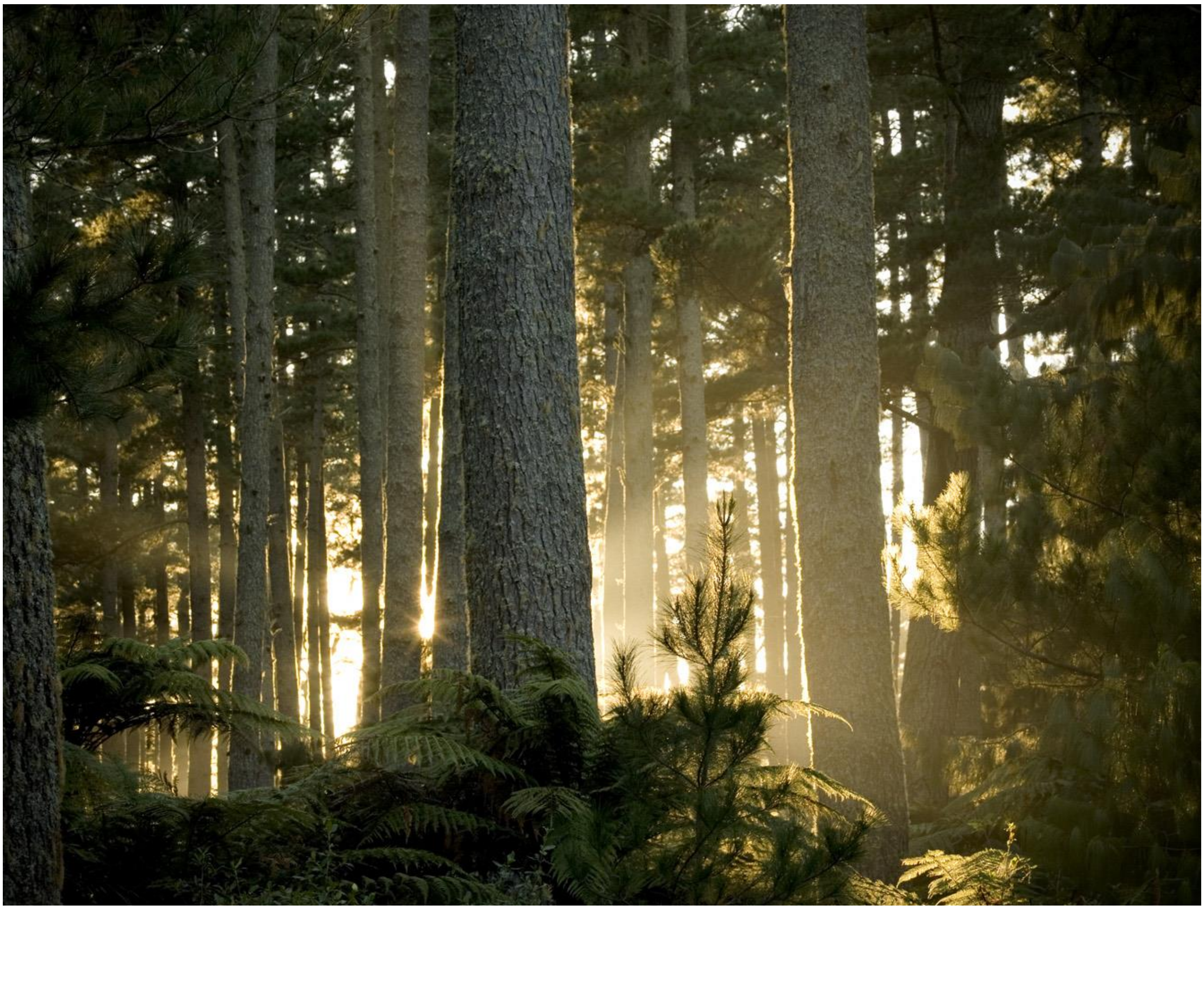
Economic comparison of Traditional and Genomic breeding programmes for *Eucalyptus nitens*



www.scionresearch.com

REPORT INFORMATION SHEET

REPORT TITLE	ECONOMIC COMPARISON OF TRADITIONAL AND GENOMIC BREEDING PROGRAMMES FOR *EUCALYPTUS NITENS*
AUTHORS	DAMIAN CORBETT
CLIENT	SPECIALITY WOOD PRODUCTS PROGRAMME
SIDNEY OUTPUT NUMBER	
SIGNED OFF BY	HEIDI DUNGEY
DATE	11 AUGUST 2016
CONFIDENTIALITY REQUIREMENT	CONFIDENTIAL (FOR CLIENT USE ONLY)
INTELLECTUAL PROPERTY	© NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED ALL RIGHTS RESERVED. UNLESS PERMITTED BY CONTRACT OR LAW, NO PART OF THIS WORK MAY BE REPRODUCED, STORED OR COPIED IN ANY FORM OR BY ANY MEANS WITHOUT THE EXPRESS PERMISSION OF THE NEW ZEALAND FOREST RESEARCH INSTITUTE LIMITED (TRADING AS SCION).

Disclaimer
The information and opinions provided in the Report have been prepared for the Client and its specified purposes. Accordingly, any person other than the Client uses the information and opinions in this report entirely at its own risk. The Report has been provided in good faith and on the basis that reasonable endeavours have been made to be accurate and not misleading and to exercise reasonable care, skill and judgment in providing such information and opinions.

Neither Scion, nor any of its employees, officers, contractors, agents or other persons acting on its behalf or under its control accepts any responsibility or liability in respect of any information or opinions provided in this Report.

Introduction

This analysis was done to compare the value of the genomic and traditional breeding programmes. The analysis builds upon results already presented to the SWP programme steering group in March 2016. Following that meeting, a number of clarifications around the assumptions used were requested. In addition, this report also attempts to better show what value is realised at different points in the value chain. This was carried out through NPV analysis for both the forest owners, and the end processors of the wood resource.

Assumptions

The percentage gains for density and volume were provided from work done by Heidi Dungey and Mari Suontama.

All gains described on a per generation basis:
Traditional breeding

- 6% volume gain
- 4% density

Genomic breeding

- 11% volume
- 6% density

Research and implementation costs were also provided by Mari and Heidi. The timeline of these costs are found in appendix A. Genotyping and the costs of trials were included in these costs.

The effect of the volume gain translates directly into increased harvestable volume, assuming an 85% harvest recovery rate. This is the sole factor in the value gain to the forest owner, no consideration was made to an increase in log prices due to increased density as there is little segregation on density basis currently undertaken operationally in forests.

The density increases were assumed to decrease the rate of non-recoverable collapse, based on research outlined in a 2009 FPWA report[1]. This in turn was assumed to increase recovery rates during processing.

As a result, a 1% increase in density was modelled to have a 0.4% increase in recovery, based on the research presented.

Genomics also allows for faster and more accurate targeting of breeding for specific wood quality traits, such as reducing growth strain and shrinkage, the two principle processing constraints. Conservative assumptions factor in an additional 10% recovery gain per generation through breeding for wood quality traits, over gains from increased density.

This scenario does not take into account the additional gains possible that genomics offers through selection of traits in addition to the growth and wood quality considered here. Resistance, fibre properties and/or more intensive measuring of branching would give additional gains for the addition of phenotyping costs.

The report also does not consider any analysis on vegetative propagation. Considerable gains would be made per generation if the time to deployment was reduced – i.e. moving from seed orchard to vegetative propagation. This is highlighted throughout the literature[2].

Management and harvest costs were extracted from Dean Satchell's master's thesis[3]. The harvest and transport rates are from Allan Laurie Consulting's guide, assumed medium-steep terrain and 100km haul, for a total harvest cost of $58/tonne.

The modelling was based off the assumption that planted area of eucalypts in New Zealand would increase by 54,000 ha over 35 years, as outlined in the 'Outcome benefits to New Zealand' document, submitted as part of the business case in the initial SWP proposal.

Log price was assumed at $130/m^3, again based off Dean Satchell's master's thesis.

The volume to weight conversion was adjusted for each generation to take into account the increases in density and volume, this had the effect of increasing harvest and transport costs on a per m^3 basis, and the effect is more pronounced for the genomics programme.

These results do not consider the de-risking for investors that may arise from other aspects of genomic breeding, notably disease resistance. They do not include carbon sequestration either.

Results

NPV for forest owners

NPV comparison, taking into account all forest management, harvesting, and transport costs has the traditional programme at $84 million compared with a Genomics programme at $91 million, assuming a 8% rate of return. This presents a NPV gain on a per ha basis of $143, over the predicted 54,000 ha of new plantings.

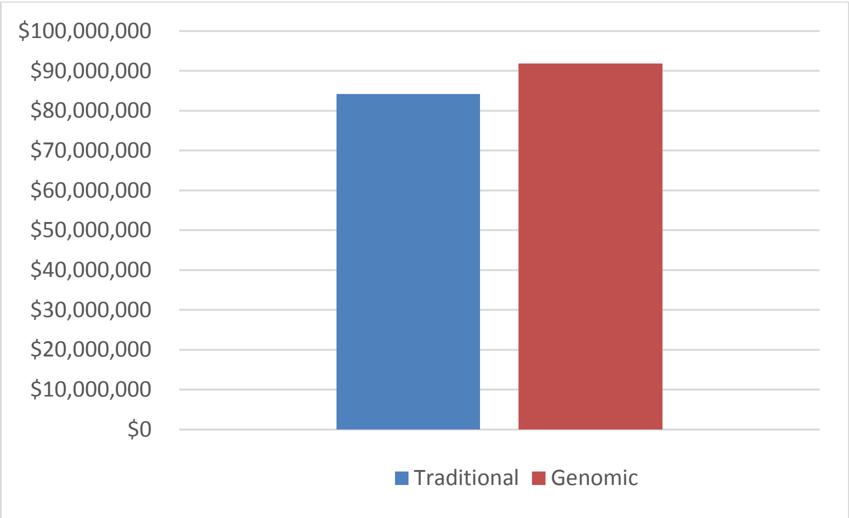


Figure 1: NPV comparison between breeding scenarios.

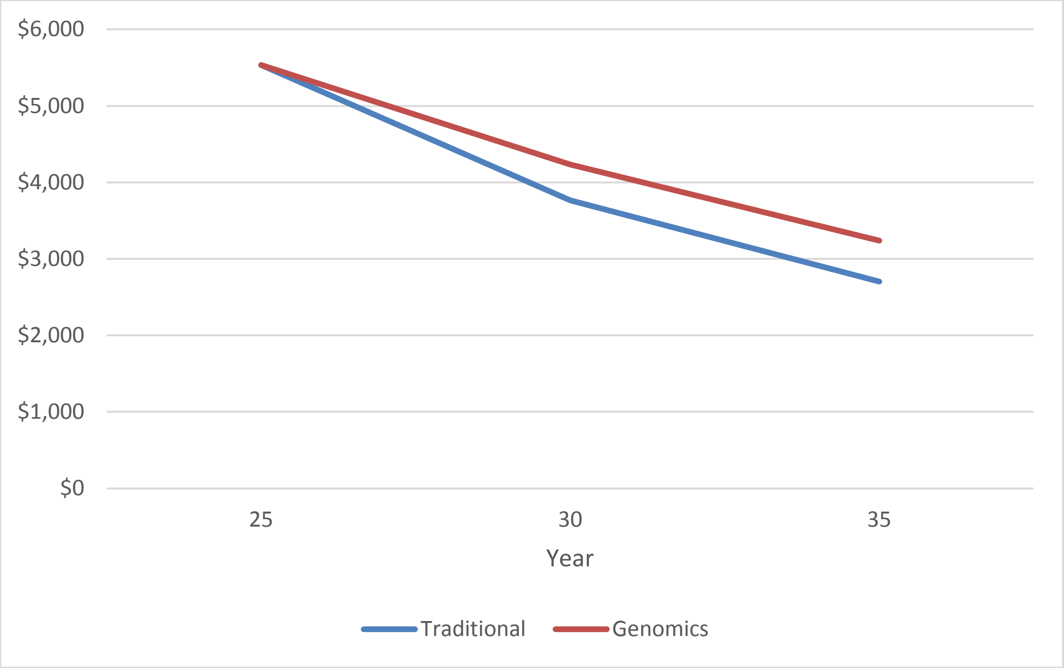


Figure 2: Discounted (8%) per ha returns for forest owners.

Discounting the per ha returns to present value, after all costs accounted for, shows that the genomics programme opens up a clear value gain as the additional volume from the genetic gain starts to come on stream.

Value gain to processors

The value gain to processors is assumed to come from two areas. Firstly, the increased volume able to be produced due to the increased available wood resource, secondly, there will be a raw material cost saving in production due to the higher recovery rates in processing. This is due to the increased density. Raw material costs were assumed to account for around 28% of end product total costs, based off the WoodScape project.

There was no accounting for any potential higher value LVL due to increased stiffness, however in practice there is likely to be a premium, further investigation is needed to quantify the extent.

Unimproved recovery rates are assumed to be 60%, based on work done for the WoodScape project. LVL was used as previous analysis had found LVL to outperform other wood processing techniques on a financial basis.

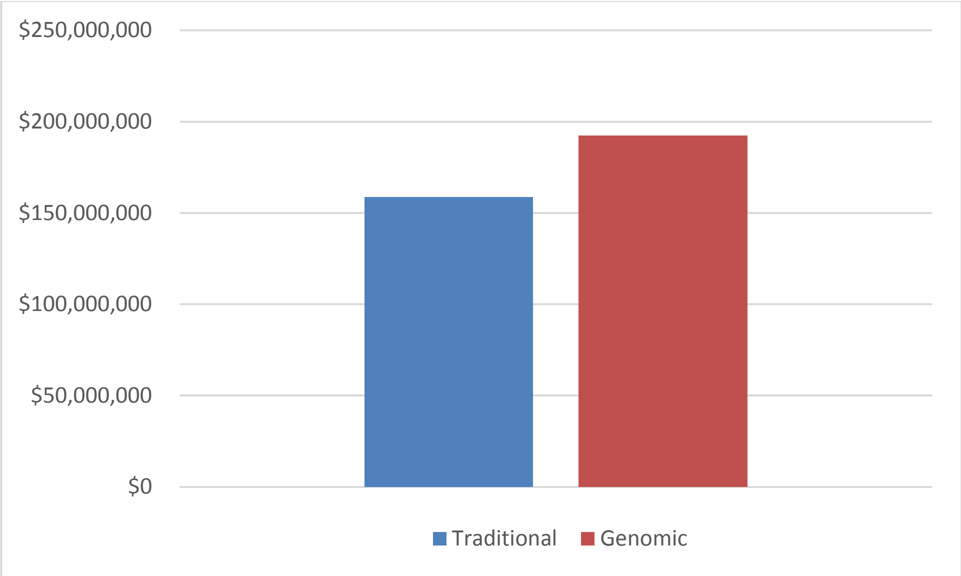


Figure 3: NPV comparison for LVL processors.

NPV comparison, traditional breeding programme has an NPV of $158 million, while the genomic programme delivers an NPV of $192 million, a gain of $34 million.

The NPV of the increased recovery alone is forecast to be worth over $10.3 million for the genomic selection, compared with $600,000 for the traditional.

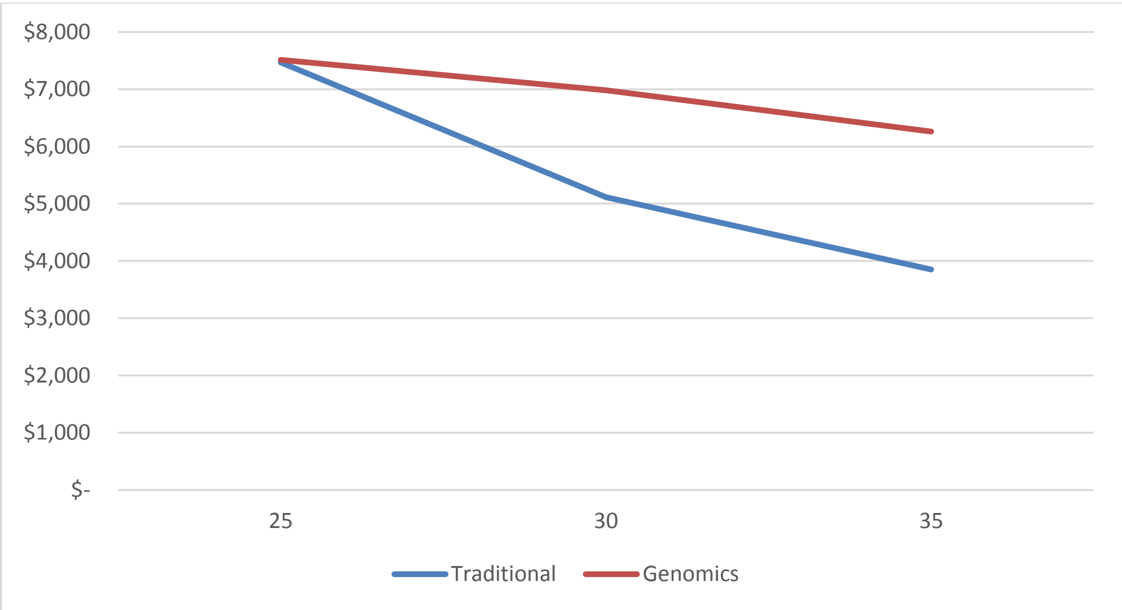


Figure 4: Discounted (8%) per ha returns from processing

The present value gap between the genomics and traditional programmes is much more pronounced in Figure 4, which evaluates the returns from processed wood, than Figure 2 which only accounts for returns to growers.

Conclusions

The analysis shows that there is the potential for substantial value gain form employing a genomic breeding program compared with employing a traditional program for *Eucalyptus nitens*. This value gain is present for both forest owners, and processors.
Further work into how that value gain translates into different processed end products would be recommended to provide information about alternative potential processing scenarios.

References

1. Blakemore, P. and R. Northway, *Review of, and recommendations for, research into preventing or ameliorating drying related internal and surface checking in commercially important hardwood species in south-eastern Australia*. 2009, Forest & Wood Products Australia
2. Harfouche, A., et al., *Accelerating the domestication of forest trees in a changing world.* Trends in Plant Science, 2012. **17**(2): p. 64-72.
3. Satchell, S.D., *Evaluating profitability of solid timber production from 15 year old pruned and thinned Eucalyptus nitens (Deane & Maiden) in Canterbury*, in *School of Forestry*. 2015, University of Canterbury.

Appendix

A)

Traditional breeding over two cycles in *E. nitens*					
Year 0	**Year 5**	**Year 10**	**Year 17-18**	**Year 20**	**Year 23**
Establishment of seed orchard	Collection of seed	Assessment of progeny trial and BLUP ebv selection	Collection of seed	Harvest commercial stand (1)	Assessment of progeny trial and BLUP ebv selection
$42k	**$5k**	**Phenotyping wood properties $400k + basic assessment & BLUP ebv analysis $85k**	**$5k**		**$400k+$85k**
	Planting progeny trial	Establishment of seed orchard	Planting progeny trial		Establishment of seed orcahrd
	$70k	**$42 k**	**$70k**		**$42k**
	Commercial stand (1)	Commercial Rogued seed(1.5)	Commercial stand (2)		Commercial stand (2.5)
					Harvest Commercial stand1
					Total$1,246k

Genomic selection over two breeding cycles in *E. nitens*										
Year 0	**Year 5**	**Year 6**		**Year 8**	**Year 14**	**Year 15**		**Year 17**	**Year 20**	
Establishment of seed orchard	Collection of seed	Genomic selection based on GEBVs		Deployment of clonal stand	Collection of seed	Genomic selection based on GEBVs		Deployment of clonal stand	Harvest commercial stand (1)	
$42k	**$5k**	**Phenotyping wood properties $400k + GEBVs $150k**			**$5k**	**$50k**				
		Establishment of seed orchard				Establishment of seed orchard				
		$42k				**$42k**				
	Commercial stand (1)					Commercial stand (2)				
		Clone best GEBV selections and deploy				Clone best GEBV selections and deploy				**Total$736k**
			year8				year8			
			Clonal stands(1)				Clonal stands(2)			
			$1.50 per plant				$1.50 per plant			