Short-rotation cold-climate eucalypt forestry for solid timber production: Prospects and Possibilities

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Future Forests Research Ltd., in collaboration with the NZ Farm Forestry Association, has undertaken a study delving into the economics of plantation eucalypt forestry, based on sawn timber recoveries from smaller-diameter logs using a novel sawmilling technique and a woodmizer portable sawmill. A summary of this study is presented below.

The Problem

Despite strong consumer demand for imported hardwood timber, eucalypt forestry has never reached a sufficient volume threshold necessary to establish specialised processing facilities and firm markets in New Zealand. Sawing logs below 40 cm small end diameter (SED) has traditionally been difficult primarily because of growth stresses. Seasoning of cold-climate eucalypt timber is also problematic, and issues such as collapse, surface and internal checking, cupping, distortion and high shrinkage can significantly lower product recovery and value. Despite these grade-limiting defects, when correctly sawn and seasoned, eucalypt timber can have an attractive appearance, along with high strength and stiffness.

The Project

Prediction of likely returns for growers requires research and data. In order to estimate real-world values for sawlogs within a mature industry and market, this study has simulated a vertically-integrated enterprise growing and processing smaller-diameter short rotation eucalypt. The resulting economic analysis provides an estimate of real-world returns from growing ash eucalypts for timber in New Zealand. If sufficient economic incentives exist then it may be possible for a viable eucalypt processing industry to develop.

Sawmilling and processing

Sawing methods have a major bearing on processing efficiency along with end product recovery. By utilising a novel sawmilling strategy and a woodmizer sawmill, specific problems associated with grade-sawing younger, smaller-diameter plantation ash eucalypt logs are addressed. A sample of 91 small diameter 18-year-old *Eucalyptus regnans* logs were milled to cover a diameter range of between 25 cm and 43 cm, with the purpose of determining sawn timber recovery for the diameter range. Nominal sawn timber and grade recoveries were recorded from each log, along with milling costs. The timber was kiln-dried and dressed four-sides to enable accurate grading according to the Australian Standards AS 2796.2 - 2006. Conversion returns from a range of log diameters were then estimated based on product recoveries, processing costs and expected returns from sawn timber products.

The case study stand just before harvest.

The stand

A cross-section of logs covering a range of diameters were harvested from a stand of 18-year-old *E. regnans* in the central North Island (near Murupara). Planted at 1111 stems per ha and subsequently untended this stand had a stocking of 556 stems/ha and standing volume of 417.6 m^3/ ha at age 19. This resulted in tall trees with typically small diameters (Figure 1) and few large branches. Branch-shedding was evident most of the way up the stems.

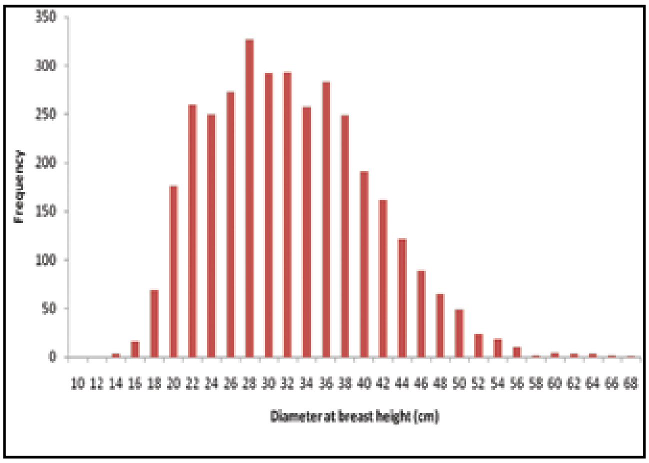

Figure 1: Diameter distribution for stand at age 18 estimated from age 16 diameter measurements.

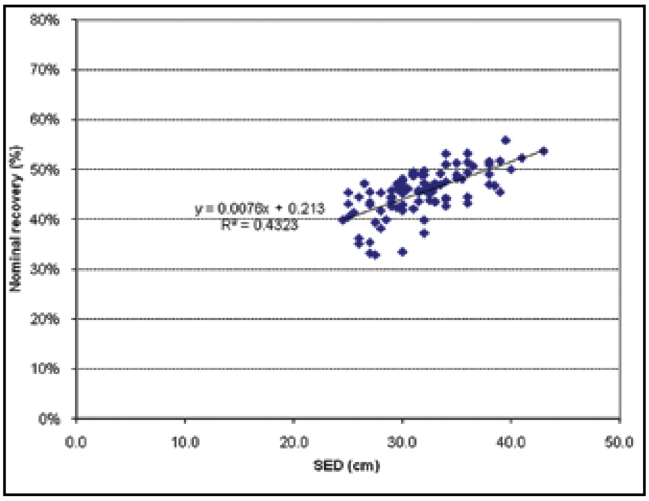

Figure 2: Relationship between log SED and nominal recovery of sawn timber as % of log volume.

Results

The estimated net present value (NPV) for production of sawn timber and pulp from the stand used in this study was over $10,000 per ha (internal rate of return 16.8%). Key contributors to this high value were:

1. The large proportion of potential sawlogs within the stand - 61% by volume - arising from the ability to recover timber from small diameter logs (Figure 2).
2. A cost-efficient sawmilling strategy (Figure 3) which produced high conversions to graded products from smaller diameter logs.
3. Given the high wholesale price received for *E. regnans* timber, this meant that sawlog value accounted for over 95% of the stand value.

Of the 25.0 m^3 of logs sawn, 14.0 m^3 of green boards were recovered. The nominal sawn recovery was 46%, and final product recovery was 43%. Product recovery was high, accounting for 93.6% of nominal sawn timber recovery. Recovery of valuable grades (select and standard) was also high, accounting for 76.8% of nominal sawn timber recovery.

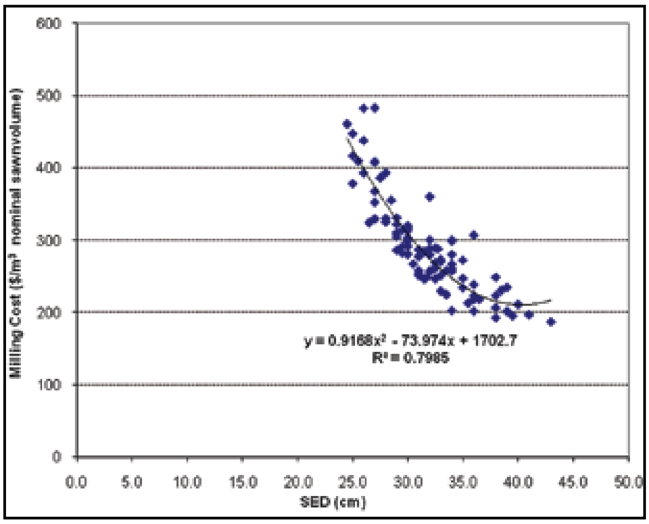

Figure 3: Relationship between milling costs per m^3 nominal recovery and SED.

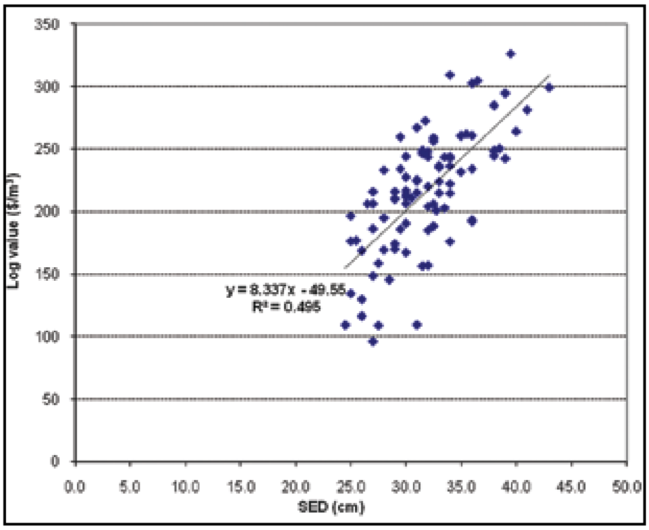

Figure 4: Relationship between log SED and log value as estimated as the conversion return for 91 logs in the sawing study.

Only 6.4% of the nominal sawn timber was lost due to degrade. Branch defects such as knots, holes, decay and excessive checking associated with branches accounted for 4.3% of sawn timber recovery. End splits accounted for 1.4% and skip caused by excessive collapse 0.5% of nominal sawn recovery. Defect resulting from sawmilling and sizing (want, wane and skip caused by undersizing) was only 0.1% of nominal sawn timber recovery.

Spring and bow did not increase during drying. All boards were assessed as meeting grading rules for spring and bow on the sawn and seasoned product at full length. No cupping or twist was present in the sawn timber and caused no loss of grade recovery. Visible shakes or heart fractures were not present and caused no loss of grade recovery.

The relationship between value (based on conversion return) and SED of sawlogs from the sawing study was reasonably strong ($R^2 = 0.495$; Figure 4). The relationship implied that a 1 cm increase in log SED contributed to an average \$8.34/m^3 increase in log value up to 43 cm SED. The increase in net log value with increased log SED is due to two main factors; (i) the increased timber recovery per m^3 of log sawn (Figure 2), and (ii) the increased milling efficiency per m^3 of timber recovered (conversion factor - Figure 3).

The economic assumptions used to estimate the conversion return of sawlogs and the discounted cash flow analysis of the study stand are given in Appendix 1 on the website given below.

Optimum rotation length and stocking assessment

A range of hypothetical regimes aimed at optimising potential economic returns were generated from the case study data along with growth modelling data. Figure 5 shows the estimated impact of rotation (years) and stocking (stems per hectare) on the net present value (using an 8% discount rate) of *E. regnans* stands. The spiked nature of the curves reflects the use of the 'average tree' for a stand because diameter distributions were not available when calculating log volumes. This means that when the SED for a log in the average tree goes above 25 cm (minimum sawlog SED) the value of the stand increases, due to increased sawlog value.

The economic assumptions for estimating the hypothetical optimum rotation length and stocking are also given in Appendix 1 at the website given below.

Stand value increases with lower final crop stocking are due to two factors:

1. the larger SED of logs from the stand average tree resulting in significant volumes of sawlogs by age 20; 41% for 400 stems/ha and 67% for 300 stems/ha;
2. the high value of *E. regnans* sawn timber which results in a large proportion of stand value attributed to sawlog conversion returns; 81% for 400 stems/ha at age 20 years.

The economically optimal rotation appears to be around 20 years (for the 8% discount rate used in this study).

The estimated increase in stand value with lower stocking should be tempered by the important negative impact lower stocking would have on branch size and therefore sawn product recoveries. Although stockings of lower than 300 sph produced higher NPV's we felt a further data set of conversion returns for low stocked trees would be necessary for valid results, so did not include these in figure 5. Furthermore, we assume that a log from two trees with the same diameter and height, but of different ages, will still have the same grade recovery, and hence conversion return. This assumption was made because we only had data from an 18-year old stand for estimating

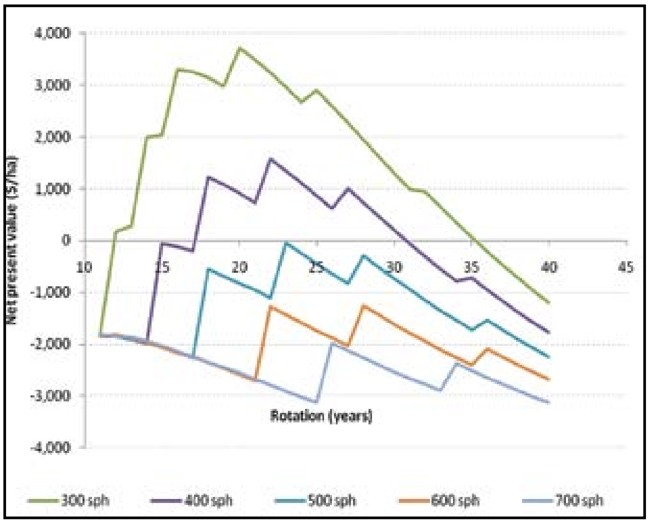

Figure 5: Impact of rotation and stocking on the net present value of E. regnans *grown for sawlogs.*

conversion returns. It is therefore important to recognise that grade recovery may change with tree age (independent of tree diameter) due to changes in wood density and grade-limiting defect that might influence grade recovery.

"Unfortunately the predicted log volumes and NPV's for the hypothetical regimes were significantly lower than for the 18 year old case study stand. Further work on the growth models, taper and volume equations and diameter distributions is clearly required to better predict sawlog volumes."

Conclusions

Managing eucalypt stands for solid timber remains a tradeoff between adequate diameters and a reasonable bole length which contains minimal branch-related defect. By demonstrating that a range of smaller diameters can be sawn cost-effectively and profitably, some flexibility is assured in the balance between maximising piece size and minimising rotation length. Logs greater than 25 cm diameter could potentially be diverted from low-value pulpwood to a considerably higher value sawlog and management regimes could target a greater proportion of sawlogs in the log-mix to improve grower profitability.

Good recoveries of timber meeting grade specifications were achieved even when grown in an unmanaged regime, with resulting high returns to the grower. The ability to achieve valuable timber recovery from logs of small diameters is an important contributor to this outcome. Standard forestry practice to improve stand value, such as early pruning to improve grade values and volumes, and thinning to reduce the number of malformed trees allowing remaining tree-stock to increase in diameter, could improve returns from this benchmark. Care may be needed to ensure sufficiently high stocking in order to limit product degrade from branches. Production thinning of small diameter trees for higher-value sawlogs could also

Timber floor constructed with E. regnans *100 × 25 mm timber from this sawing study. The walnut colour is achieved by fuming the timber with ammonia.*

pave the way for permanent canopy plantation eucalypt forestry in New Zealand.

An emerging plantation industry must be confident that processing methodology allows for adequate volume recoveries of a product which meets market quality standards, and which can be produced relatively cost-efficiently. This was achieved in this trial. The processing costs and timber recoveries from the sawmilling technique used in this study show that there should be adequate returns to growers from plantation *E. regnans* sawlogs. However, given that estimated economic returns from *E. regnans* grown for sawlogs are sensitive to the sawn timber prices used, further market research will be helpful in understanding the potential returns from *E. regnans* timber. There appears to be considerable scope for product development and niche marketing for ash eucalypt in New Zealand. The forest industry has the opportunity to generate additional value to the existing radiata estate, open new markets and profitably substitute imported timber with locally grown hardwood product.

The full study can be found on the Farm Forestry website at: http://www.nzffa.org.nz/farm-forestry-model/trees-for-timber/the-eucalypts/report2010/

Wardrobe constructed from 50 × 50 mm laminated E. regnans *from this sawmilling study.*