TREE BREEDING AUSTRALIA

ANZIF Conference 2023

Tree improvement in plantation forestry in Australia

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forico

HQPlantations

Plantation forestry

Increasing demand for forest products

Options: utilise more native forest resources (not likely)
increase imports (not desirable)
increase plantation estate area (constraints)
increase productivity per unit area
increase recoveries

Improved genetics plays a crucial role

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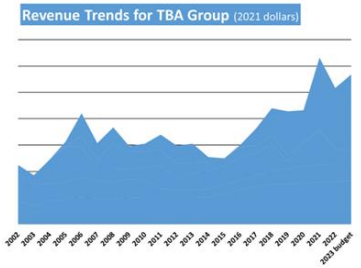

Industry consortium supporting national cooperative programs radiata pine and blue gum

Founded in 1983 (as STBA) to breed and produce seed

Divested of seed production in 2001 to focus on breeding

Transitioned to TBA in 2019 to reflect its national profile

Supports breeding programs of collaborating companies and organisations in Australia and overseas – providing access to systems, tools and expertise

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Fundamentals of tree improvement

Define the breeding objective(s)

Need genetic resources fit for purpose (adapted)

Effective breeding programs

Rigorous testing programs

Efficient management of data and information

Best practise data analysis and genetic evaluation

Effective selection for further breeding and deployment





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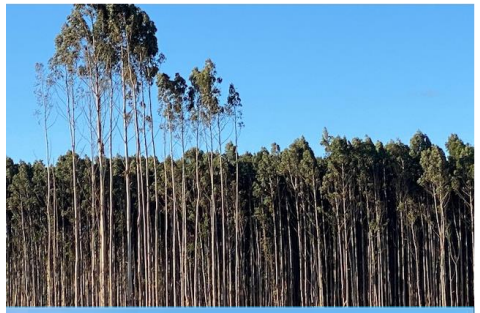
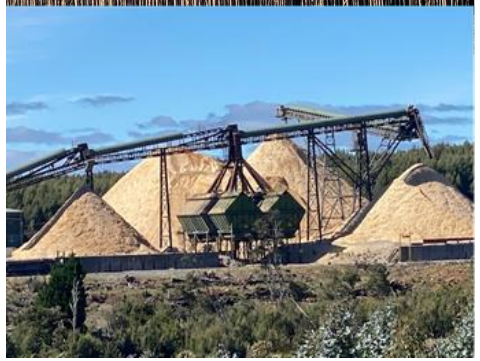
Tree improvement programs

We have advanced generation breeding programs for the main species

Some interest in other minor and emerging species

Breeding objectives (largely economic)





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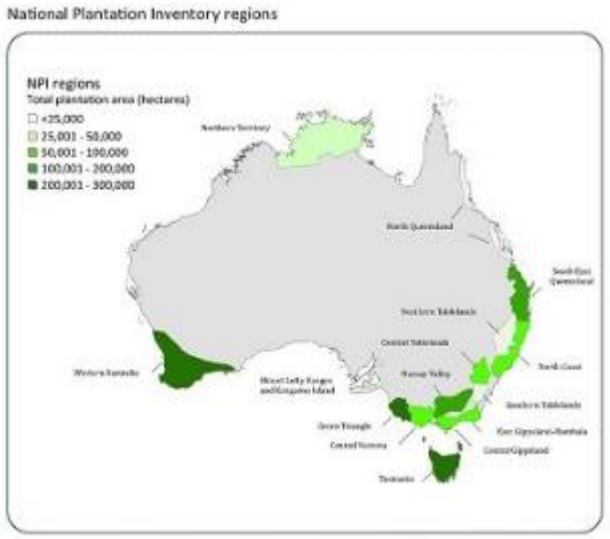
Australian breeding programs



	P. radiata	*E. globulus*	*E. nitens*	Southern pines
Climate	Temperate - medium rainfall	Temperate - medium to high rainfall	Temperate - medium to high rainfall	Tropics and sub-tropics high rainfall
Region	NSW, Victoria, SA, WA and Tasmania	WA, SA, Victoria and Tasmania	Tasmania and Victoria	Queensland (+ N NSW)
Area	691,000+ ha	342,000 ha decreasing	182,000 ha	140,000 ha
Market	Structural sawn timber for building, joinery, plywood, posts, poles, residues for pulp, particle and panel board	Export chip for pulp and paper (developing interest in solid wood and veneers)	Export chip for pulp and paper, solid wood and veneers	Structural sawn timber for building, joinery, plywood, posts, poles, residues for pulp, particle and panel board
Breeding Programs began	1950s	late 1980s	1970s	1950s

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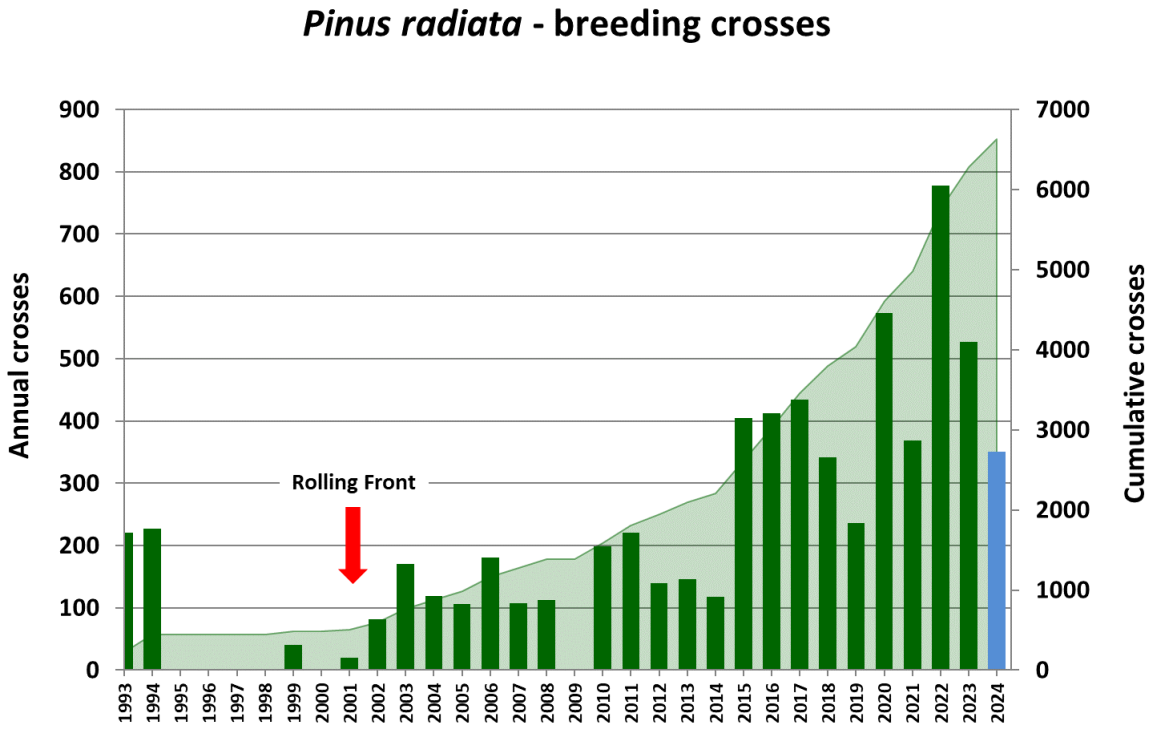
The rolling front

Change from discrete cycles of breeding to rolling front programs has led to efficiencies and increased rates of gain

Introduced some challenges in data analysis

Overcame with better analytical software (TREEPLAN)

Need effective breeding programs



Dedicated facilities for breeding

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We must keep breeding

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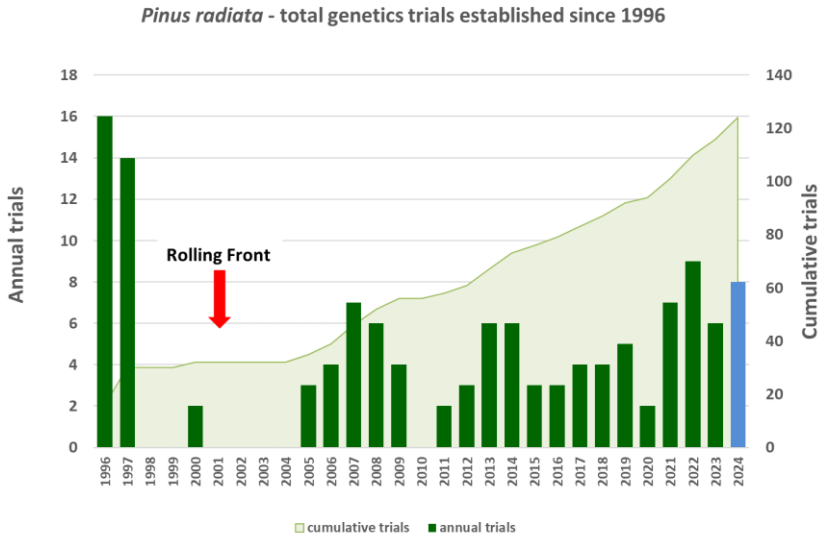
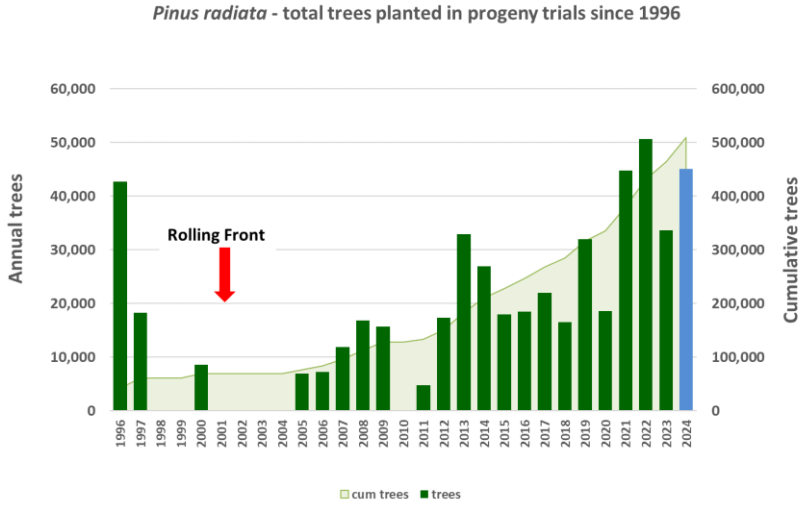
Need rigorous testing programs





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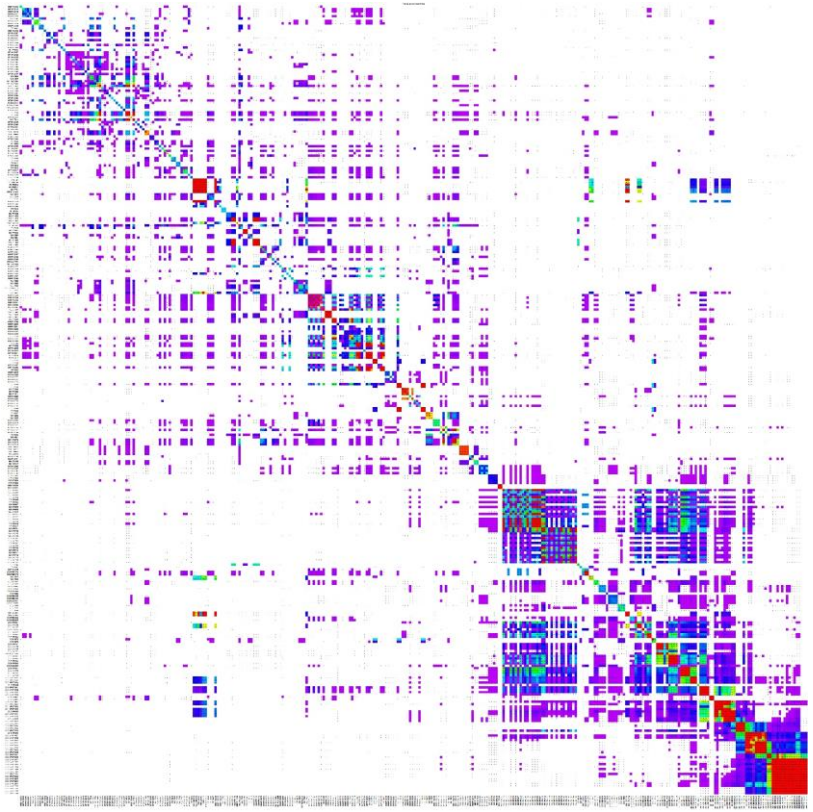
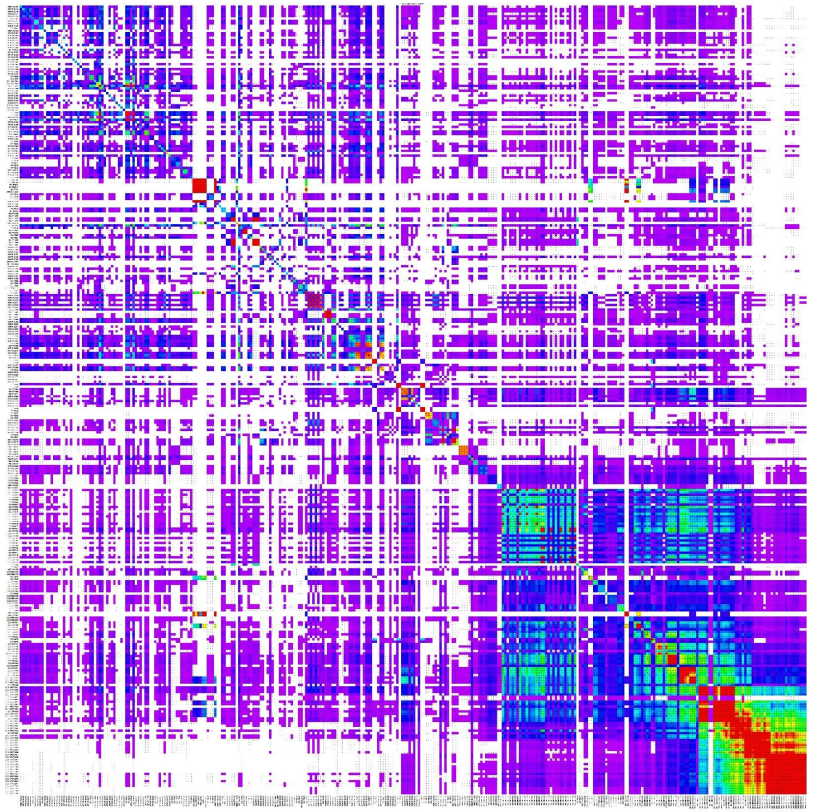
Trials are better linked across sites and years



Families in common



Parents in common

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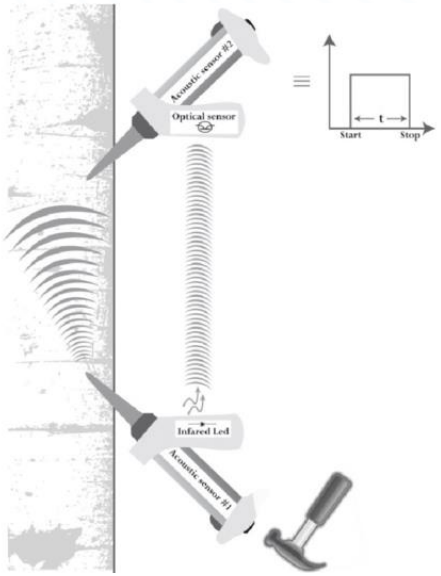
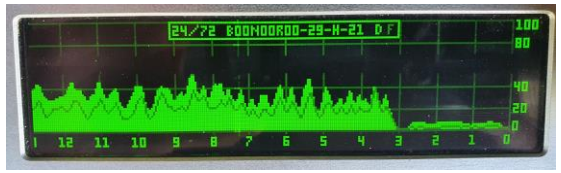
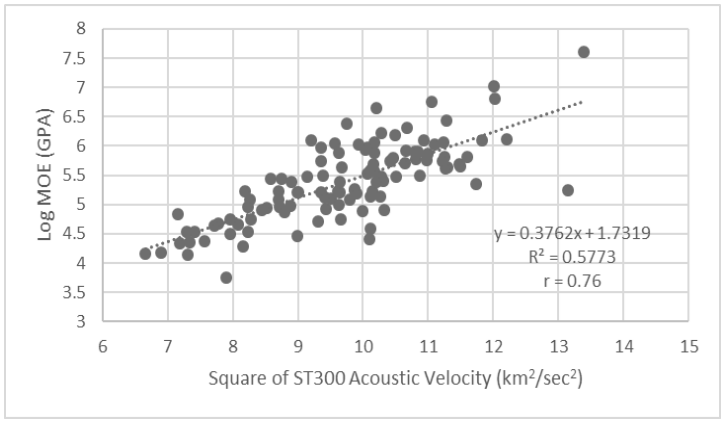
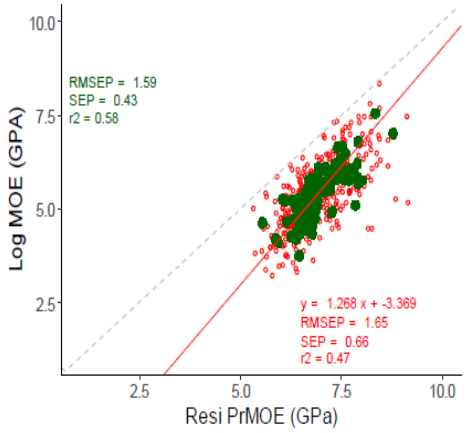
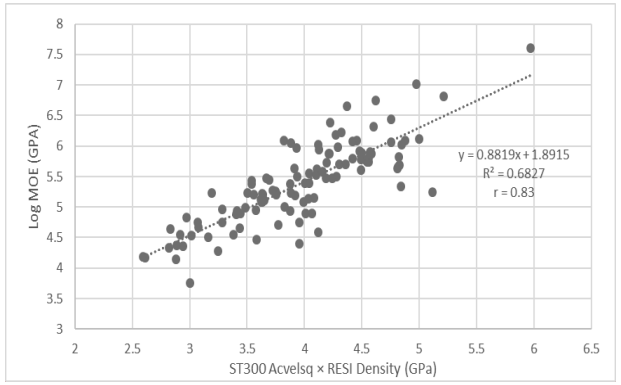
We did the research (ongoing) to develop non-destructive methods of assessing wood quality











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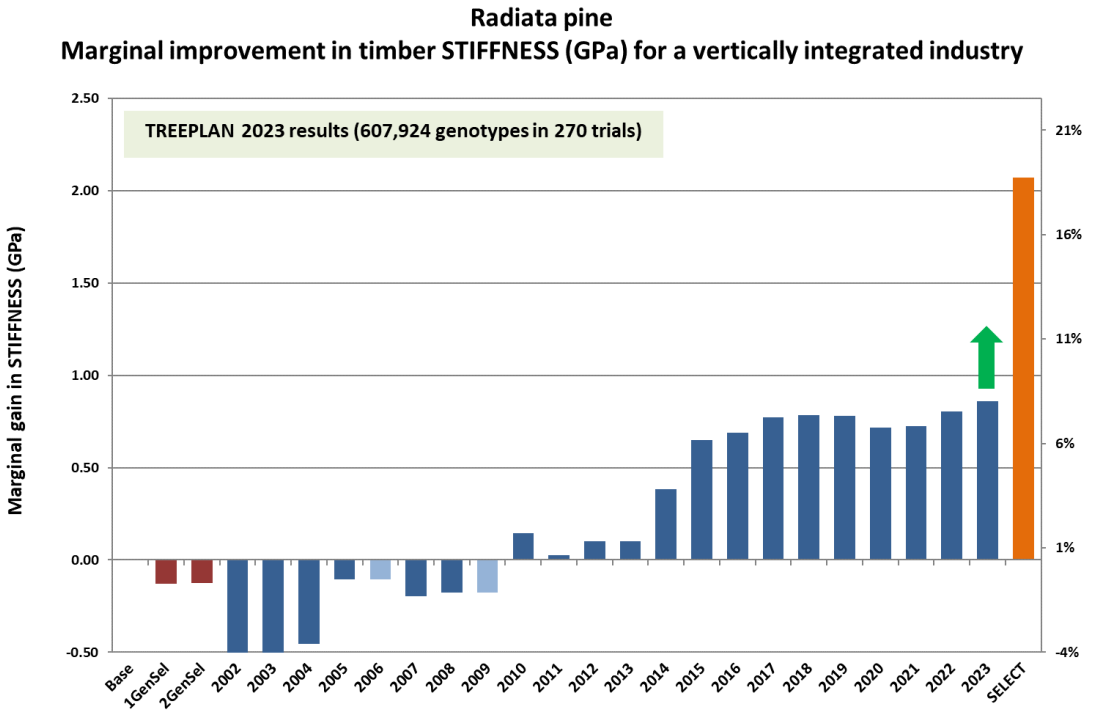
Tools are used routinely in tree breeding programs.

	Acoustic wave velocity (ST300 and Fakopp)		IML RESI PD3-400	
	Trials	Trees	Trials	Trees
Radiata pine	67	62,381	29	122,903
Blue gum	3	2332	20	44,882
Shining gum	10	6,260	18	32,949
Southern pines	30	52,154	3	1915



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More testing in more environments

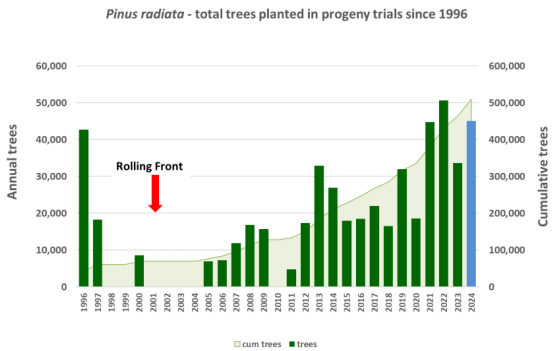
Want to double the rates of genetic gain

Testing in more environments (climate change and industry expansion)

More phenotyping and genotyping (want the right plant in the right place)

FWPA and NIFPI projects supported by government and industry

Some collaboration with NZ (radiata pine)



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Forest&Wood Products Australia

NATIONAL INSTITUTE FOR FOREST PRODUCTS INNOVATION

We share tools and systems for efficiencies

DATAPLAN (data management)

TREEPLAN (genetic evaluation)

SEEDPLAN (population management tools)

we also share technicians, breeders and geneticists

we do R and D collaboratively

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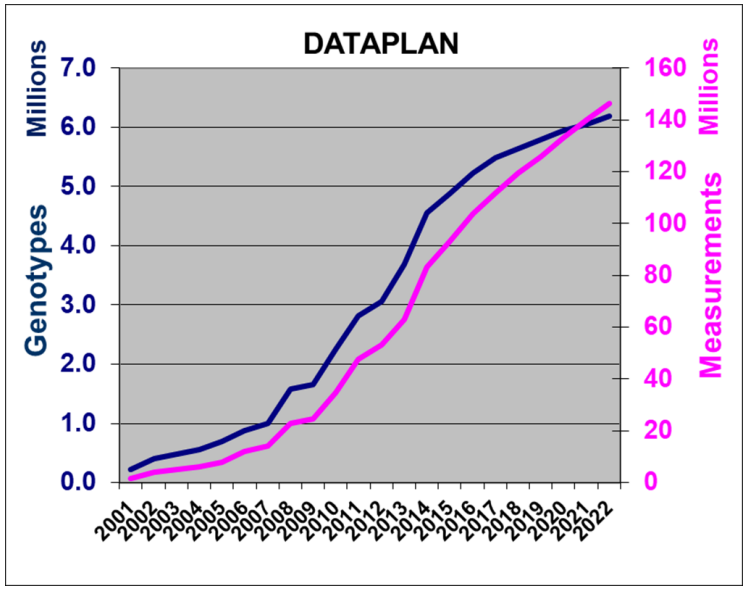
National database for management of data and information



DATAPLAN system – since 2000

Web based to facilitate user access

Services multiple species – is flexible

Integrated with other tools to facilitate data analysis, genetic evaluation, population management …

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National database for management of data and information

Species	Programs	Trials	Genotypes
Radiata pine	TBA	502 (273)	1,170,910
Southern pines	HQP	102 (73)	191,996
Blue gum	TBA	243 (186)	614,820
Shining gum	Forico, STT, HVP and SCION	216 (163)	384,997
TOTAL	+ other collaborators (14)	3,430 (1452)	6,390,854

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Data analysis and genetic evaluation

Data sets are large and highly unbalanced

We use best practise analytical methods

TREEPLAN software since 2001 – prediction of genetic and breeding values

We use all the data and information – both phenotypes and genotypes

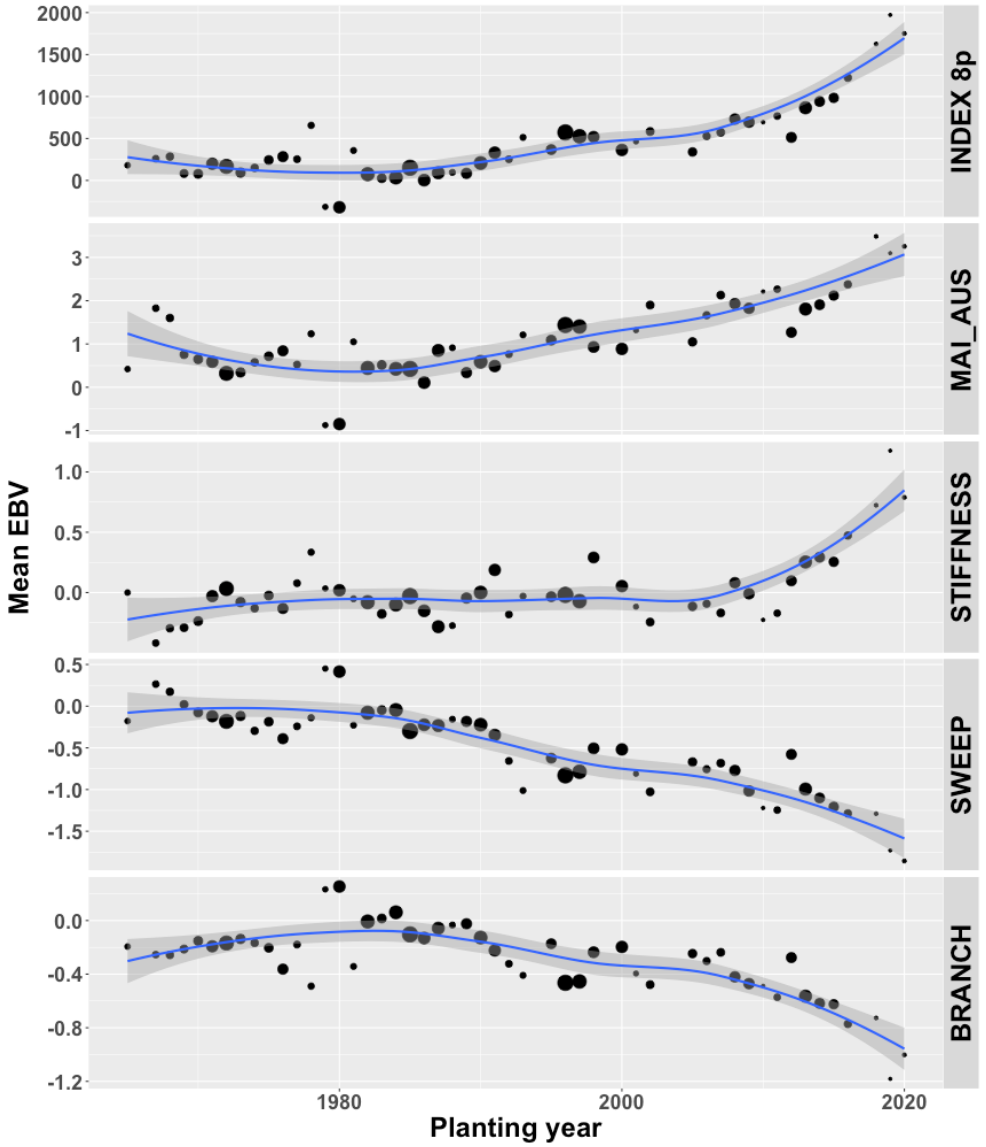
in single-step TREEPLAN evaluations – one situation one result

Efficient for industry to invest in common platforms (across commodities)

Joint evaluations enabled for collaborating (and competing) breeding organisations

We measure a trial – we update all the breeding values

Are we making genetic gain ?



Natural radiata pine stand

a selection in 2011 now progeny tested as a parent

Embedded gain designs with large plots since 2009

Gain is consistently demonstrated in independent trials for all species (IRRPLAN project)

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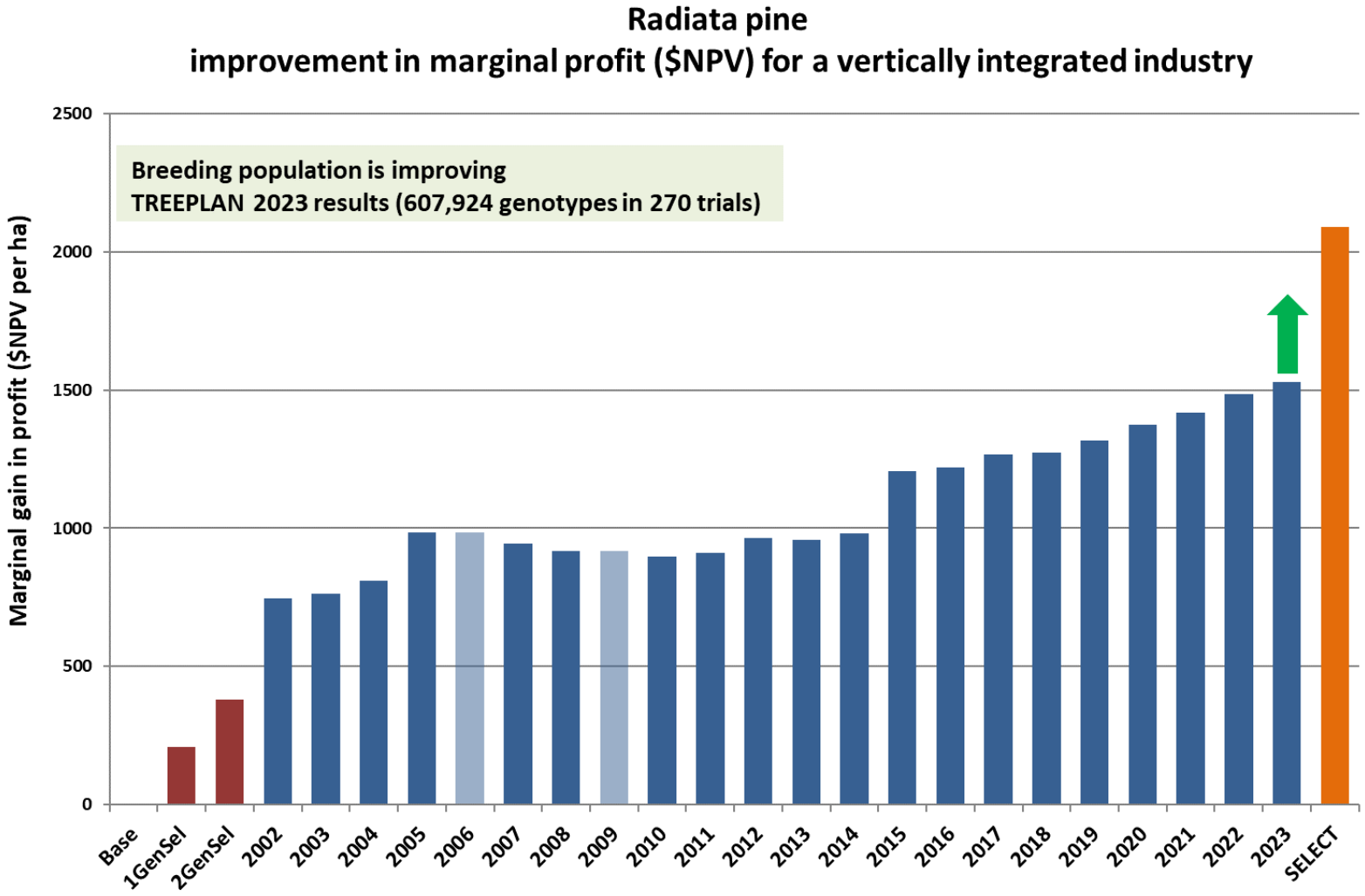
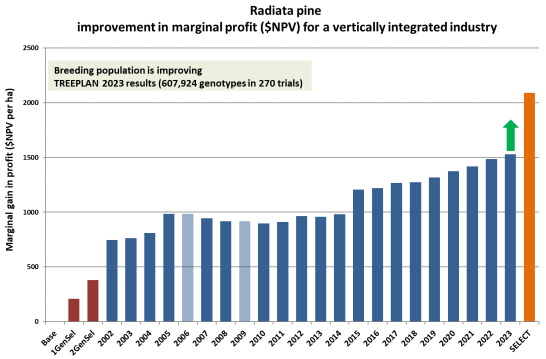
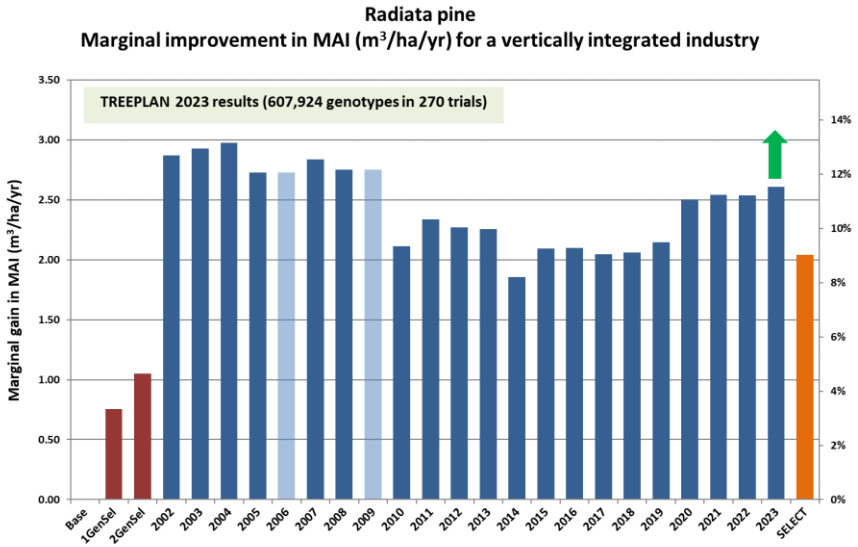
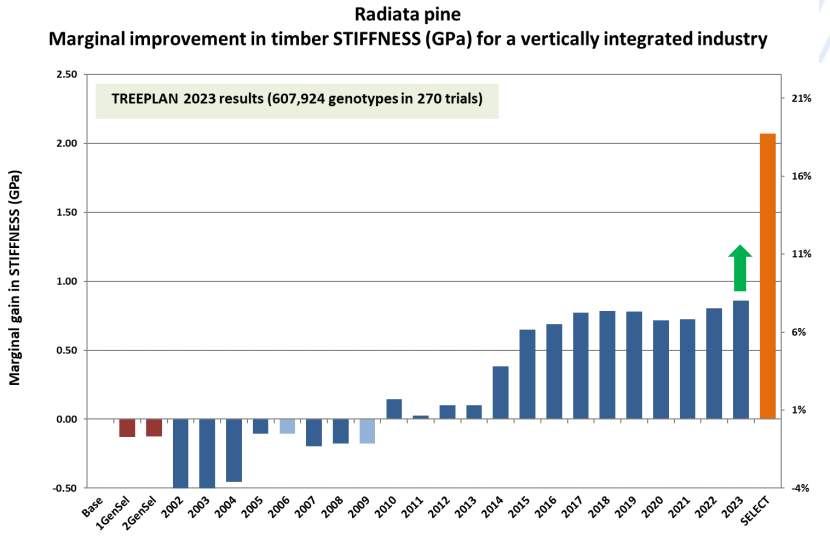
Radiata pine – monitoring gain for $ index

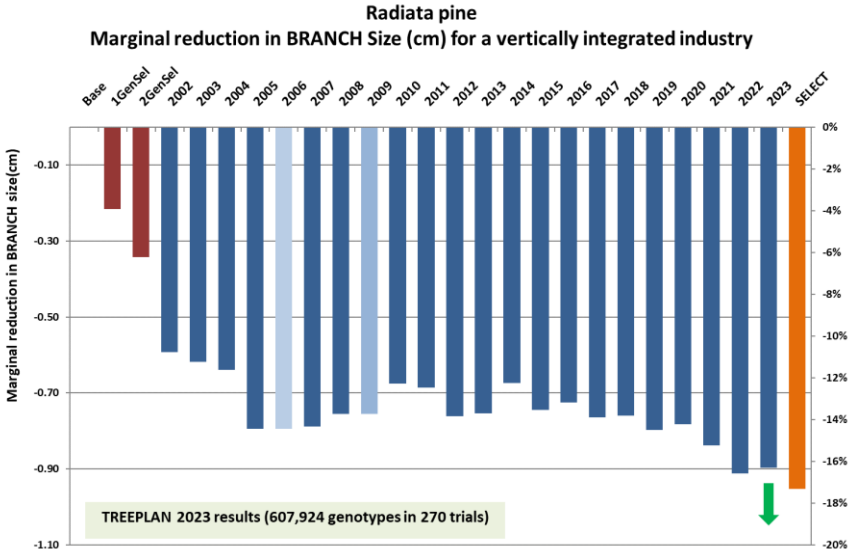


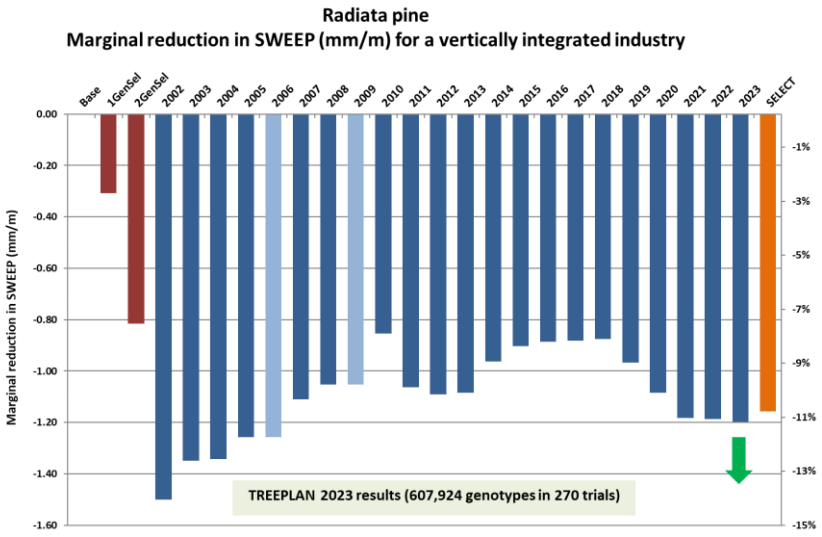
Radiata pine – monitoring gain











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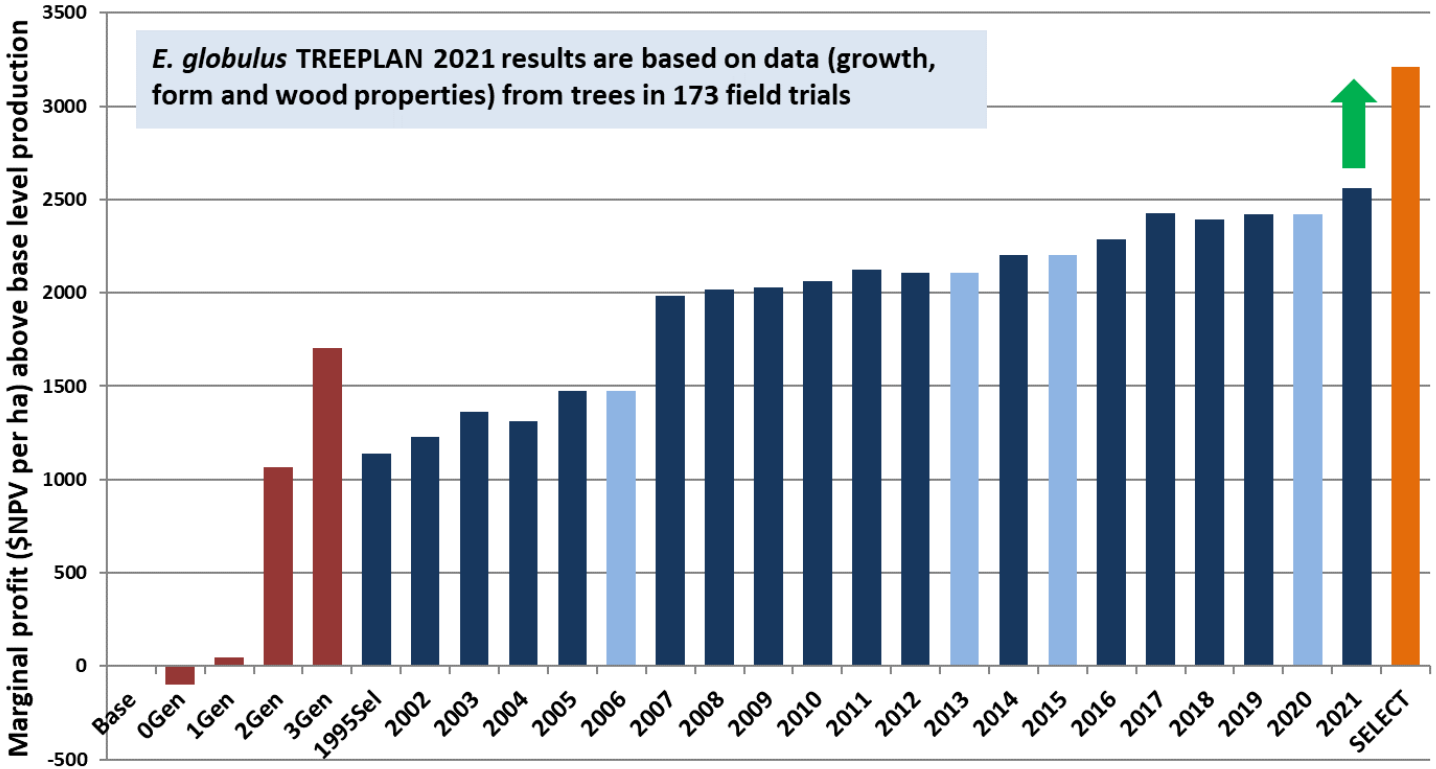
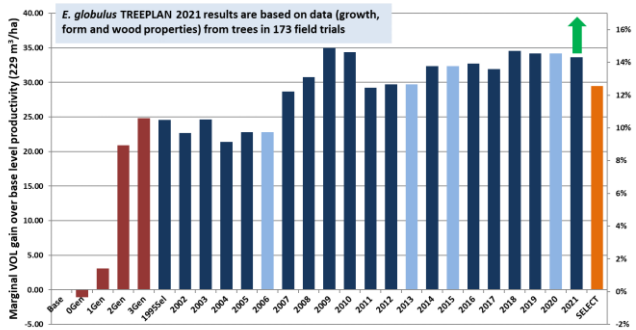
Blue gum – monitoring gain

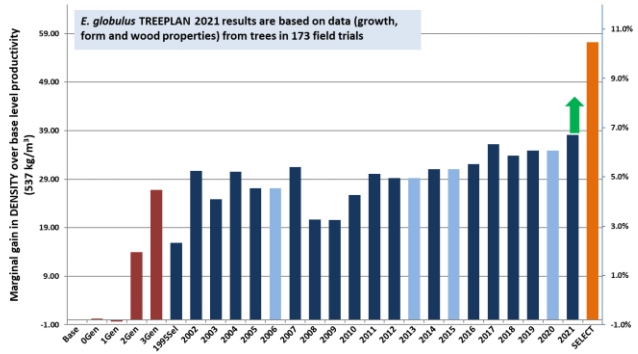
Improvement in marginal profit ($NPV) per ha across generations and over time for the best 1% of genotypes (trees) based on the national economic objective for breeding



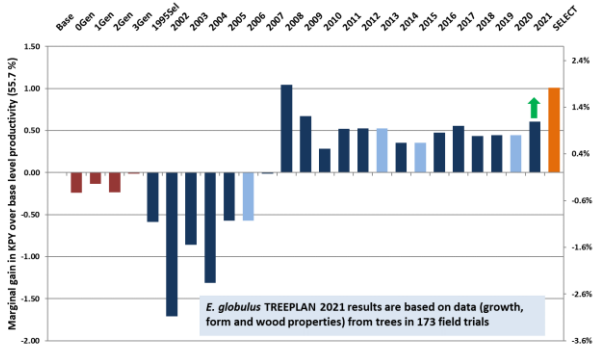
Marginal improvement in VOLUME (m^3/ha) across generations and over time for the best 1% of genotypes (trees) selected using the national breeding objective index for $NPV



Marginal improvement in timber DENSITY (Kg/m^3) over time for the best 1% of genotypes (trees) selected using the national breeding objective index for $NPV



Marginal movement in Kraft Pulp Yield (%) over time for the best 1% of genotypes (trees) selected using the national breeding objective index for $NPV



Where does genomic selection fit ?

Genotyping to date has been somewhat ad hoc – more investment in DNA assays to "commercial proof" the technology

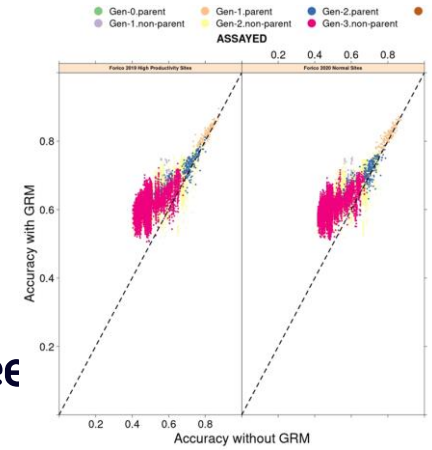
Single-step TREEPLAN prediction operational since 2018

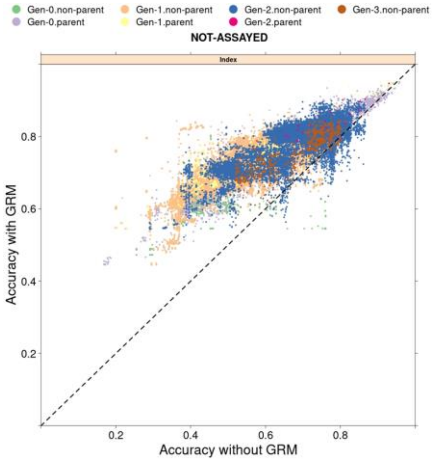
Evaluate benefit by increasing accuracy and reducing generation interval

Genomics is adding value in eucalypts through single step approach – mostly due to pedigree recovery and improved accuracies for early generation selections

More problematic in pines with big genomes

Can we accurately select within new FS families without phenotypes ?





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CONCLUSION

Cooperative and industry wide breeding programs are delivering genetic gain

Scaling up operations with more breeding and testing (phenotyping)

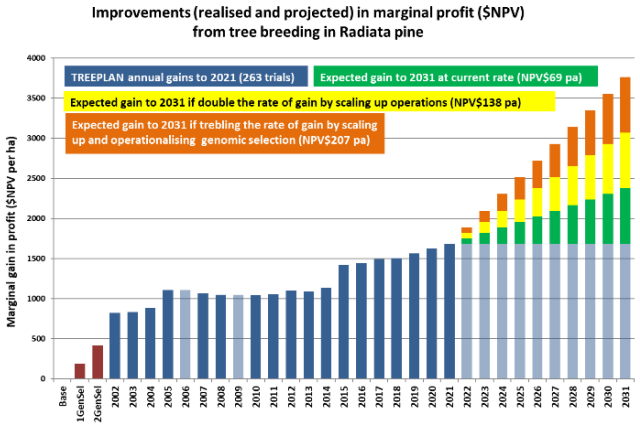
Economic objectives need updating

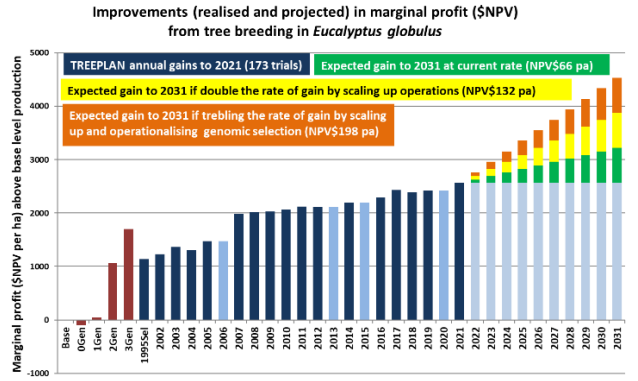
Climate change is a challenge

Genomic selection is operational (but must also be cost effective)

Share tools, systems and people across species

Science underpins decision making





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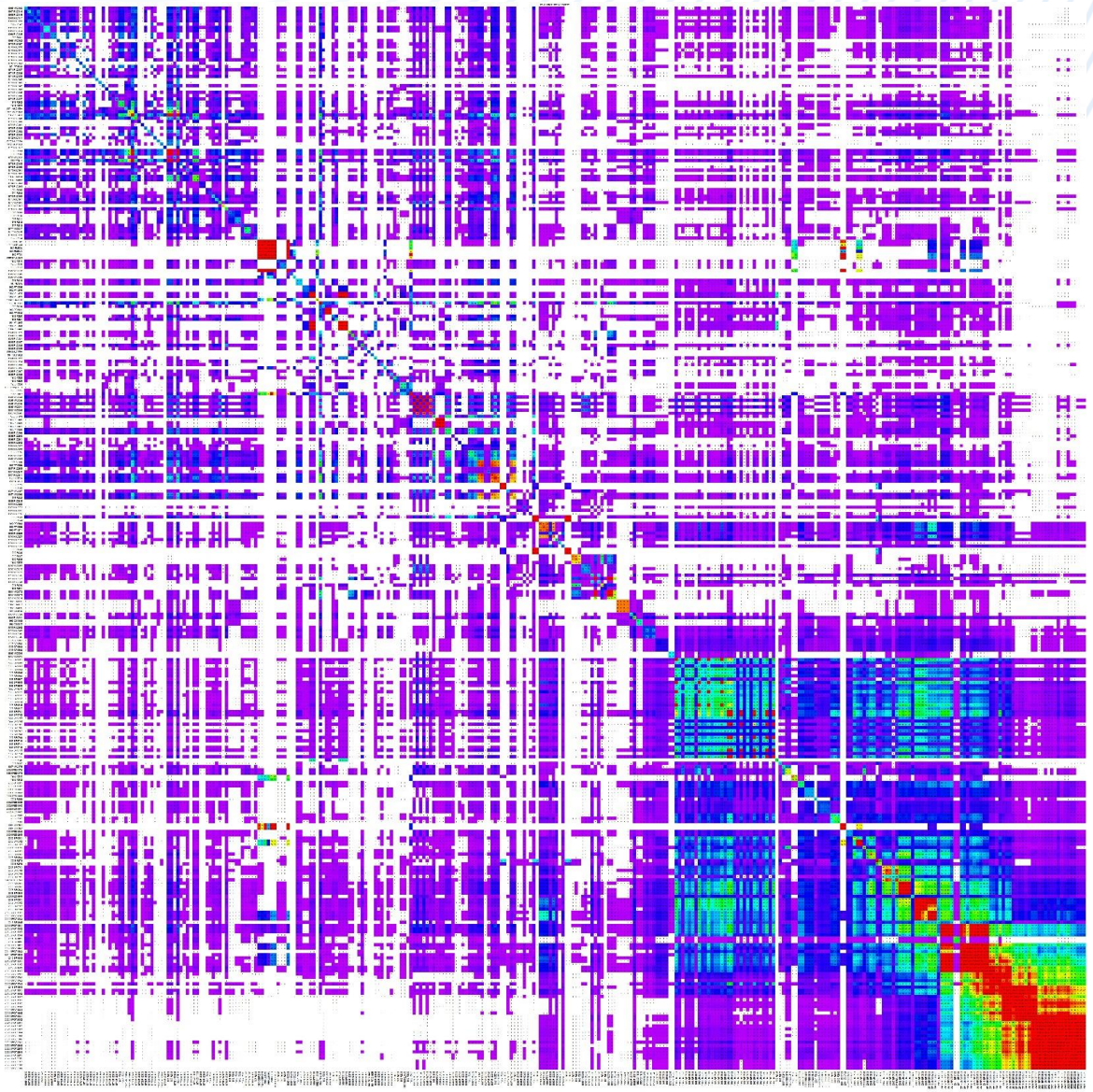
We plant every year



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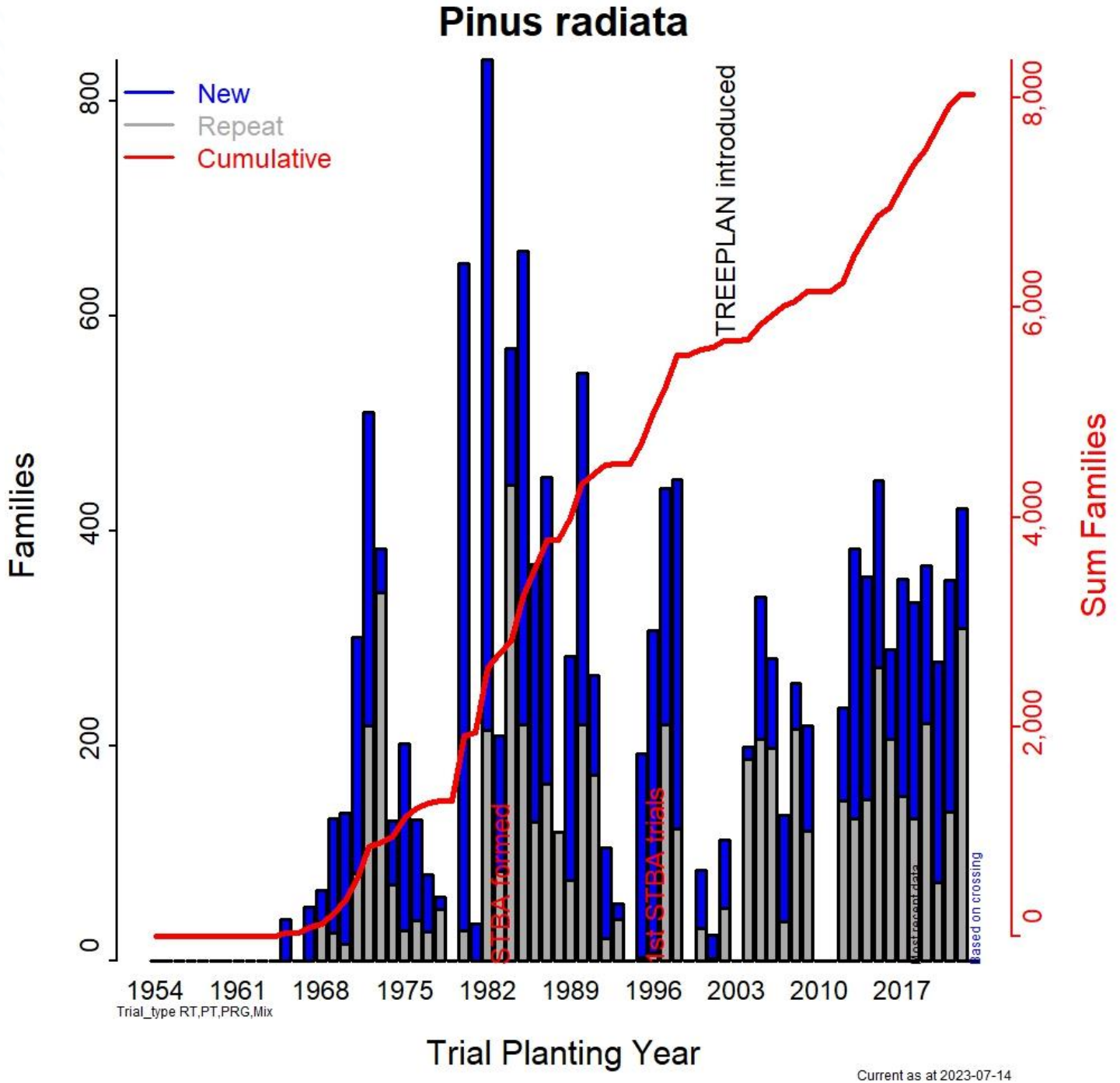
We cross every year



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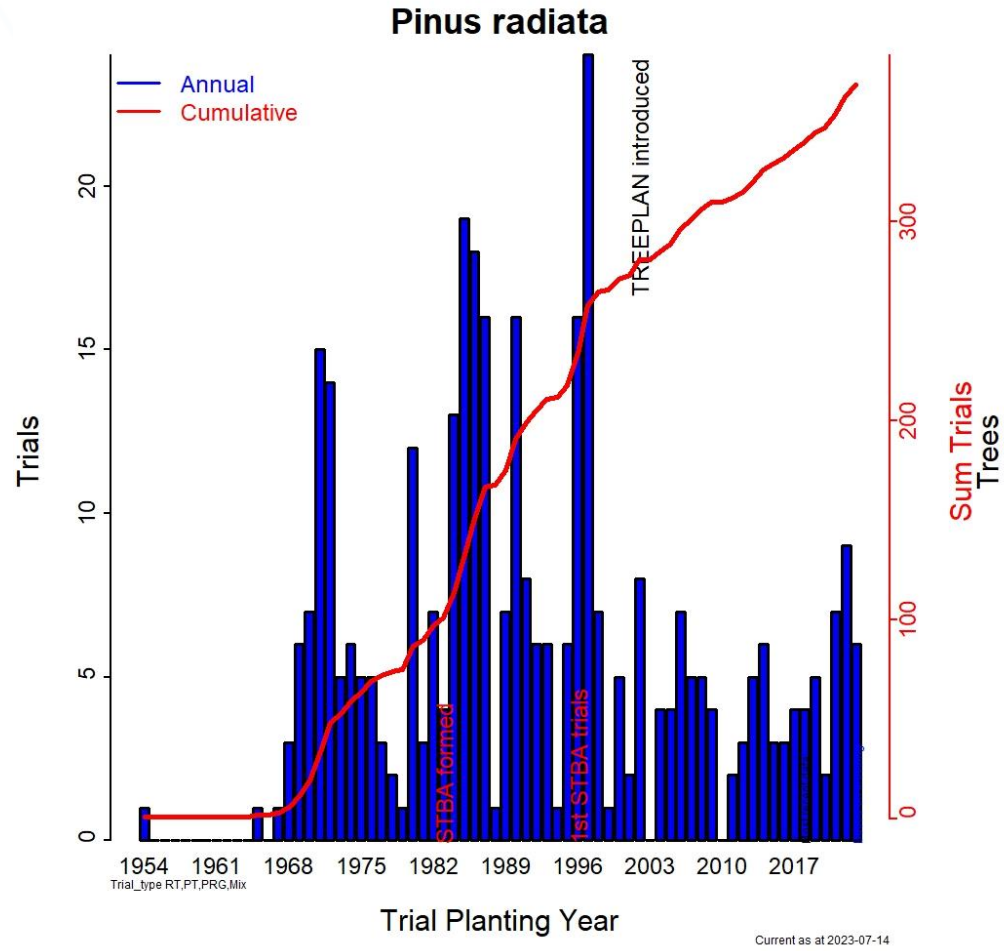
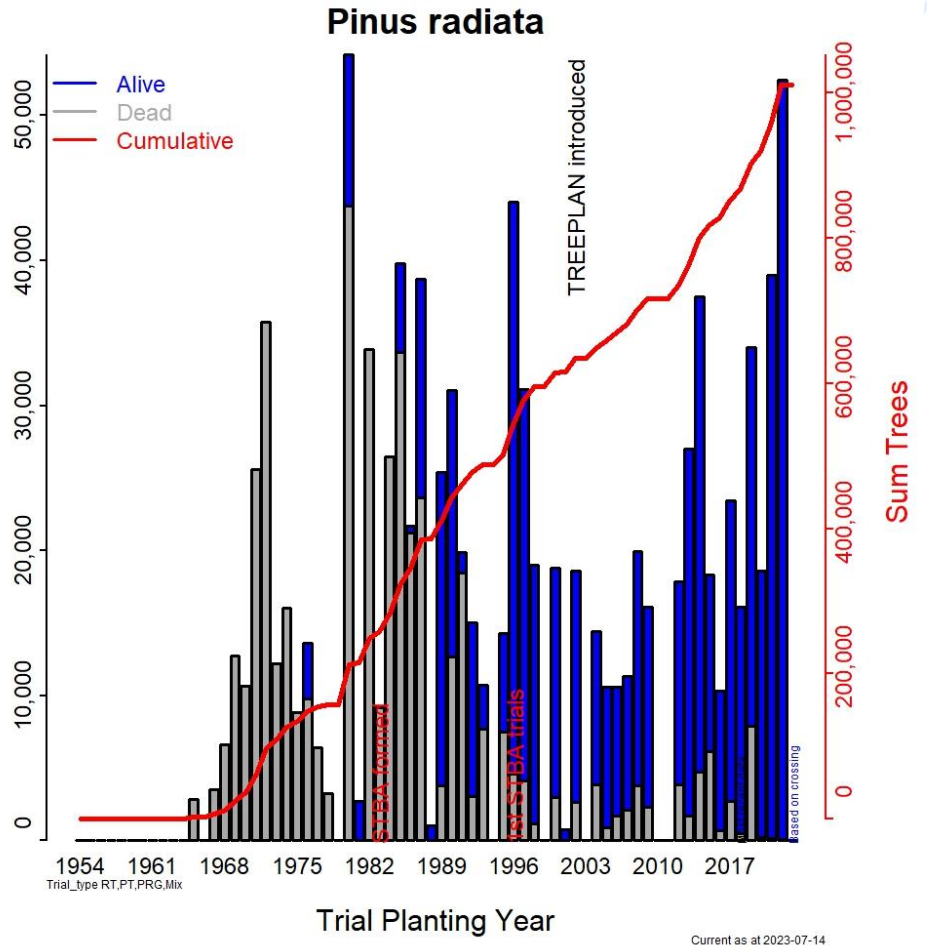
We plant every year





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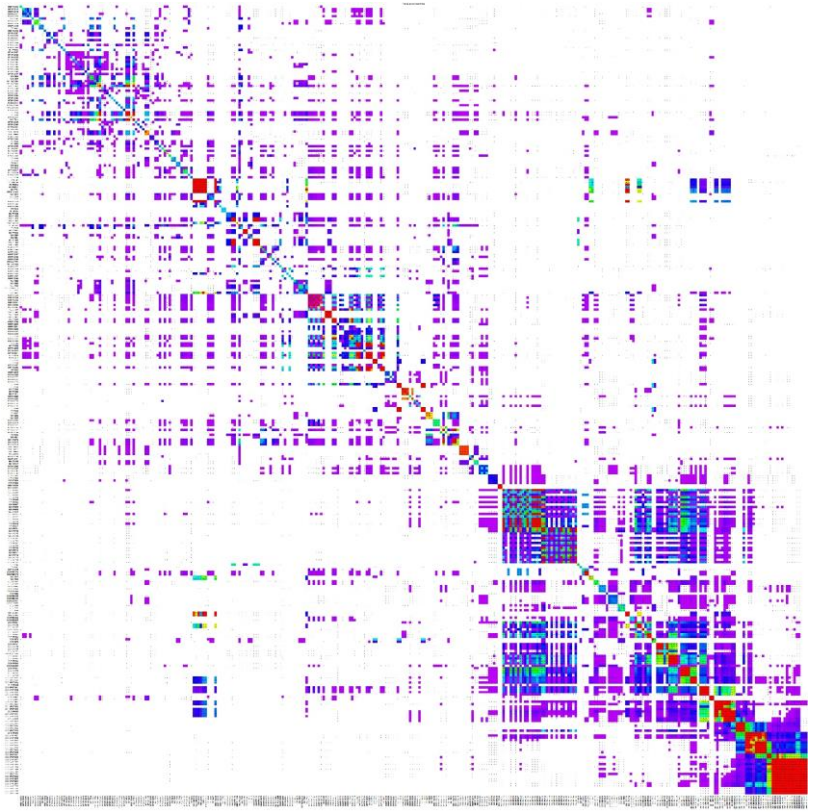
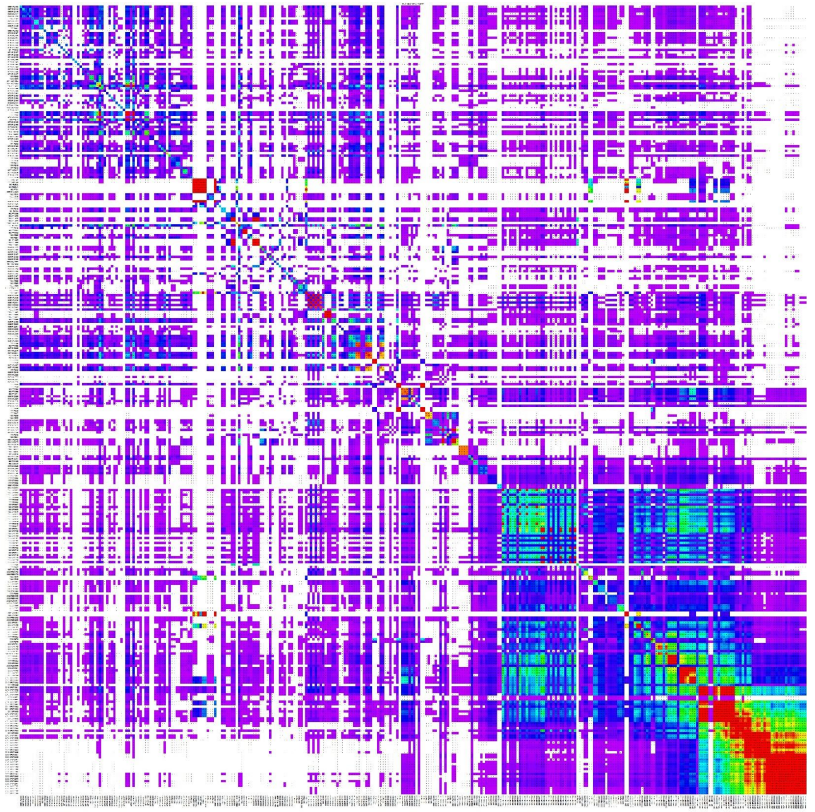
Trials are better linked across sites and years



Families in common



Parents in common

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