

Technical brief: genetic gain continues to improve in the national *E. globulus* breeding program

15 July 2021

Tree Breeding Australia Limited (TBA) has completed a new genetic analysis (run) for the national *Eucalyptus globulus* tree improvement program using TREEPLAN. Each run builds on previous analyses by including new measurement data gathered for new and existing trees in genetic trials across Australia. This run is a single-step genomic selection evaluation which includes phenotypes and also results of more than 5000 DNA assays - producing genomically enhanced breeding values. The evaluation allows us to identify new selections and improve the accuracy of prediction for use in breeding and deployment.

Genetic values for each tree are predicted for selection criteria and objective traits, such as volume and wood properties (density and kraft pulp yield) at harvest age. Economic indices (based on various production environments, processing systems and end uses) are generated to enable us to rank each genotype relative to other trees on a net present value basis. Growers can then compare the genetic and economic worth of seedlots and trees depending upon their production and processing objective.

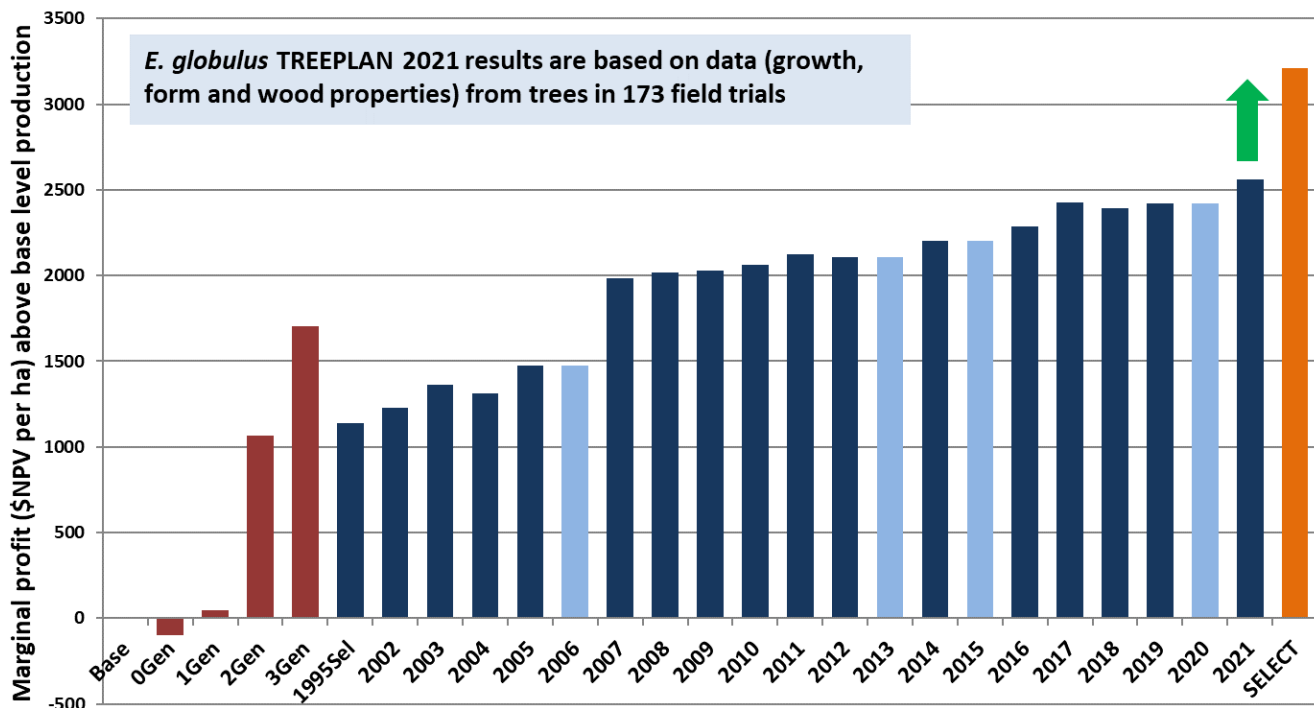
For example:

The value of gain in: **Volume (m³/ha)** plus **Density (kg/m³)** plus **Kraft Pulp Yield (%)**
Equals \$NPV marginal increase in net present value by using seed from this tree relative to a set of base line trees

The integrated approach provides efficiencies as the national database allows TREEPLAN to use all historical and new information (including genomic data) in a single industry wide multivariate genetic analysis enabling objective comparisons to be made.

TREEPLAN statistics for this run	Trials	Genotypes	Measured traits
Total number included:	173	345,540	18
Number of objective traits: 3 (with Volume growth on a regional basis, Density and Kraft Pulp Yield)			
	Trials	Individual genotypes	Measurements
Size of <i>E. globulus</i> database:	232	582,900	5.6 million

TBA is the national body which manages the Australian tree improvement programs for radiata pine (*P. radiata*) and blue gum (*E. globulus*). TBA is a not-for-profit cooperative with members collectively contributing resources for efficiencies in maximising the genetic quality and value of the plantation resource.



This graph shows the average marginal improvement in net present value \$ of the best 1% of genotypes identified for breeding purposes with each annual analysis. For comparative purposes, each group of genotypes identified previously is now described in terms of its updated NPV value in the 2021 TREEPLAN analysis. This allows for an objective comparison of genetic material over time. The SELECT result is more indicative of the gain which could be achieved in a new deployment orchard based on an average Australian index.

**The results indicate a high and competitive return (13-26%)
on investment through membership fees can be achieved.**

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Table 1 below shows the average performance of each generation for each trait as well as the average trait values of the best 1% of trees selected for a single trait. For example, the best 1% of trees for Volume alone would have an average predicted increase in volume production of 55 m³/ha (24% more than base productivity) but only deliver a marginal improvement in economic value (profit) of \$1160 due to trade-offs in other quality traits. The SELECT orchard result is indicative of the gain which could be achieved in a new orchard based on an average Australian index.

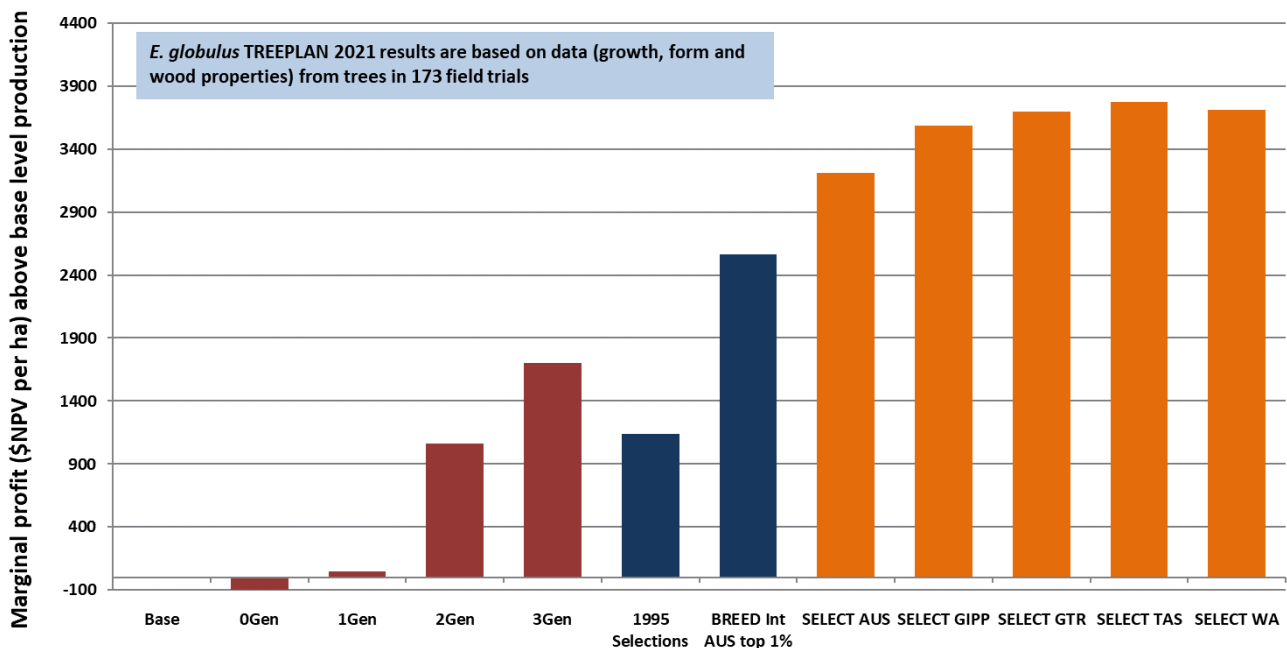
Table 1: Marginal gain (or loss) in selecting various groups of genotypes based on generation, a national multi-trait index or independent traits.

	INDEX	Volume		Density		Kraft Pulp Yield	
Base productivity* and units	NPV \$/ha	229 m ³ /ha		537 kg/m ³		55.7%	
Baseline genotypes	0	0	-	0	-	0	-
Overall mean (345,540 trees)	337	8.03	4%	3.87	1%	-0.16	-0%
First-Gen. average^	46	3.11	1%	-0.33	-0%	-0.13	-0%
Second-Gen. average^	1065	20.88	9%	13.91	3%	-0.23	-0%
Third-Gen average^	1701	24.84	11%	26.81	5%	-0.01	-0%
1995 Selections average^	1138	24.58	11%	15.86	3%	-0.59	-1%
Top 1% for NPV\$	2563	33.62	15%	38.12	7%	0.61	1%
Top 1% for Volume	1160	55.16	24%	-13.59	-3%	-0.40	-1%
Top 1% for Density	1785	4.20	2%	52.73	10%	-0.48	-1%
Top 1% for Kraft Pulp Yield	350	-11.81	-5%	0.45	0%	2.25	4%
SELECT Orchard	3212	29.45	13%	57.26	11%	1.01	2%

* Base Productivity consist of 616 native stand trees used in 1987 and 1988 CSIRO seed collections
 ^ Average values for a group of trees identified from each generation and selections made in 1995.

Deployment gains are more targeted

The following graph is indicative of the additional marginal improvement in NPV\$ available when deploying TBA genetic material. National and regional orchards (SELECT – orange) are compared with the average NPV\$ of the generations (red), the 1995 selections and the best 1% of genotypes identified for breeding purposes (BREED - blue). The breeding program must retain diversity and targets national objectives, whereas seed producers and forest growers can increase selection intensity and focus more on regional performance. For example, despite the national breeding program delivering a marginal improvement of NPV \$2563, a new orchard for the Green Triangle Region (SELECT Int. GTR) could deliver a marginal gain of NPV \$3700. The marginal gains are shown using an 7% discount rate.



For more information see the TBA web site (www.treebreeding.com) or contact the General Manager, Dr Tony McRae (tmcrae@treebreeding.com) or Business Manager, Peter Cunningham (pcunningham@treebreeding.com).