Challenges and advances in genetically improving trees for the plantation forestry sector

Paper TI01-PA

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(with acknowledgement to CSIR Tree Improvement Researchers)

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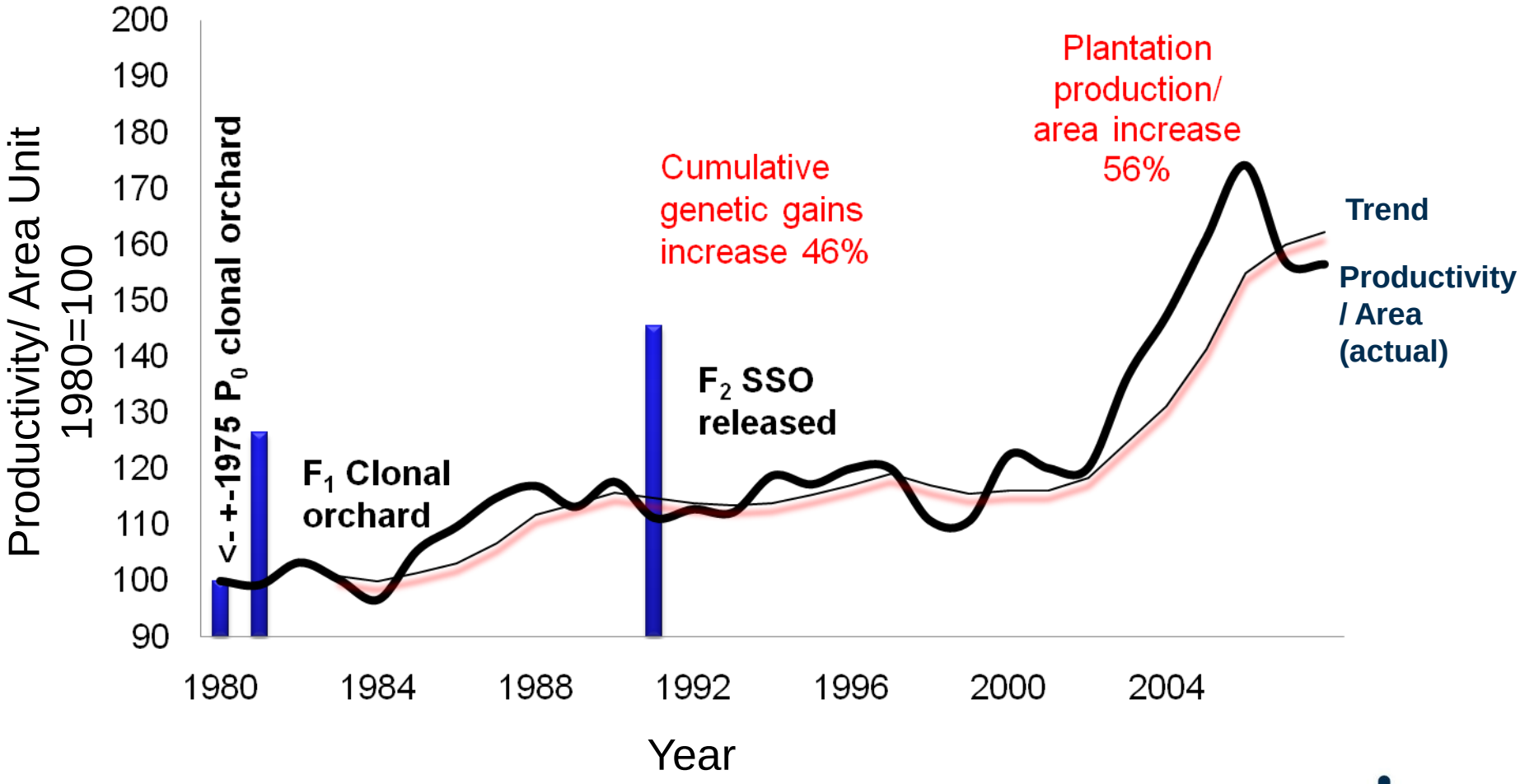
our future through science

Outline of presentation

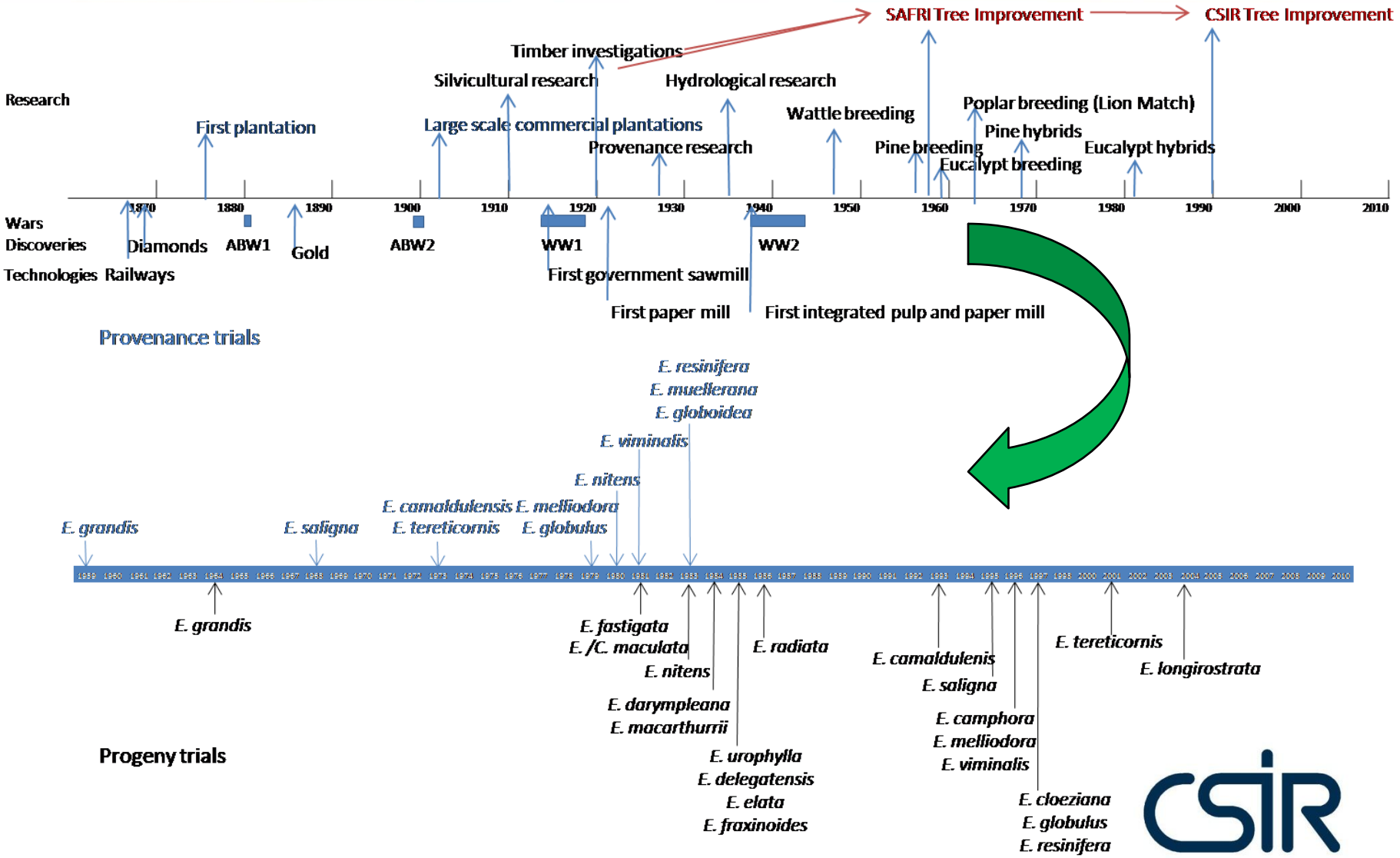
- South African plantation forestry sector: contributions and improvement in productivity
- Acquiring the genetic diversity
- Selected challenges and advances in genetically improving trees
- Transforming the value of the plantation
- Looking to the future

South African roundwood production per planted area and genetic gains of *E. grandis* at seed orchard release



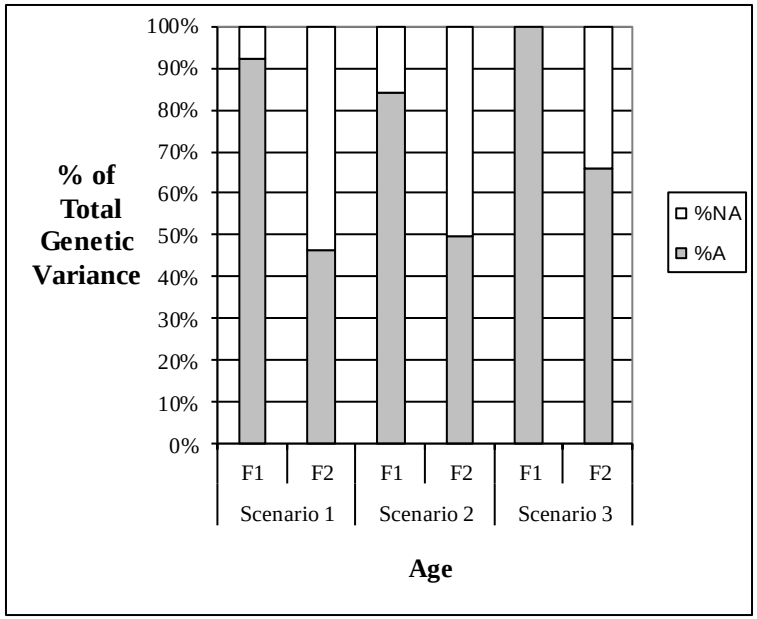
Based on FSA 2009, Verryn 2002, Verryn *et al* 2007

Acquiring the genetic diversity



How should we breed and deploy material?

- Understanding the underlying genetics
  - Inheritance patterns in *E. grandis*

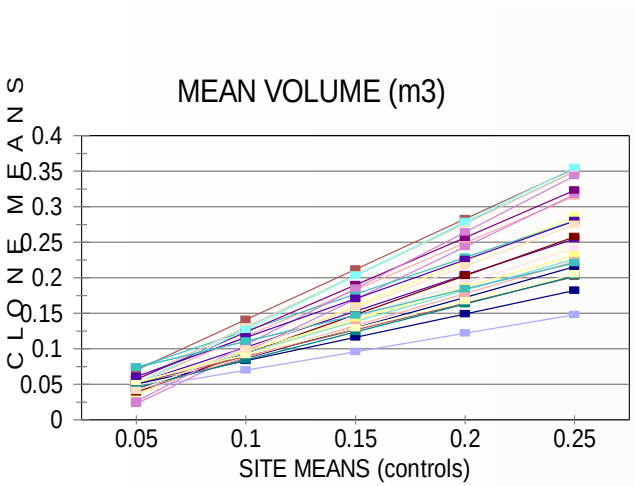


Estimated additive (A) and non-additive (NA) variances as a percentage of total genetic variance for height at 66 months over generations (F_1 and F_2) for the three scenarios considered.

Cloned breeding population

How do genotypes respond to different environments?

- Genotype by Environment Interaction (GEI)



Linear regressions depicting predicted *E. grandis* clone means across site at 5 years of age

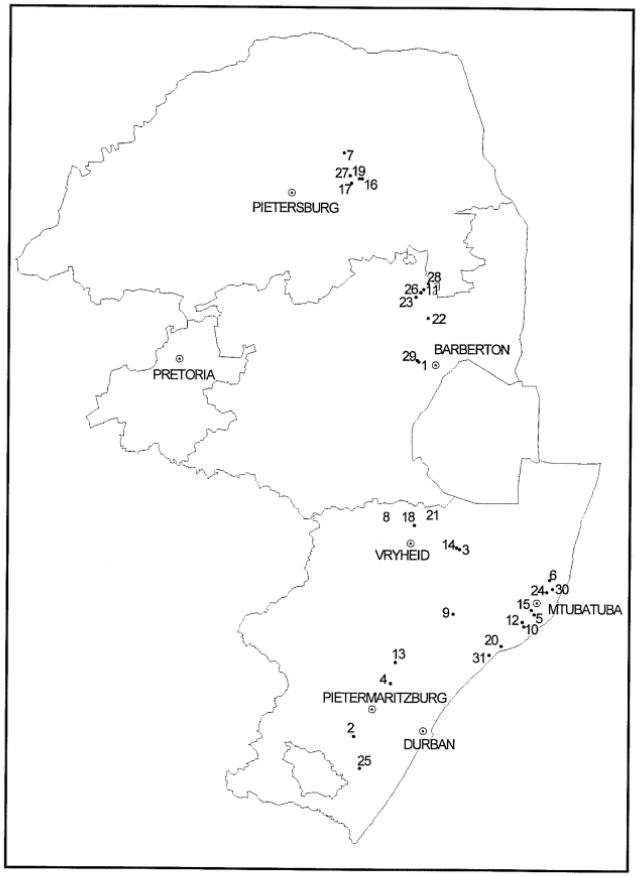


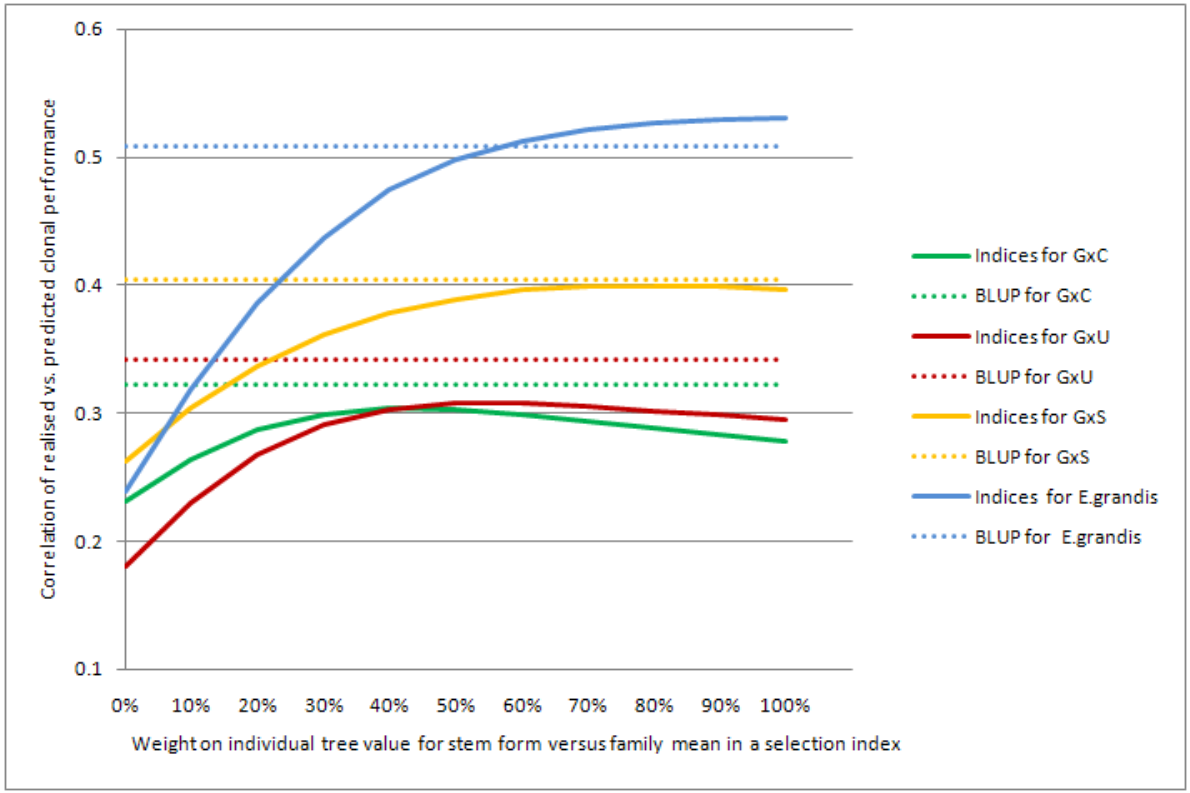
Figure 1. Map of the eastern portion of South Africa showing the locations of the GEI trials

Are the genetic rankings reliable?

- First empirical confirmation of the negative impact of collinearity
- Simulation studies using BLP (Best Linear Prediction)
- 80% of cases showed lower genetic gains than alternative techniques

Overcoming hybrid hurdles

- Prediction of clonal performance in eucalypt hybrids
  - Are the methods we use to select in hybrid populations efficient?
  - Results
    - BLUP seems to give sufficiently reliable results for the prediction of clonal performance in hybrids
    - … but prediction difficult for wide hybrids

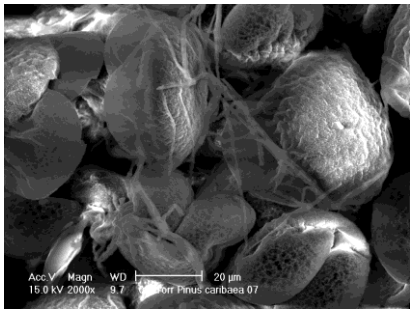


Mitigating risks through genetics

- Example of risks
  - Biotic
  - Abiotic
- Recovery of the Mapiep Breeding Orchard post fire

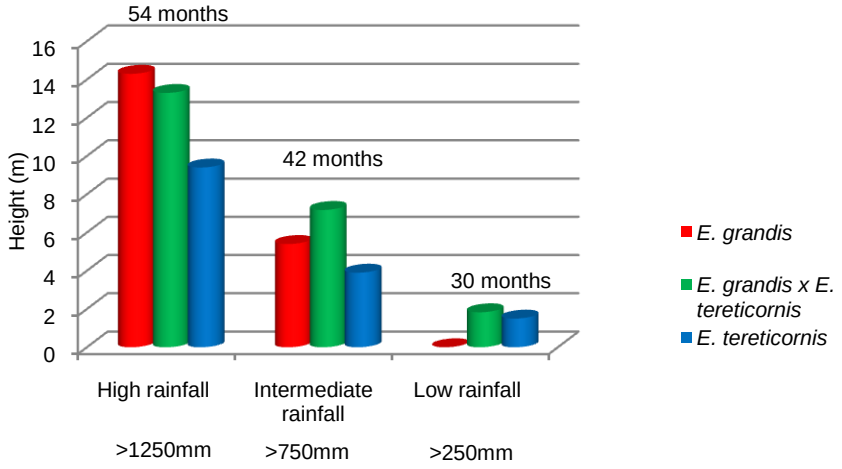
Overcoming hybrid hurdles

- Reproductive barriers in the production of hybrid seed
  - Producing seed a critical step in hybrid production
  - Recent studies include
    - Incompatibility barriers in
    P. elliottii x P. caribaea hybrid
    - Improving controlled pollination techniques



Trees for marginal areas

- Limited land for afforestation
- Commercial viability in marginal areas depends on ability to productively produce timber on these sites
- Germplasm for marginal sites
- A hybrid success story
  - Swaziland trials



- GxC at Salique

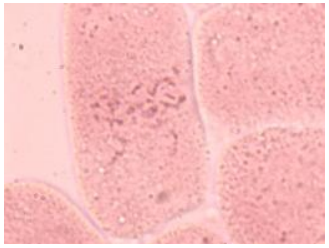
E.camaldulensis (unimproved)

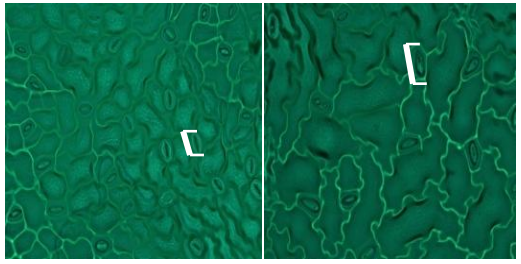
E.grandis x E.camaldulensis hybrid

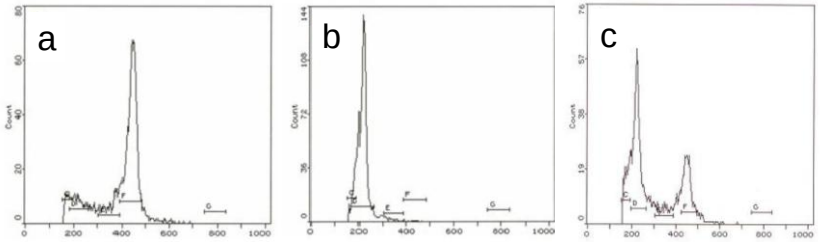
The polyploid journey of discovery

- Potential
  - Reduce fertility
  - Increase biomass
  - Wood properties
- Producing polyploid eucalypts

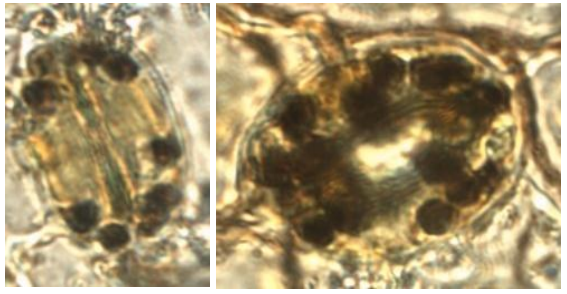
Induction of polyploidy





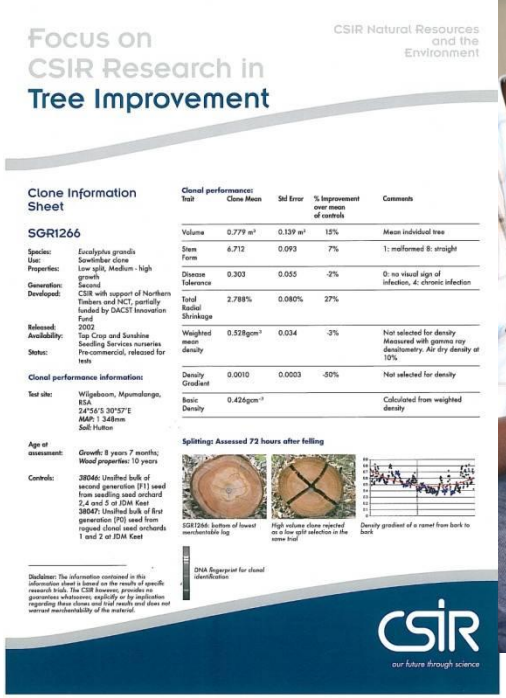


Verification of ploidy levels



Transforming the value of the plantation

- High value products for growers
- Tools for breeding
- Sharing the knowledge & technologies



Focus on
CSIR Research in
Tree Improvement

CSIR Natural Resources and the Environment

Clone Information Sheet

SGR1266

Species: *Eucalyptus grandis*
Use: Sawtimber clone
Properties: Low split, Medium - high growth
Generation: Second
Developed: CSIR with support of Northern Timbers and NCT, partially funded by DACST Innovation Fund
Released: 2002
Availability: Top Crop and Sunshine Seedling Services nurseries
Status: Pre-commercial, released for tests

Clonal performance information:

Test site: Wilgeboom, Mpumalanga, RSA
24°56'S 30°57'E
MAP: ± 348mm
Soil: Hutton

Age at assessment: Growth: 8 years 7 months; Wood properties: 10 years

Controls: 38046: Unsifted bulk of second generation (F1) seed from seedling seed orchard 2,4 and 5 at JDM Keet
38047: Unsifted bulk of first generation (F0) seed from rogued clonal seed orchards 1 and 2 at JDM Keet

Clonal performance:

Trait	Clone Mean	Std Error	% Improvement over mean of controls	Comments
Volume	0.779 m³	0.139 m³	18%	Mean individual tree
Stem Form	6.712	0.093	7%	1: malformed 8: straight
Disease Tolerance	0.303	0.055	-2%	0: no visual sign of infection, 4: chronic infection
Total Radial Shrinkage	2.788%	0.080%	27%	
Weighted mean density	0.528gcm⁻³	0.034	-3%	Not selected for density Measured with gamma ray densitometry. Air dry density at 10%
Density Gradient	0.0010	0.0003	-50%	Not selected for density
Basic Density	0.426gcm⁻³			Calculated from weighted density

Splitting: Assessed 72 hours after felling

SGRT266: bottom of lowest merchantable log

High volume clone rejected as a low split selection in the same trial

Density gradient of a ramet from bark to bark

DNA fingerprint for clonal identification

Disclaimer: The information contained in this information sheet is based on the results of specific research trials. The CSIR however, provides no guarantees whatsoever, explicitly or by implication regarding these clones and trial results and does not warrant merchantability of the material.

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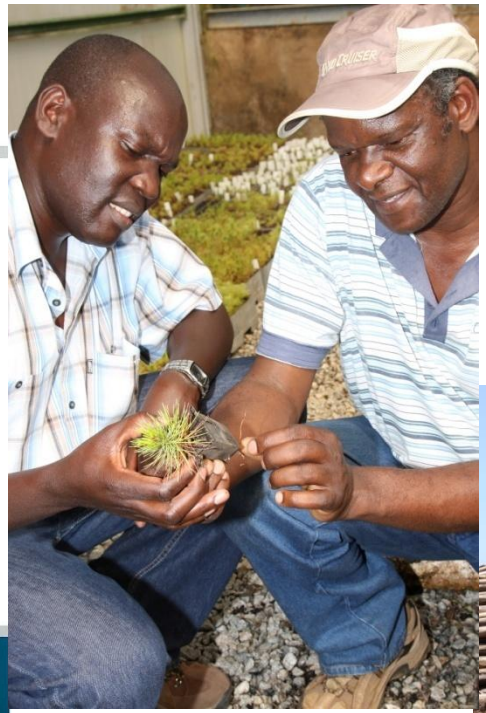

Looking to the future

- Breeding today for future needs
- New challenges & opportunities
  Some of these include
  - Bioenergy
  - Carbon sequestration
  - Climate change
  - New landowners and small scale forestry growers
  - New technologies for timber utilisation

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Acknowledgements

- Our people

- Our stakeholders and collaborators

Your are invited to visit our demonstration

in celebration of 20 years of

Tree Improvement Research

at the CSIR

Thank You

our future through science