

Technical brief: genetic gain continues to improve in the national *P. radiata* breeding program

1 March 2023

Tree Breeding Australia Limited (TBA) has recently completed a new genetic analysis (run) for the national *Pinus radiata* 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 Australasia. The evaluation allows us to identify new selections and improve the accuracy of prediction for use in breeding and deployment.

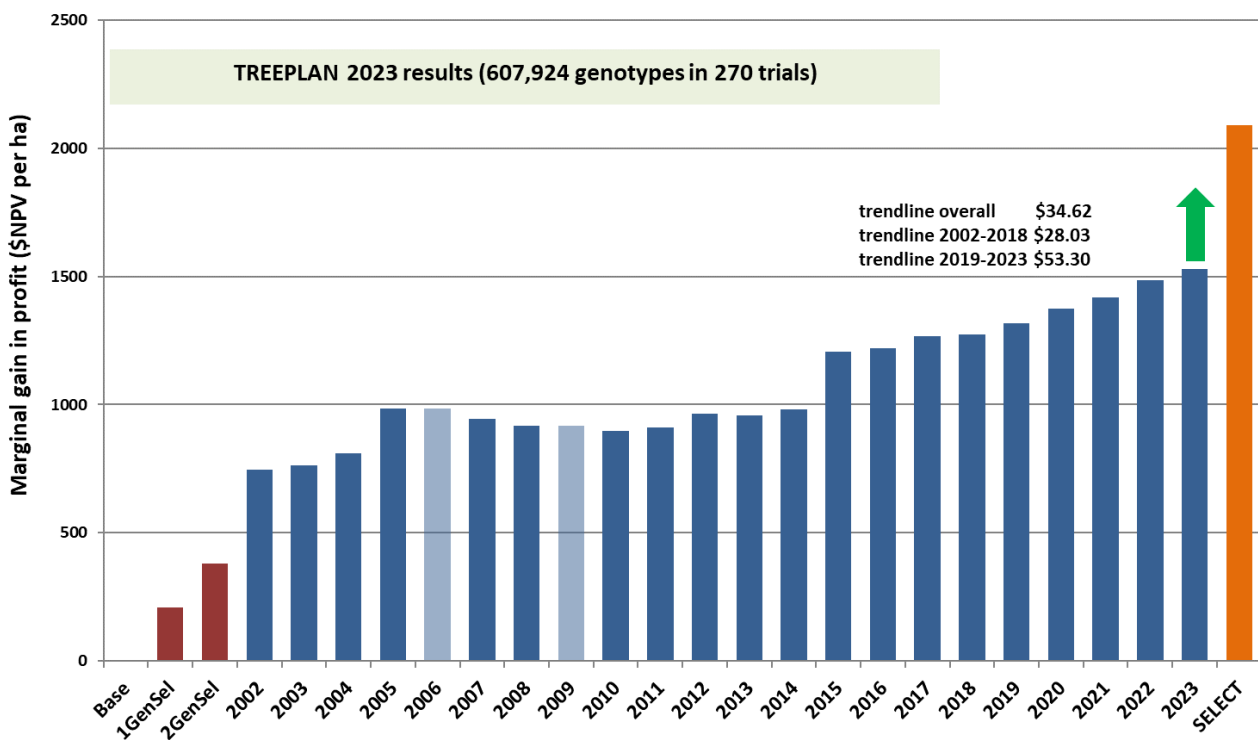
Genetic values for clearfall harvest age characteristics of growth (MAI), form (SWEEP and BRANCH size) and wood properties (STIFFNESS) are produced for each genotype. Economic indices (based on various production systems and end-use processing) are used to quantify the net present value (NPV) of each tree against all other tested trees. Growers can then objectively compare the genetic and economic worth of trees (and seedlots) depending upon their particular production and processing objectives.

For example: The value of gain in:
MAI growth (MAI m³/ha/yr) plus **STIFFNESS** (GPa) plus
 reduced **BRANCH** size (cm) plus reduced **SWEEP** (mm/m) **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:	270	607,294	35
Number of objective traits: 4 (with MAI on a regional basis, STIFFNESS, BRANCH size and SWEEP)			
	Trials	Individual genotypes	Measurements
Size of <i>P. radiata</i> database:	495	1,169,671	16.2 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 and our members collectively contribute 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 5% 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 2023 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 (10-14%)
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 5% of trees (30,365 genotypes) selected for a single trait. For example, the best 5% of trees selected for MAI (volume) alone would have an average predicted increase in volume production of 4.09 m³/ha/yr (18% more than base productivity) but only deliver a marginal improvement in economic value (profit) of \$947 due to trade-offs in other correlated traits. The very best trees for growth have MAI breeding values 33% better than the baseline (set of early generation selections) genotypes. The SELECT orchard result is indicative of the gain which could be achieved in a new orchard based on an average Australian index.

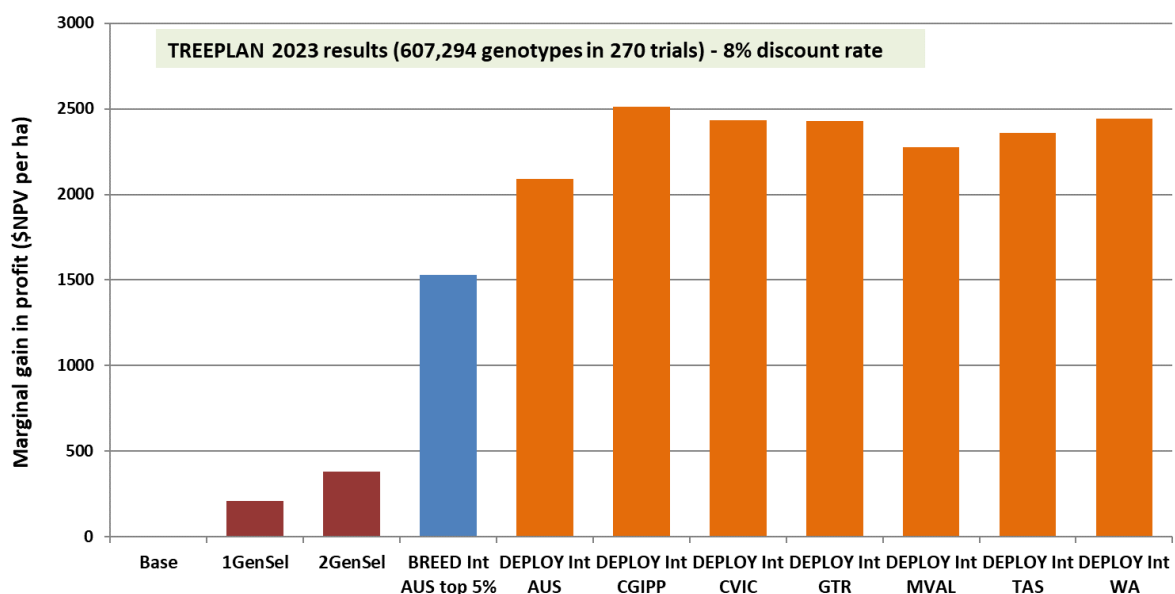
Table 1: Marginal gain (or loss) in selecting various groups of genotypes based on generation, the national multi-trait index or independent traits.

	INDEX	MAI (volume)	STIFFNESS	BRANCH SIZE	SWEEP
<i>Base productivity* and units</i>	<i>NPV \$/ha</i>	<i>22.6 m³/ha/yr</i>	<i>11.3 GPa</i>	<i>5.5 cm (lower is better)</i>	<i>10.5 mm/m (lower is better)</i>
Baseline genotypes	0	0	0	0	0
Overall mean (607,294 trees)	347	0.98	-0.05	-0.27	-0.47
1G Selections (1137 trees) [^]	210	0.75	-0.13	-0.22	-0.31
2G Selections (855 trees) [^]	378	1.05	-0.13	-0.34	-0.82
Top 5% for NPV\$	1529	2.61	0.86	-0.90	-1.20
Top 5% for MAI	947	4.09	-0.57	-0.43	-1.28
Top 5% for STIFFNESS	910	0.21	1.22	-0.50	-0.11
Top 5% for BRANCH	990	1.57	0.12	-1.28	-1.39
Top 5% for SWEEP	778	2.21	-0.46	-0.74	-2.53
SELECT Orchard	2020	2.04	2.07	-0.96	-1.16

* Base Productivity is an average commercial performance indicator used in developing TREEPLAN Genetic Values for Pinus radiata.
[^] 1G and 2G trees were selected using breeding values reported in STBA TR92-02 and TR92-04.

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 (DEPLOY – orange) are compared with the average NPV\$ of the generations and the best 5% 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 \$1529, a new orchard for the Green Triangle Region (DEPLOY Int. GTR) could deliver a marginal gain of NPV \$2428 using an 8% discount rate. Individual results will vary depending upon the production model assumed by growers.



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).