood volumes and wood properties of selected tree species, identified potential markets for western Queensland hardwoods, determined appropriate processing and seasoning methods, and estimated costs and saleable recoveries for potential timber processing operations (Venn *et al.* 2002). One of the study's aims was to make research findings relevant to landholders. Thus, for example, harvesting and sawmilling trials were performed by a two-person team employing a chainsaw, farm truck, tractor, and a Lucas eight-inch single circular saw portable sawmill.

[1] QFRI has recently been restructured and is now known as Horticulture and Forestry Sciences, Queensland Department of Primary Industries and Fisheries.

Drawing upon the outcomes of QFRI trials, this paper estimates the private landholder costs associated with the harvest, portable sawmilling and further processing of *Acacia* logs from the woodlands of western Queensland. The rationale for portable sawmilling trials in western Queensland is explained, and the western Queensland hardwood resource and study area described. The harvesting and portable sawmilling trials are outlined and findings on sawn timber recovery and labour productivity achieved in the trials reported. The assumptions and method for calculating portable sawmilling costs for western Queensland hardwoods are described, and average variable, fixed and total costs of sawn timber production estimated.

THE RATIONALE FOR PORTABLE SAWMILLING TRIALS IN WESTERN QUEENSLAND

Portable sawmills are considered to have several advantages over fixed-site mills, including reducing or eliminating log transport costs, being capable of handling small and odd-shaped logs with minimal re-setting of equipment, increasing sawn timber recovery from the log, allowing milling to be undertaken by small teams or even a single person, and offering a low setup cost and low-technology entry point into the timber industry (Kowero *et al*. 1985, DPI 1998). These factors have resulted in portable sawmills becoming popular in many developing countries, but also in the USA and Australia (Smorfitt *et al*. 1999). In recent years, portable sawmills have accounted for most of the growth in licensed primary log processing facilities in Queensland (DPI 1998); however, not all types of portable sawmills require licensing (Smorfitt *et al*. 1999). In western Queensland, where potential sawlogs are small and there are few fixed-site sawmills within an economic log haulage distance of the resource, portable sawmills appear highly suited to landholders wishing to diversify their enterprises into forestry. However, few reliable estimates of the operating costs of portable sawmills are available (Stewart and Hanson 1998, Smorfitt 2000).

The recovery rate of green-off-saw (GOS) timber from roundlog volume, and the speed at which logs can be converted into sawnwood, have a major bearing on the operating costs of portable sawmills. Australian promoters of portable sawmills claim recovery rates of between 60% and 70% (Smorfitt *et al*. 1999). However, it is impossible to achieve such rates with small western Queensland sawlogs, particularly considering that east-coast fixed hardwood sawmills in Queensland achieve GOS recoveries of about 36% from much larger sawlogs (Native Forest Sawlog Pricing Working Group 1997). The throughput capacity of portable sawmills processing traditional timber species, particularly exotic conifers and eucalypts, generally ranges from about 0.1 m^3 GOS/hr for chainsaw mills to 0.84m^3 GOS/hr for single circular saw sawmills (similar to the Lucas mill employed in this study) to 2.5m^3 GOS/hr for twin circular saw sawmills (Stewart and Hanson 1998). However, such throughputs are unlikely to be achieved with the non-traditional western Queensland hardwood timber resource.

Surveys of 25 portable sawmill operators in Victoria (Stewart and Hanson 1998) and 14 portable sawmill managers in north Queensland (Smorfitt 2000) found that none were able to provide a definitive estimate of the cost of producing milled timber. In eastern Queensland, felling, docking and snigging costs have been estimated at \$18/m^3 to \$33/m^3 of roundlog (adjusted by the Consumer Price Index to 2002 dollars)

(Native Forest Sawlog Pricing Working Group 1997, Leggate *et al.* 1998)[2]. Operating costs (i.e. excluding overheads) for portable sawmilling of eucalypts in Victoria and rainforest cabinet timbers in north Queensland have been estimated by Stewart and Hanson (1998) and Smorfitt (2000) to be about \$62/m^3 and \$140/m^3 of roundlog respectively. The total cost (i.e. including overheads) of harvesting, transporting and milling timbers from the Western Australian Goldfields have been estimated at \$600/m^3 to \$800/m^3 GOS for experienced operators and \$1,200/m^3 GOS for inexperienced operators (Siemon and Kealley 1999). However, the timbers of western Queensland differ considerably from the resources harvested and milled in these studies, and much of the financial information is likely to have limited applicability to western Queensland. Consequently, the estimation of costs of portable sawmilling operations in western Queensland required data collected from milling trials.

TIMBER SPECIES AND STUDY AREAS FOR PORTABLE SAWMILLING TRIALS IN WESTERN QUEENSLAND

Many western Queensland hardwood species have wood properties that make them potentially suitable for a range of high-value timber products (Fairbairn 1999). As a group, they have high air-dry (12% moisture content) densities of between 1,000 kg/m^3 and 1,300 kg/m^3, high Janka hardness (13 kN to 18 kN), low shrinkage from green to air-dry (typically about 1.5% radial and 2.5% tangential), and sound gluing properties (Cause 1999). Western Queensland hardwoods offer a variety of attractive timber colours from yellows through to light browns, chocolate browns and reds.

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[2] All monetary values in this paper are in Australian dollars.

Some species, including *Acacia cambagei* (gidgee), can have highly attractive figuring.

From the large diversity of western Queensland hardwoods, *A. aneura* (mulga) and gidgee were selected for the portable sawmilling study on the basis of their wide distribution in western Queensland (National Land and Water Resources Audit 2001), the potential for large (1,000s m^3/yr) ecologically and economically sustainable harvests of timber, and favourable wood properties for high-value specialty timber product manufacture. Manufacturers of musical instruments (e.g. guitar, violin and flute) and custom knife handles have indicated a willingness to pay prices in the order of \$20,000/m^3 to \$30,000/m^3 for mulga and gidgee clearwood (Venn and Whittaker 2003). Mature mulga and gidgee trees are typically up to about 10 m to 12 m tall and 20 cm to 30 cm diameter at a height of 30 cm above ground. Stem form is frequently poorly suited to the production of sawn timber, with heavy branching and log defects (e.g. from fire and fungal infection) being common.

The harvesting and portable sawmilling trials were conducted on Maryvale Station (located south-west of Morven) and Yankalilla Station (located south of Cunnamulla) in western Queensland. These properties were chosen because they contain areas of mulga and gidgee woodlands respectively that were regarded as broadly representative of woodlands in the region, and because enthusiastic landholders were willing to provide unpaid assistance in the trials. The study sites had probably been selectively cut in the past for fence-posts and other low-value products, which is common for these woodland types in western Queensland.

PROCEDURES ADOPTED IN THE PORTABLE SAWMILLING TRIALS

Portable sawmillers were contracted by QFRI to undertake harvesting, snigging, hauling and portable sawmilling operations over a six-day period at Maryvale Station in 2000, and a five-day period at Yankalilla Station in 2001. A 20 ha mulga woodland site at Maryvale Station, and two gidgee woodland sites at Yankalilla Station of 4.5 ha and 5.5 ha each, were inventoried prior to harvesting. All trees at each site capable of producing a sawlog[3] were marked for removal and their diameters were measured at 30 cm above ground level. The portable sawmilling contractors felled each marked tree with a chainsaw and crosscut the tree bole to maximise log length. QFRI personnel measured the large-end and small-end or centre diameters of the logs, and log length. Each harvested log was assigned a unique identifier, which would enable all sawnwood to be traced back to the log and tree from which it had been sawn.

Portable sawmilling procedures were varied at each station to facilitate a preliminary examination of the financial performance of fixed-site portable sawmilling versus multi-site portable sawmilling. On Maryvale Station, a fixed-site sawmilling regime was employed; a tractor snigged the mulga logs to loading zones where logs were lifted onto a truck for haulage to the portable mill. The mill had been erected close to the homestead, about 6 km from the harvested mulga paddock. On Yankalilla Station, a multi-site sawmilling regime was adopted; a tractor snigged the gidgee logs to the nearest of three predetermined sawmill sites in the woodland. Sawn boards were then

[3] Standard hardwood sawlog specifications for timber harvesting in Queensland are based on eastern species, which differ markedly in tree form from western Queensland hardwoods. This necessitated development of an alternative sawlog specification. For the purposes of this study, a sawlog was at least 1.2 m in length, had a minimum small-end diameter under bark of 125 mm and had sweep or bend generally not exceeding about 20 mm/m. If a tree had a large scar (e.g. from a fire or from physical damage) or showed other obvious signs of defective wood, it was rejected as a sawlog tree.

hauled to the homestead following portable sawmilling. Since each regime was applied once to one woodland type, no conclusions can be drawn about the relative merit of one portable sawmilling strategy over the other.

At each sawmilling site, logs were sorted into batches of similar sizes and the sawmilling contractors' experience was used to determine suitable sawing patterns for each log size. Logs were processed into sawn boards (approximately 75% of total sawn volume), bark-to-bark slabs (5%) and block sections (20%), with the aim of maximising recovery of GOS timber. Boards of standard widths and thicknesses, ranging from 12 mm x 50 mm to 50 mm x 125 mm, were sawn oversize to allow for shrinkage and dressing. The thickness of bark-to-bark slabs ranged from 12 mm to 25 mm, and block sections were 75 mm x 75 mm and 100 mm x 100 mm in cross-section.

Sawn boards on each station were then randomly partitioned allocated into four groups for seasoning and grading studies. Approximately half the sawn volume remained on the stations to be air-dried, with the rest freighted to Brisbane for solar kiln and dehumidifier kiln drying. Once dried to between 10% and 12% moisture content (approximate average atmospheric equilibrium moisture content in western Queensland and Brisbane respectively), sawn boards were visually graded to Australian standard *AS2796* (1999) - *Timber-Hardwood-Sawn and Milled Products*. Boards that met or exceeded High Feature (HF) grade of this standard were considered saleable.

SAWNWOOD RECOVERY AND PRODUCTIVITY OF LABOUR IN PORTABLE SAWMILLING TRIALS WITH MULGA AND GIDGEE

Table 1 lists the sawlog resource and sawn timber recovery rate at the study sites. Short lengths, small diameters and defects such as fire scars, fungal infections and termite and other insect damage, were characteristic of the sawlogs, which made milling difficult. Nevertheless, the GOS recoveries achieved were similar to recovery rates in eastern Queensland fixed-site hardwood sawmills; 28% for gidgee and 35% for mulga. Defects were more prevalent in the gidgee sawlogs, which is likely to explain most of the difference in GOS recovery between species.

Table 1. Sawlog resource and sawn timber recovery rate in the mulga and gidgee portable sawmilling trials in western Queensland

Summary statistic	Mulga	Gidgee
Logged area (ha) site 1	20	4.5
site 2	na	5.5
Number of trees harvested	124	126
Average tree diameter (cm)	21.9	26.4
Number of millable logs cut	128	117
Average log centre diameter (cm)	18.2	24.3
Average log length (m)	2.1	1.7
Gross roundlog volume harvested (m^3)	7.24	9.86
Average roundlog volume (m^3)	0.057	0.084
Gross roundlog volume per hectare (m^3/ha)	0.36	0.99
GOS recovery (% of roundlog volume)	34.6	27.6
HF recovery (% of GOS volume) [a]	35.9	35.5

a. Boards were graded according to *AS2796* (1999).

Observations of time required for the two-person teams to harvest and process mulga and gidgee sawlogs in the portable sawmilling trials are reported in Table 2. Production of GOS boards required 37.1 and 30.4 person hours per cubic metre GOS for mulga and gidgee respectively, for an average of 33.8 person hours per cubic metre GOS or 16.9 hours per person per cubic metre GOS. Lack of contractor experience in milling western Queensland hardwoods resulted in large time requirements for clamping logs and blade repairs. Some of this downtime, totalling 1.5 hours and 6.8 hours over the entire trial for the mulga and gidgee portable sawmilling operations respectively, has been omitted from Table 2 because it was considered avoidable for more experienced western hardwood millers.

Table 2. Labour requirements for the two-person mulga and gidgee portable sawmilling trials in western Queensland

Activity	Total person hours	
	Mulga	Gidgee
Tree selection	10.0	7.5
Tree felling	10.0	8.8
Snigging	13.0	12.8
Hauling	5.0	0.0
Mill set-up/down	2.0	6.0
Milling	46.5	35.5
Mill sharpening and refueling	5.5	1.5
Mill saw blade changing	1	1.0
Total hours	93.0	73.0
Total hours/m^3 GOS [a]	37.1	30.4

a. Total hours divided by GOS volume from Table 3.

Although differing harvesting and sawmilling practices between the two operators could have contributed to some of the divergence in labour requirements, differences in log availability and size (Table 1) were probably the major contributing factors. Low mulga sawlog volumes per hectare increased felling, docking and snigging labour requirements by approximately 1.7 hours/m^3 of log relative to gidgee. The smaller diameter of mulga logs made holding them in place during sawing more difficult, resulting in greater wear and tear on the sawblade and necessitating additional sawblade sharpening. Log holding techniques and other skills acquired by

QFRI staff overseeing the mulga study were applied during the gidgee trial, which contributed to the reduction in blade sharpening time in the gidgee study.

Table 3 reports the productivity of the Lucas portable sawmill in the mulga and gidgee trials. These rates are approximately one-eighth the level suggested by Stewart and Hanson (1998) for a single circular saw portable mill, such as the Lucas mill. The difference can be explained by Stewart and Hanson's adoption of productivity rates claimed by sawmill manufacturers, which are likely to be optimistic, and the difficulties associated with milling small western Queensland logs with high levels of defect.

Table 3. Productivity of the Lucas eight inch single circular saw portable sawmill during the mulga and gidgee trials in western Queensland

Item	Mulga	Gidgee
Volume of roundlogs sawn (m^3)	7.24	8.69
GOS sawn timber recovery (m^3)	2.51	2.40
Hours spent milling [a]	26.5	19.0
Volume of roundlogs sawn (m^3/hour)	0.27	0.46
GOS sawn timber recovery (m^3/hour)	0.09	0.12

a. Hours spent milling includes time spent milling, refuelling and sharpening, and changing the sawblade, as detailed in Table 2.

ASSUMPTIONS AND METHOD FOR ESTIMATING PORTABLE SAWMILLING COSTS IN WESTERN QUEENSLAND

A model that estimates portable sawmilling costs from a private landholder perspective has been developed based on the mulga and gidgee sawmilling trials, i.e. logs are harvested, portable milled, air-dried and graded. For the purposes of cost analysis, three additional procedures are assumed to be undertaken to convert hardwood logs into saleable sawn timber. First, in accordance with the Queensland *Timber Utilisation and Marketing Act 1987*, mulga and gidgee boards containing sapwood are chemically protected against attack from lyctid beetle (*Lyctus brunneus*). The small size of mulga and gidgee logs means that most sawn timber is likely to have sapwood hence all sawn timber has to be treated prior to air-drying. Second, board sections that do not meet the HF grade of *AS2796* are not saleable and are discarded. Third, the treated, dried and graded HF product is freighted to the nearest major market, Brisbane, a distance of approximately 1,200 km. It is assumed that landholders do not process the timber into a finished dressed product, because several timber industry experts commented that landholders entering the industry on a part-time basis are unlikely to have the required skills, and would wish to minimise setup costs.

In the model, it is assumed that two landholders devote half of their annual work hours to timber production, with a work year comprising 48 weeks at 40 hours per week or 1,920 hours in total. Setup costs for portable sawmilling in western Queensland are listed in Table 4. It is assumed that a 7 t capacity farm truck and a tractor, already owned by the landholder, can be made available for timber production. All equipment purchases are financed with a 10-year bank loan with a fixed interest rate of 8% per annum. Portable sawmilling costs are analysed for the cases where timber is harvested from leasehold land (royalty payable) and freehold land (no royalty payable). The average of royalties charged by the Queensland Department of Primary Industries – Forestry for mulga and gidgee, $\$45/m^3$, as provided by Walls (2002), is adopted in this analysis. Taxation implications are not modelled.

Table 4. Cost of equipment for portable sawmilling by landholders in western Queensland

Item	Cost ($)
Chainsaw and safety equipment	2,170
Portable sawmill	13,500
Chemical treatment tank	3,500
Air-drying shed	10,000
Small docking saw	2,500
Total	31,670

Due to the lack of reliable operating cost information for portable sawmills, estimates of the non-labour expenses were gathered through informal discussions with Lucas (2002) and Burns (2002), who are respectively a portable sawmill manufacturer and contractor, and a certified portable sawmilling trainer and contractor. Details of portable sawmill operating expenses for a Lucas portable sawmill follow Venn *et al.* (2002). Published literature, private industry, the Australian Tax Office, and several government agencies and academic institutions were consulted for plausible estimates of labour and non-portable sawmill equipment operating costs. A labour cost of $20/hour, including one-third on-costs for superannuation and workers' compensation, has been adopted, which approximates the Queensland State Award (including on-costs) for fellers, sniggers and sawmill workers in 2002 (Queensland Government 2002).

Variable cost in dollars per cubic metre of HF output is assumed to be constant over the output levels achievable by landholder portable sawmillers. The average productivity of labour (33.8 person hours/m^3 of GOS timber produced) and productivity of the sawmill (0.105 m^3 of GOS timber produced per hour of sawmill operation) achieved in the mulga and gidgee trials have been incorporated into the model. No time studies were conducted for chemical treatment, air-drying and docking of mulga and gidgee boards. QFRI chemical treatment, seasoning and wood processing experts estimated the labour requirements for these activities at 2.6 hours/person/m^3 GOS for a two person operation (McNaught 2002, Norton 2002). The average of GOS and HF recoveries achieved in the mulga and gidgee portable sawmilling trials are employed in the cost analysis. The only fixed cost item in the model is loan repayments for equipment, which totals $4,720/year. The method for estimating western Queensland landholder harvesting, snigging, loading, hauling, chemical treatment, and seasoning expenses, is provided in Venn *et al.* (2002). Sensitivity analyses have been performed to assess the effect of changes in parameter assumptions on portable sawmilling costs.

ESTIMATED COSTS OF PORTABLE SAWMILLING *ACACIA* SPECIES IN WESTERN QUEENSLAND

While sawlog harvesting expenses are usually estimated on a roundlog basis, it is typical for the costs of other activities – including chemical treatment, air-drying, dressing and freight costs – to be expressed per cubic metre GOS or per cubic metre of final product. In Table 5, cost estimates for landholders producing western Queensland *Acacia* timber with a portable sawmill are presented in all three formats (where HF boards are the final product). Reported fixed (and hence total) costs assume landholders have a half-time involvement in portable sawmilling. Total output of sawn, treated, seasoned and docked HF *Acacia* timber boards is estimated to be 17.7 m^3 per annum[4].

Table 5. Harvesting, portable sawmilling and further processing costs for *Acacia* timber production in western Queensland

Activity	Cost ($/$m^3$)		
	Roundlog	GOS [a]	HF [b]
Variable costs (including labour)			
Royalty on leasehold land	45	146	406
Tree selection	21	69	191
Fell and merchandise	28	89	248
Snig	32	103	286
Log haulage (incl. loading/unloading) [c]	11	34	95
Mill setup/setdown	6	18	49
Portable sawmilling	151	486	1,350
Total harvesting and portable sawmilling on freehold land	248	799	2,219
Total harvesting and portable sawmilling on leasehold land	293	945	2,624
Chemical treatment	11	35	97
Air drying (seasoning)	9	30	83
Docking	16	50	139
Administration	16	50	139
Freight off-farm [d]	11	35	97
Total variable costs on freehold land	311	998	2,774
Total variable costs on leasehold land	356	1,144	3,180
Average fixed costs [e]			
Business loan for equipment	30	96	267
Average total costs on freehold land [e]	341	1,094	3,039
Average total costs on leasehold land [e]	386	1,240	3,444

a. GOS recovery is 31% of roundlog volume.
b. High feature grade recovery is 36% of GOS sawn timber volume.
c. A return journey of 12 km has been assumed.
d. Freight distance is 1,200 km.
e. Fixed and total costs have been calculated under the assumption of a half-time operation (i.e. 960 hours/person/year) producing 17.7 m^3 of HF product per annum.

[4] Annual output of HF *Acacia* timber is estimated with the equation: 960 / (16.9 + 2.6) x 0.36, where 960 is the number of forestry work hours/person/year; 16.9 is the average time to harvest and portable mill mulga and gidgee sawlogs in hours/person/m^3 GOS; 2.6 is the estimated labour requirement for chemical treatment, air-drying and docking of mulga and gidgee sawn timber in hours/person/m^3 GOS; and the recovery rate of HF timber from GOS boards is 36%.

Average total cost (ATC) of sawn timber production is estimated to be \$3,039/m^3 and \$3,444/m^3 of HF product or \$1,094/m^3 GOS and \$1,240/m^3 GOS for timber harvested on freehold and leasehold land respectively. Portable sawmilling accounts for 44% and 39% of the ATC when timber is harvested on freehold and leasehold land. About 76% and 67% of ATC are payments to landholder labour when harvesting from freehold and leasehold land. Figure 1 illustrates the sensitivity of ATC of HF board production to labour cost when landholders operate the portable sawmill on a half-time basis. Figure 2 illustrates the sensitivity of ATC to GOS and HF recovery rate when the sawmill is operated half-time. Relatively small changes in both parameters have a large effect on ATC.

Figure 1. Sensitivity of average total cost of portable sawmilling western Queensland hardwoods to labour cost, under half-time mill operation

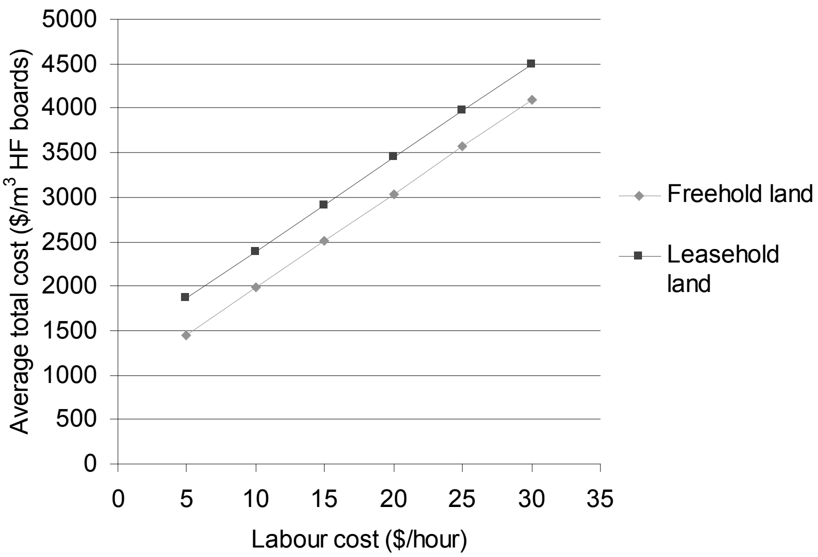

Figure 2. Sensitivity of average total cost of portable sawmilling western Queensland hardwoods to GOS and HF recovery, under half-time mill operation

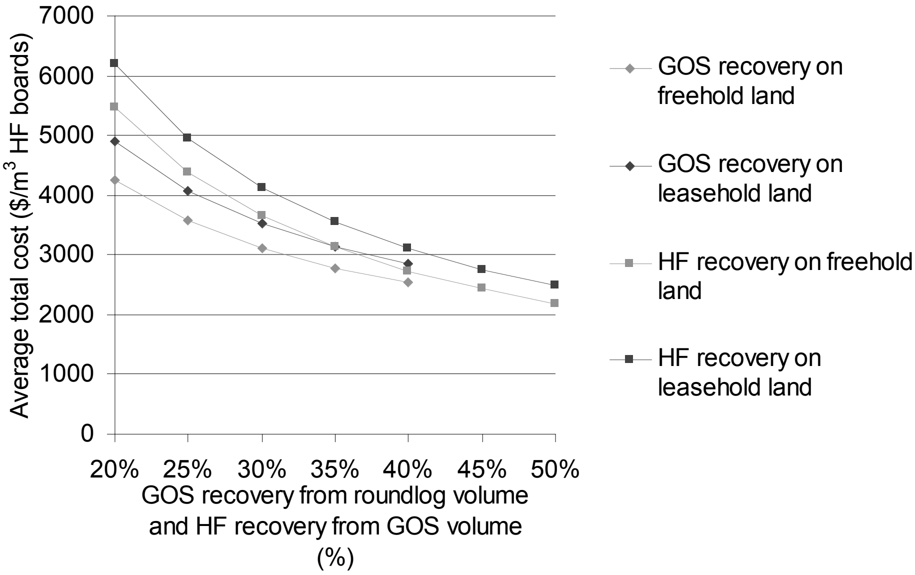

Figure 3 illustrates the variation in average variable cost (AVC), average fixed cost (AFC) and ATC of portable sawmilling western Queensland acacias with level of output, in the short-run. ATC decreases sharply as annual output increases below about 10 m^3 per annum. Table 6 reports the effect on ATC when landholder involvement varies from quarter-time to full-time. Reducing landholder involvement from half-time to quarter-time increases ATC by $265/$m^3$ of HF product. Relatively small cost savings per unit of output are achievable by increasing landholder involvement beyond half-time.

Figure 3. Estimated relationship between production costs and annual output for landholders portable sawmilling western Queensland hardwoods

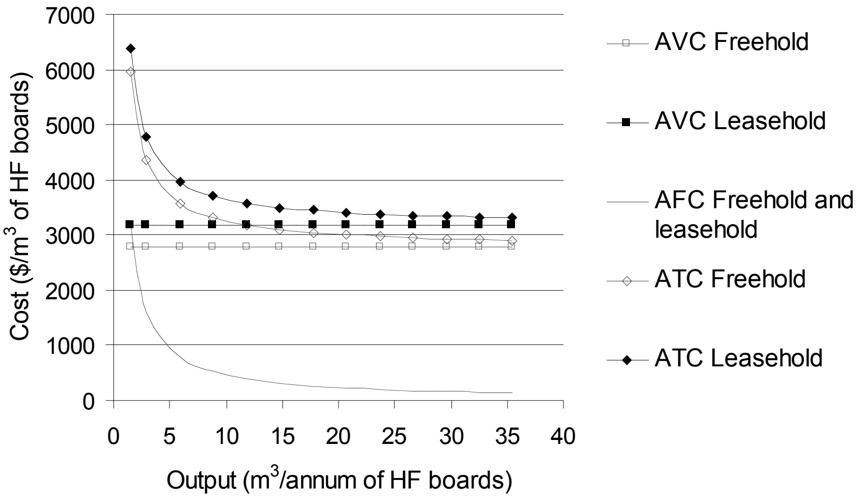

Table 6. Average total cost of production of HF western Queensland hardwood boards by level of landholder involvement and land tenure

Land tenure	ATC of production ($/m^3 HF boards) by level of landholder involvement			
	Quarter-time	Half-time	Three-quarter-time	Full-time
Freehold land	3,304	3,039	2,950	2,906
Leasehold land	3,710	3,444	3,356	3,312

DISCUSSION

The financial analysis reveals that milling *Acacia* logs in western Queensland is a highly expensive undertaking, with costs per cubic metre GOS being approximately double those reported to be typical for the Queensland east-coast hardwood sawmilling sector by the Native Forest Sawlog Pricing Working Group (1997). This is a result of high felling and merchandising and snigging costs, low log throughput, and low GOS and HF recovery rate from *Acacia* logs due to the prevalence of defects and small log sizes.

It is reasonable to expect that forestry activities undertaken on a part-time basis by landholders with little timber-milling experience and without purpose-built equipment, will be carried out less efficiently in terms of sawlog volumes delivered to the mill per hour than can be achieved by commercial operators in eastern Queensland. Portable sawmilling cost estimates for western Queensland acacias are high compared with those of Stewart and Hanson (1998) for southern Australian eucalypts, due to the lower sawnwood recovery rate and mill throughput. Estimates of portable sawmilling costs per cubic metre of log for north Queensland cabinet timbers (Smorfitt 2000) are similar to the estimates in this study. ATC estimates for western Queensland portable sawmilling are similar to those for timbers from the remote and semi-arid Western Australian Goldfields reported by Siemon and Kealley (1999).

The results of the above cost analysis are subject to several limitations. Costs per cubic metre of product will vary with the stocking density and size of millable logs. Stands with greater stocking density or larger logs than the stands harvested in the milling trials could be harvested and milled with lower costs than reported here. The GOS recovery rate also has a major effect on portable sawmilling costs, since any improvement potentially increases volumes of saleable timber with little additional cost. Therefore, investment in training and experimentation with processing techniques and equipment technology to maximise GOS recovery from western Queensland acacias is likely to have a large payoff for portable sawmill operators. Similarly, developing timber markets that accept higher levels of defects than permitted by the HF grade of *AS2796*, could substantially reduce production costs per cubic metre of product. Research in progress at QFRI indicates that recovery of sawn, seasoned and graded timber can vary considerably between western Queensland *Acacia* species. Preliminary results from a sawmilling trial with *A. shirleyi* (lancewood) suggest higher recoveries than achievable with mulga and gidgee.

Portable sawmilling of western Queensland hardwoods provides landholders with an opportunity to diversify their farm business with a small initial capital outlay. This could increase the value that landholders attribute to woodlands, and lead to reduced land clearing intentions in western Queensland. However, high costs of production mean that the financial viability of portable sawmilling operations is likely to depend on development of low-volume, high-value niche markets, where buyers are willing to pay a premium for the unique properties of these timbers. It is therefore conceivable that market demand could be satisfied by only a small number of landholders.

While portable sawmilling encourages timber harvesting, this is highly selective harvesting of individual stems, as distinct from land clearing. However, due to the lack of information about the remaining area, distribution and growth rate of *Acacia* woodlands in western Queensland, establishment of a timber industry will need to be accompanied by ecological studies and resource inventories that facilitate the development of ecologically sustainable management practices.

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REFERENCES

AS2796 (1999), *Timber-Hardwood-Sawn and Milled Products*, Standards Australia, Sydney.

Brennan, G.K. and Newby, P. (1992), 'Potential of Western Australian Eastern Goldfields timbers for high quality wood products', *Australian Forestry*, **55**(1), 74-79.

Burns, D. (2002), personal communication. Portable Sawmill Trainer, Blackbutt.

Cause, M. (1999), Wood Properties of Selected Inland Timbers, Summary report for the Department of Natural Resources, Desert Uplands Build-Up and Development Strategy Committee, and South-West Strategy Group, Queensland Forestry Research Institute, Brisbane.

DPI (Department of Primary Industries) (1998), *An Overview of the Queensland Forest Industry*, Information Series QI 98015, DPI, Brisbane.

Fairbairn, E. (1999), *Australian Timbers Volume Two: Western Queensland Trees and Their Timbers*. Department of Natural Resources, Brisbane.

Kowero, G.S., Kalage, S.E. and O'kting'ati, A. (1985), 'The performance of mobile sawmills in Northern Tanzania', *Commonwealth Forestry Review*, **64**(3): 219-225.

Leggate, W., Palmer, G. and Walduck, B. (1998), 'Economic aspects of eucalypt hardwood plantation forestry: a case study on *E. cloeziana* plantations in S.E. Qld', *Plantation and Regrowth Forestry: A Diversity of Opportunity*, Australian Forest Growers Biennial Conference Proceedings, 6-9 July, Lismore, NSW, pp. 229-243.

Lucas, R. (2002), personal communication. Manager, Lucas Mill Pty Ltd, Beechworth (Victoria).

McNaught, A. (2002), personal communication, Principal Research Scientist, Queensland Forestry Research Institute, Brisbane.

National Land and Water Resources Audit (2001), *Australian Native Vegetation Assessment 2001*, National Land and Water Resources Audit, Land and Water Australia, Canberra.

Native Forest Sawlog Pricing Working Group (1997), *Hardwood Pricing Review,* Hardwood Working Group Report for submission to the Native Sawlog Pricing Tribunal, DPI-Forestry, Brisbane.

Norton, J. (2002), personal communication, Leader, Forest Products Biodeterioration, Queensland Forestry Research Institute, Brisbane.

Queensland Government (2002), *Forest Resources Industry Award - State (Southern Division Western District)*, http://www.wageline.qld.gov.au/sumsheets/sdwd.htm, accessed 2 April 2002.

Rolfe, J.C. (2000), 'Broadscale tree clearing in Queensland', *Agenda*, **7**(3)**,** 219-36.

Siemon, G.R. and Kealley, I.G. (1999), *Goldfields Timber Research Project: Report by the Research Project Steering Committee*, Department of Commerce and Trade, Goldfields Esperance Development Commission, Department of Conservation and Land Management, Goldfields Specialty Timber Industry Group Inc., Curtin University, Perth.

Smorfitt, D.B., Herbohn, J.L. and Harrison, S.R. (1999), 'Factors in the acquisition and utilisation of portable sawmills in Queensland', *Australian Forestry*, **62**(1), 45-50.

Smorfitt, D.B. (2000), A commercial evaluation of the sawmilling industry in north Queensland with special reference to the current and potential role of portable sawmills. Master of Commerce by research thesis, School of Business, James Cook University, Townsville.

Stewart, M. and Hanson, I. (1998), *On-site Processing for Farm Forestry*, RIRDC Publication No 98/79, Rural Industries Research and Development Corporation, Canberra.

Venn, T.J., McGavin, R.L. and Leggate, W.W. (eds) (2002), *Utilisation of Western Queensland Hardwoods as Specialty Timbers*, Queensland Forestry Research Institute, Brisbane.

Venn, T.J. and Whittaker, K. (2003), 'Potential specialty timber markets for hardwoods of western Queensland, Australia', *Small-scale Forest Economics, Management and Policy*, **2**(3): 377-95.

Walls, J. (2002), personal communication, Principle Marketing Officer, Native Forests, DPI-Forestry, Brisbane.

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