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REVISTING EUCALYPTS - A STRATEGIC ASSESSMENT

1. INTRODUCTION

A prolonged recession is as good a time as any to re-examine one's premises: to identify what is excellent and what is failing. For too long pine foresters have been involved in an industry that – like airlines, computer hardware and semiconductors – it has on aggregate suffered a loss of capital during the last decade.

Over the last 50 years the State has invested $1 billion on forest R&D – and most of that on pine. This has not provided the expected returns because it failed to appreciate the huge natural variability with respect to wood quality, and especially in the corewood of pine. The intrinsic wood properties of today's pine are little better than that of 80 years ago.

The belated recognition that all species are unimproved with regard to intrinsic wood properties puts eucalypt and pine on an equal footing in that both face the same challenge of getting the best out of the existing resource, as well as of developing greatly improved breeds.

Eucalypts, and alternative species generally, have been ignored by most forest companies with support coming largely from farm foresters and small investors. Many have been on the receiving end of the question "Why bother?" when pressing the case for the *possibility* of planting eucalypts. Too often this is followed by a condescending explanation of past failures, and that in the old days the Forest Service tested hundreds of species and that radiata pine was the winner. We tried, they did not work out. Yet any professional gambler will tell you that "you don't bet on the horse you think is gonna win, you bet on the horse that's got the best odds"; and that you spread your bets/investments (alternative species) and hedge against uncertainties. Our failure to develop a large eucalypt estate is in stark contrast to other Southern Hemisphere countries (Table 1), both in temperate and sub-tropical regions. Most of these plantations are being established by the private sector, which is looking to maximize profit. Many of the new projects involve very high biomass productivity (either for pulp or energy production). These are cutthroat businesses where New Zealand has little prospect of competing on equal terms with countries like Brazil or Uruguay. However around the world there has been less progress with solid wood products and therein lies an opportunity.

The true contrast is between a viable, unexceptional, utilitarian species that captures value by integrating itself within a supply chain (let us call it the 'Tenon strategy') and species that position themselves to supplant the prized timbers of the tropics - ebony, ivory, mahogany, teak – or match in their desirability Appalachian cherry, Italian walnut and French oak. There is nothing to lament in producing a major commodity, but it is also desirable to have high-valued species – both hardwoods and softwoods – to complement pine on domestic and international markets.

The excuses such as pests and diseases and our proximity to Australia are pardonable (if over-blown). Such difficulties have been contrasted with the ease of growing and processing pine everywhere around New Zealand. Historically, the risk-reward balance in favour of pine was unchallenged with pine displaying little downside risk compared to the (soluble) complexities of growing and processing eucalypt. These complexities can be more than offset by the market-driven aesthetic and environmental benefits of speciality products.

The twin themes to the *Revisiting Eucalypts* workshop are: (1) getting the most out of our existing eucalypt plantation resources, and (2) the opportunities to make a new beginning. The challenge is to view both themes with a critical but compassionate eye.

Table 1. Area of forest plantations (ha) for six countries in the Southern Hemisphere.

	Australia[1]	Brazil[2]	Chile[3]	New Zealand[4]	South Africa[5]	Uruguay[6]
Pine		1,808,336	1,474,540	1,603,000	688,313	274,568
Douglas fir				113,000		
Softwoods	883,494					
Eucalypts		3,751,867	554,374	31,000	478,191	676,096
Acacias		189,690	12,903			
Hardwoods	1,010,155					
Other[*]		235,504	41,976	53,000		1,767
Total	1,893,649	5,985,397	2,083,793	1,800,000	1,166,504	952,431

[1] Softwoods is dominated by *Pinus radiata*, while hardwoods is dominated by *E. globulus* and *E. nitens*. Statistics at 2007, from <http://www.affashop.gov.au/product.asp?prodid=13940>.
[2] *Eucalyptus* dominated by the *E. urophylla x E. grandis* hybrid. Statistics at 2007, from <http://www.abraflor.org.br/estatisticas.asp>.
[3] *Pinus radiata* dominates softwoods. Hardwoods are dominated by *E. globulus* and *E. nitens*. Statistics at 2006, from <http://infor.cl/estadisticas_mercado/super_plantaciones_forest.htm>.
[4] Statistics at 2007, from New Zealand Forest Industry Facts & Figures 2007/2008.
[5] Sixty percent of *Eucalyptus* is *E. grandis*. *P.patula* and *P. elliottii* dominate the softwoods. Statistics at 2006, from <http://www2.dwaf.gov.za/dwaf/cmsdocs/4318__facts2006.pdf>.
[6] Hardwoods are dominated by *E. globulus* and *E. grandis*. Statistics at 2007, from <http://www.mgap.gub.uy/Forestal/DGF.htm>.
[*] Others include both softwood and hardwood species.

2. THE EXISTING RESOURCE

Regarding the existing eucalypt plantation resource a few points can be made (Poole, 2009).

- Many introductions are of limited or unknown provenance.
- Too few foresters fully appreciate the art of species selection and thoughtful siting: relying rather on trial and error.

- Pests and diseases are a recurring theme.
- Recommended rotation lengths are far too long.
- Foresters should avoid late thinning and over-slender (height/diameter >100:1) trees (Washusen, 2009).
- There are opportunities for much shorter rotations for carbon, pulp and durable posts/poles.
- Variable local resources are often too limited to be of commercial interest.

Our disappointments become easier to understand when comparing industry and State investment in R&D on pine to the trivial amounts distributed thinly, unequally and intermittently across all other species. In so doing industry forgot that all species are essentially unimproved, clothed with a veneer of respectability. Externally they may look fine and straight, but the majority of trees are like cross-dressers in that they have all the attributes of pretty women - except the essential ones. It is within that the vices and virtues of individual trees are revealed. There are good trees and bad trees, and the sawmiller gets them all. All too frequently, woodlot owners have grown their trees for 25-35 years to find that the only buyers of their timber are firewood merchants. This is in large part because variability is not just an important feature of wood quality of all species, it is their defining characteristic.

Of course successful forest management always needs the pre-essentials of healthy, straight, vigorous trees without which there would be no access to markets. However it is the distinctive features of the wood of any species (colour, figure, hardness, odour and stability) that allow it to make it – or not – on the world stage. Characterization and stratification of the highly-variable existing resources for specific end-use applications would build confidence of the forest growers and of their customers. Characterization is also essential for an effective selection in breeding for future resources.

Over the past few years, foresters have made progress with regard to these pre-essentials, above all by paying attention to site conditions and matching species and provenance to the micro-environment. Here the case is made for selection within the sub-genus *Monocalyptus* on the grounds that they suffer fewer pests and diseases, although species with the sub-genus *Symphyomyrtus* are probably safe growing in drier and colder parts of New Zealand (Poole, 2009).

2.1. New approaches to processing small logs

Eucalypt processing in New Zealand suffers from lack of scale – giving it a folksy, artisan image. Until the industry can achieve some size the future relies on Wood-Mizer portable saws or their equivalent. The only exception is the more mature chip and pulpwood market, e.g. of *E. nitens* in Southland, where a permanent twin-circular HewSaw mill would appear to be a viable prospect. For some years Forest Enterprises Australia has processed young, 10 yr-old *E. nitens* at its HewSaw mill to the west of Launceston, Tasmania. Where processing small logs (<< 60 cm), the release of growth stress and subsequent drying defects play a major part in determining cutting strategies and cutting patterns.

Herritsch and Nijdam (2009), Satchell (2009) and Washusen (2009) demonstrate that the key constraints – checking, collapse, growth stress, inordinately long drying, excessive shrinkage, splitting, warping – need not be as formidable as some might assume. Indeed, this list of "processing problems" is not altogether different to those for the high-valued red and white oaks of North America (and our own red beech) – and these problems can be addressed.

223. Only hardwoods can excel on short rotations

Hardwoods have a material advantage over softwoods, especially with regard to short rotations. The first 10 growth rings around the pith (the corewood zone) of softwoods such as pine are noted for their low density, poor longitudinal stability and low stiffness. Hardwoods do not have a low-quality corewood zone *per se* because the microfibril angles are low, < 30^0, whereas in softwoods they are high, > 30^0 (Figure 1). Consequently only hardwoods have the potential to grow quality wood in fast-grown, short-rotation woodlots.

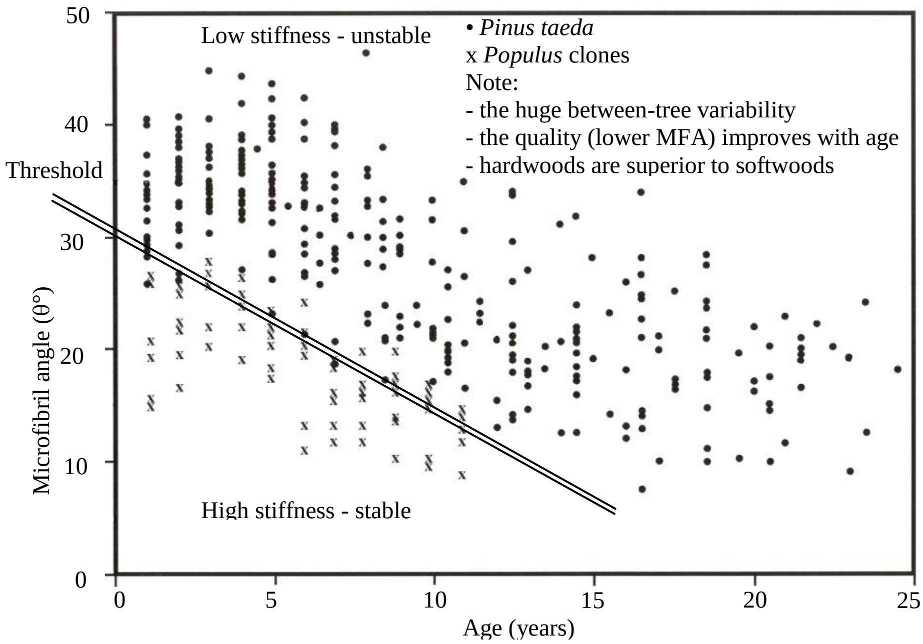

Figure 1. For young trees there is a threshold microfibril angle at around 25-30^o at age 1 that for softwoods is a glass ceiling, while for hardwoods is a firm floor (Walker, 2007). This threshold falls to around 15^o at age 10. The data relate to *Pinus taeda* (Yang *et al.*, 1994) shown as large dots and various *Populus* clones (Shengzuo Fang *et al*., 2006) shown as small crosses; see also Donaldson (2008).

3. A NEW START

It is obvious that the vast majority of eucalypt introductions have been scoping trials preoccupied at best with survival, growth, and form (Hocking, 2009). They also provide some indication regarding site requirements and limitations (Nicholas *et al.*, 2009). These existing plantations consist of wild populations whose intrinsic properties are unimproved. They are an inadequate resource for propagation.

3.1. Large breeding populations and short breeding cycles

If a breeding population – with improved form, disease resistance and faster growth – has no "elite" wood quality traits, then the potential worth of that resource has been devalued. It is essential to bulk screen a very young population for wood properties using simple measures, either to produce a sub-population with greatly reduced difficulties in wood processing or to remove the worst from the population.

Finding superior trees for multiple traits requires a large number of genotypes underlying the base and deployment populations of a breeding programme (Apiolaza, 2009). Probably the only currently deployed eucalypt that approaches the desired critical mass is *E. nitens.* For this reason, the Drylands Forest Initiative is proposing planting a total of 18 000 individuals across three sites for each of six species in which their initial focus is only on growth, form, survival and early heartwood formation for the vineyard post and pole market (Millen, 2009).

Another imperative is to drastically shorten the breeding cycle from 8-15 years to as little as 3-5 years. This is not too radical if the target rotation age is being reduced from 30-40 years to 15-20 years. Furthermore, wood quality traits should be assessed within the same time scale of 3-5 years. It is better to select and deploy material after 3-5 years regardless of the uncertainty in mature wood characteristics. Indeed it is illogical to breed for improved outerwood properties where critical threshold values are largely satisfied, so age-age correlations should be secondary matters. It is in the corewood where much wood fails to meet minimal threshold values that the greater financial loss occurs. Further, such age-age correlations are unlikely to ever be developed for many of the critical wood quality characteristics.

Selecting eucalypts that coppice strongly is a major strategic advantage as it permits rapid, cheap, total destructive testing of one's base population for a whole range of wood quality characteristics at an early age (Chauhan, 2009).

3.2. Variability: biomechanical, chemical and in processing

Gomide (2009) and Raymond *et al.* (2009) provide a sharp reminder that few comprehend the huge variability that exists in an enormous number of chemical, mechanical and physical characteristics. That the largest companies in Brazil, some of whom with a long tradition of deploying hybrid eucalypt clones, should have production clones that differ so greatly in key pulp characteristics is extraordinary (Gomide, 2009). No Brazilian company's clone had optimised for all key pulp characteristics (Table 2). These differences amongst elite clones (Gomide, 2009) will result in large differences in profitability. More telling, International Paper's R&D centre at Mogi Guaçu in São Paulo State deploys some 5-10 clones in any one year. These are selected from some 5000 clones within its breeding population every one of which has been mini-pulped, generating values for large number of physical, chemical and processing variables (see also Henson, 2009, and Raymond *et al.*, 2009). Clonal forestry at this level is only a dream even for New Zealand radiata pine.

Table 2. Characterization of the new generation of Brazilian eucalyptus clones in which ten major Brazilian pulp mills provided one of their best clones (summarized data from Gomide, 2009). Shaded figures are the most desired values. This data shows that even in Brazil with a long history of breeding there are large differences in the performance of elite individuals clones.

Clone	Volume, m^3/ha/yr	Density kg/m^3	Lignin %	Glucans %	Pulp yield %	Acetyls %	Uronic acids %	Effective alkali %
A	52.9	510	30.5	45	50.2	2.9	3.8	18.5
B	46	465	27.5	49.2	57.6	3	3.2	13.7
C	47	482	30.6	47.8	53.4	2.6	3.7	16
D	45.4	472	28.2	50	55.4	2.6	4.3	15.5
E	33.9	486	30.1	44.6	50.8	2.9	4.4	17.5
F	40	505	27.5	47.6	54.5	3	4.6	15
G	43.9	503	29.2	45.7	52.3	3.1	4.7	15.5
H	39.5	482	31.7	44.5	49.3	2.8	3.9	19
I	46.1	490	27.8	46.5	54.3	2.9	3.9	15.8
J	50	501	29.9	44.8	51.1	2.7	4.3	17
Range	33.9/52.9	465/510	27.5/31.7	44.5/50.0	49.3/57.6	2.6/3.1	3.2/4.7	13.7/19.0

Optimising such variables while relevant for pulp and paper only partially address the interests of sawmillers. Paradoxically, Chauhan (2009) argues that for structural and decorative eucalypt lumber one might wish to select improved planting stock with lower density, higher microfibril angle, shorter fibre length and higher lignin – a strategy that is the antithesis of desirable traits for eucalypt pulp, and for pine pulp and solid wood. Such material would have reduced growth stress and better drying characteristics.

3.3. Early cash flow

The virtue of biomass, chip wood and post/pole regimes lie in their ability to generate early cash flow without being too demanding of tree breeders and forest managers. The beauty of these regimes lies in their minimal specifications, only for growth, form and health etc. Subsequently when the grower wishes to on-grow the crop to progress to sawlog production, perhaps by way of a European "coppice and standard" regime do the biophysical properties and wood chemistry become critical – and the challenges to the breeder increase considerably.

3.4. The golden snitch: elite hybrids and plant breeding rights

Such a second generation breeding cycle might include crossing species to capture the best of each and so establish hybrid breeding lines – maybe to extend the range of climates and sites for planting, or to provide coloured heartwood for future solid wood products. Such underlies the logic in Millen (2009) bracketing six dryland species into potential hybrid pairs.

4. REFERENCES

All references relate to other papers presented at this workshop except:

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6. AFFILIATIONS

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