Guest editorial

Sawmilling of eucalypts in Australia

In Australia over recent decades the processing of solid-wood products from native forest eucalypts has had a history of change as a result of wildfire, community demands for the conservation of older forests and the emergence of the softwood industry as a major competitor in structural markets. Old-growth forests have now largely been replaced with younger regrowth as a source of log supply, and processing strategies have been modified to meet new market requirements. In some states the conversion of production forests to conservation reserves has had such an impact that the hardwood processing industry is struggling to survive.

Background

While the circumstances in each state vary, constraints to log supply and continued strong demand in domestic and export markets have produced interest in developing alternatives to conventional log supplies. Commercial thinning of native forests, experimental in the 1950s to 1980s, is now relatively common for forest species that tend to produce single-aged stands, such *Eucalyptus regnans* and *E. delegatensis* (Tasmania and Victoria), *E. sieberi* (Victoria and New South Wales) and *E. diversicolour* (Western Australia). The experimental work produced higher yields of sawlogs in a relatively short time, effectively meaning that smaller areas of forest can be set aside for harvesting. The rapid expansion of Australia's eucalypt plantations over the past 15 years is another change taking place. While the existing hardwood sawmilling industry has shown fleeting interest, resource-constrained softwood processors and larger plantation owners are emerging as possible processors of a potential resource.

In this editorial I will discuss the technical issues associated with processing these potential new resources and outline the research experience that CSIRO Forest Biosciences (CFB) has gained while exploring this next possible transition for the Australian hardwood industry[1].

Growth stress

It is difficult to discuss production of sawn wood from eucalypts without first talking about longitudinal tensile growth stress release. This phenomenon is inexorably linked to the way stresses are distributed within trees: that is, the stresses are highest at the stem periphery and decline towards the tree centre as the distance from the periphery increases. This radial gradient in stresses poses challenges. Longitudinal tensile growth stresses, when released by harvesting or sawing, tend to produce a shortening in the wood (strain) more-or-less proportional to the stress level. Where there is a differential in the strain from one side of any piece of wood to the other, it tends to bend. A consequence of this is that during log handling and sawing, gradients in stresses produce deflection in sawn boards; bending of logs during sawing results in variation in product thickness and width and splitting of wood ahead of saws, and it can contribute to splitting of logs during harvest transport and handling and worsening of log end-splitting during sawing. Critically, as log diameter declines for a given peripheral stress level, the gradient in stress becomes steeper.

Initially in Australia during processing of old-growth logs sawmillers did contend with growth stress release, but in these large-diameter logs few problems were encountered. As younger and smaller-diameter resources were made available the consequences of growth stress release became more significant. While it is debatable as to whether the stresses were higher in these younger resources, as the resource age declined, and with it the log diameter, the gradient in stresses did increase. Sawmilling equipment has consequently been modified to improve sawing accuracy and to better control growth stress release. For example, the 'line-bar' carriage and log turning devices, and twin-saw and multi-saw systems, have gradually become more common over recent decades. These modifications no doubt improved sawing accuracy and have assisted in the control of stress release by applying more symmetrical cutting patterns. Sawing methods are still being modified as the characteristics of native forest resource across Australia change. The most recently commissioned sawmill dedicated to eucalypt processing in Australia is the Whittaker's Timber Products small-log processing line in Western Australia. This mill, now only two years old, has employed the latest twin- and multi-saw technology to process small-diameter jarrah (*E. marginata*) with good effect.

Obviously young thinned native forest and plantations produce relatively small-diameter logs with steep stress gradients. So how effective are modern 'conventional' systems at processing these potential new resources? This has been an area of research that we have been active in over the past 10 years, in partnership with hardwood sawmillers across Australia. Numerous trials have now been conducted in a range of resources and a clear picture is emerging. Probably the most controversial aspect of this is that when I was first introduced to this area of research I was told, and I read in numerous scientific journals, that 'fast grown' eucalypts were associated with all sorts of processing 'problems'. This commonly held belief needs to be carefully qualified, and I will do that later. For now it is sufficient to say that in logs of conventional sawlog quality, with a minimum small-end diameter of about 25 cm and obtained from thinned regrowth and plantations where fast growth was evident, processing performance has been acceptable.

Recent conversion studies

As far as thinned regrowth is concerned, recent nationwide experiments supported by Forest and Wood Products Australia

[1] More details about the industry future will be available in the proceedings of a 2007 conference, Plantation Eucalypts for High-Value Timber, to be published by the Joint Venture Agroforestry Program.

and forest management agencies and processors in Victoria, Tasmania, New South Wales and Western Australia have just been completed. Some of these trials, the most intensive ever attempted, have indicated that processing performance of comparatively young thinned regrowth was comparable to that of conventional regrowth for log samples matched on quality and diameter. In one case when 1939 regrowth *E. regnans* was compared to 1972 regrowth, there were even some advantages in processing the younger logs. Clearly fast growth was not a detriment in any of the five studies undertaken.

The largest of the plantation resources and hence the one of most importance for this discussion is the *E. globulus* resource in the Green Triangle and in the south-west of Western Australia. Many of these stands have been grown for pulpwood. Trials have indicated that, as with thinned regrowth, there is clearly potential to produce logs of conventional sawlog quality in a much shorter time than in unthinned native forests. Good results have been obtained from repeated trials in both pruned and unpruned stands. The best results, however, have been where pruning has been conducted to yield 'clearwood' logs such as those produced in CALM's experimental plantations in Western Australia. Good results have also been found for a few other species.

Forestry Tasmania has embarked on an ambitious program of clearwood plantation establishment with *E. nitens*. This program aims to produce a supply of logs to supplement that from native forests. Results from processing trials with young plantation-grown *E. nitens* from Tasmania and Victoria in conventional hardwood sawmills have so far been mixed. While sawing with conventional processing strategies is technically feasible, drying results have been far more variable; trials in Tasmania revealed that collapse and surface checking were major challenges requiring attention. An important aspect of this is that conventional native forest drying strategies in Tasmania often incorporate a period of air-drying when, if ambient temperatures are not controlled, collapse can be a major problem. CFB through the CRC for Forestry is currently undertaking trials with strictly controlled conditions to better understand the factors that contribute to drying defects.

It is reasonable to conclude that there is potential to develop new resources for the existing processing industry if the latter is equipped with appropriate technology. If sufficient resources were to be developed, thinned regrowth and managed plantations could supplement supplies from very much older conventional unthinned native forest. These resources would probably need to be in the 10–35 year age range, depending on species and growth rate.

Modelling conversion operations

There is inevitably a question about how viable it would be to process these resources in existing sawmills. To attempt to answer this we have developed the CSIROMILL system. CSIROMILL incorporates all of the data we have collected from numerous trials. This includes product recovery, quality, dimensions and values for individual logs with measured log quality indicators such as diameter, sweep and surface defects. The system also has a number of modules representing the best hardwood sawmills where we have undertaken work. These modules include accurate capital and operating costs, and can calculate the mill door prices for logs grouped on common log quality indicators for a given internal rate of return (IRR) for the sawmill. Variables that we can test include log feed rates, IRR and product value.

These analyses suggest that sawmills equipped with efficient modern technology such as the Whittaker's Timber Products mill in Western Australia (Fig. 1) and the new ITC Ltd mill in Tasmania are capable of profitably processing many of the resources represented in our processing trials. It is reasonably clear that these mills are capable of supplementing supplies from native forests with sawlogs from both thinned native forest and plantations.

This technology, however, is probably not the most suitable for these younger resources which have more uniform but smaller diameter than unthinned native forest logs. This raises a point about log length and growth stress release. One of the simplest solutions to reducing the adverse effects of growth stress release is to shorten logs for sawmilling. This in effect reduces the overall

Figure 1. The system at Whittakers Timber Products processing 17-year-old pruned plantation-grown *Eucalyptus saligna*. Left: sawing on the twin band-saw; right: scanning of the central cant prior to sawing on the multi-saw.

shortening of the wood as the stresses are released and therefore bending is reduced. However, it also produces shorter average boards which can have dire consequences for product value on export markets. In addition, processing short logs in reciprocating carriage sawmills is inefficient and the cost of processing increases as log length declines. The greatest difficulty for all conventional hardwood mills is the common use of reciprocating systems for log break-down.

Linear processing

One potential way to reduce costs while maintaining recovery is to adopt linear flow, multi-saw systems, which eliminate the log reciprocation and apply symmetrical sawing patterns. Some of these systems are coupled with chipper profilers capable of removing highly stressed wood at the log periphery prior to or simultaneously with sawing. A number of trials have been conducted in sawmills of this type such as the HewSaw R250 and R200. We have demonstrated that eucalypt logs may be processed successfully in mills such as these, although minor modifications to board sorting and conveyor systems are probably warranted. Log length can also be increased beyond that normally considered appropriate for conventional mills, with the added benefit of producing long boards and reducing losses to end-splitting.

CSIROMILL modules representing linear systems are still being developed and will be finished by the time this editorial is published. Early results are clearly indicating considerable reductions in processing costs while sawing accuracy and recovery are maintained or even improved. The cost savings of these systems are linked to log input, which would be of the order of 120 000–150 000 $m^3\ y^{-1}$ for a single shift operation compared to 25 000–35 000 $m^3\ y^{-1}$ for the most modern hardwood mill. It is possible for these systems to be set up to process 20–40 cm small-end diameter eucalypt logs with log intake around 300 000 $m^3\ y^{-1}$, assuming a two-shift operation. The major challenge in developing these systems is to ensure that an adequate resource is available and that material produced can be dried effectively. The forest area required within a given supply zone would probably need to exceed 30 000 ha. Alternatively it would be possible for softwood processors with suitable equipment to supplement their existing log supplies with young hardwoods, as Forest Enterprises Australia (FEA) Ltd has done.

Branch-related defects and variation in stress

The discussion so far has largely avoided two issues that are critical for plantation-grown eucalypts. These are branch-related defects and variation in the levels of growth stress at the log periphery.

Lack of pruning in plantations is a major obstacle to any successful transition to the processing of high-quality products from plantation-grown logs. While sawlogs of good quality can be produced where branch-related defects are uncommon, most plantations yield small-diameter logs with a large knotty core. FEA in Tasmania has overcome this by developing new products from very young unpruned *E. nitens*, and markets that tolerate knots. It is uncertain, however, how large these markets will become. Research can do very little to assist industry with this, as it is largely a marketing issue.

Variation in the levels of growth stress adds another element to eucalypt processing; this is certainly an issue that can be assisted through research. While the exact link between tension wood and growth stresses remains unresolved, it is quite clear that where tension wood has formed growth stresses are extreme and there is an added problem of poor wood drying characteristics (high tangential, radial and longitudinal shrinkage).

One of the major challenges in processing the new plantation-grown resources such as the *E. globulus* in southern Australia is coping with or avoiding logs with tension wood. From my experience of processing eucalypts, it is this aspect of fast-grown eucalypts that is at the core of the problems often reported by sawmillers and researchers that I referred to earlier. An irony is that had growth been even faster it is likely that the problems would have been avoided, as you will see below.

We have been undertaking research over many years to understand why tension wood forms in apparently straight vertical trees (the best trees for sawlogs), and this research is set to continue. Using the SilviScan technology at CFB we do know that tension wood formation is associated with thinning. In some cases thinning will reduce tension wood occurrence, and this is one of the reasons why the processing trials with *E. globulus* and some other species have been successful. However, we have also found instances where thinning has contributed to tension wood formation. Our most recent work, yet to be published, confirms the suspicion that tree geometry (the ratio of height to diameter), spacing and fertiliser treatments are implicated in tension wood formation. The take-home message is that if silvicultural strategies reduce the tree height : diameter ratio, tension wood will be less common. In other words if the trees grow rapidly in diameter relative to their height, problems will be largely avoided.

Conclusion

Our research indicates that there is some potential for a transition to new resources, although a great deal of work is still required — particularly for plantation-grown eucalypts — to ensure successful uptake. The exploration of market opportunities must be undertaken by industry, but more research is essential. Issues that need attention are poor drying performance of collapse-prone species such as *E. nitens* or, given Forestry Tasmania's plantation strategy, investigations of veneer production if sawn wood is not a viable option. Improvement in drying of backsawn wood of all species is also warranted. This is particularly important for produce from small-diameter logs (< 40 cm) from which modern sawmills cut a high percentage of backsawn boards. Finally, tension wood formation needs further investigation.

Probably the greatest challenge of all will remain the inadequacy of research funding from industry in Australia. While there have been many financial contributors to the research discussed above, CSIRO has been by far the major contributor and this past level of investment is unlikely to continue. Industry must now take up some responsibility for research funding if any transition to these potential new resources is to be successful.

Russell Washusen
Principal Research Scientist, CSIRO Forest Biosciences
russell.washusen@csiro.au