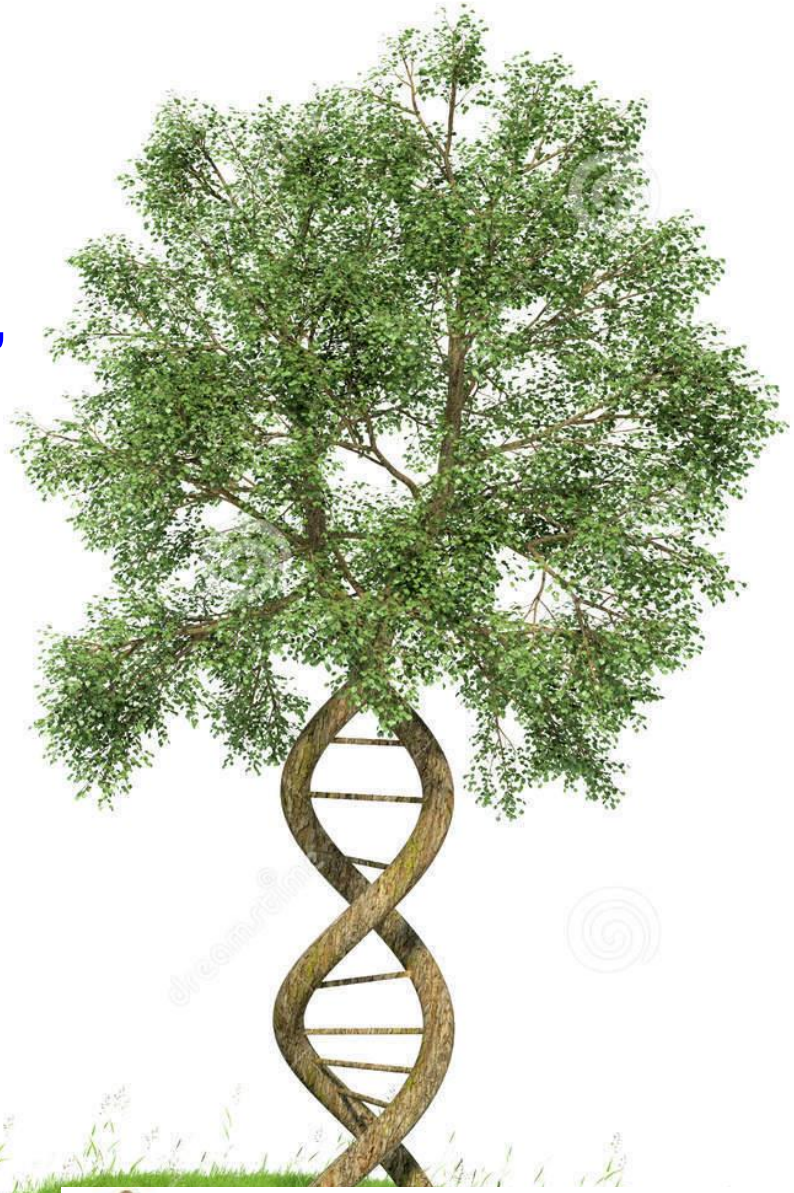
GM Forestry

Sanushka Naidoo, Victoria Maloney,
Adri Veale & Alexander Myburg

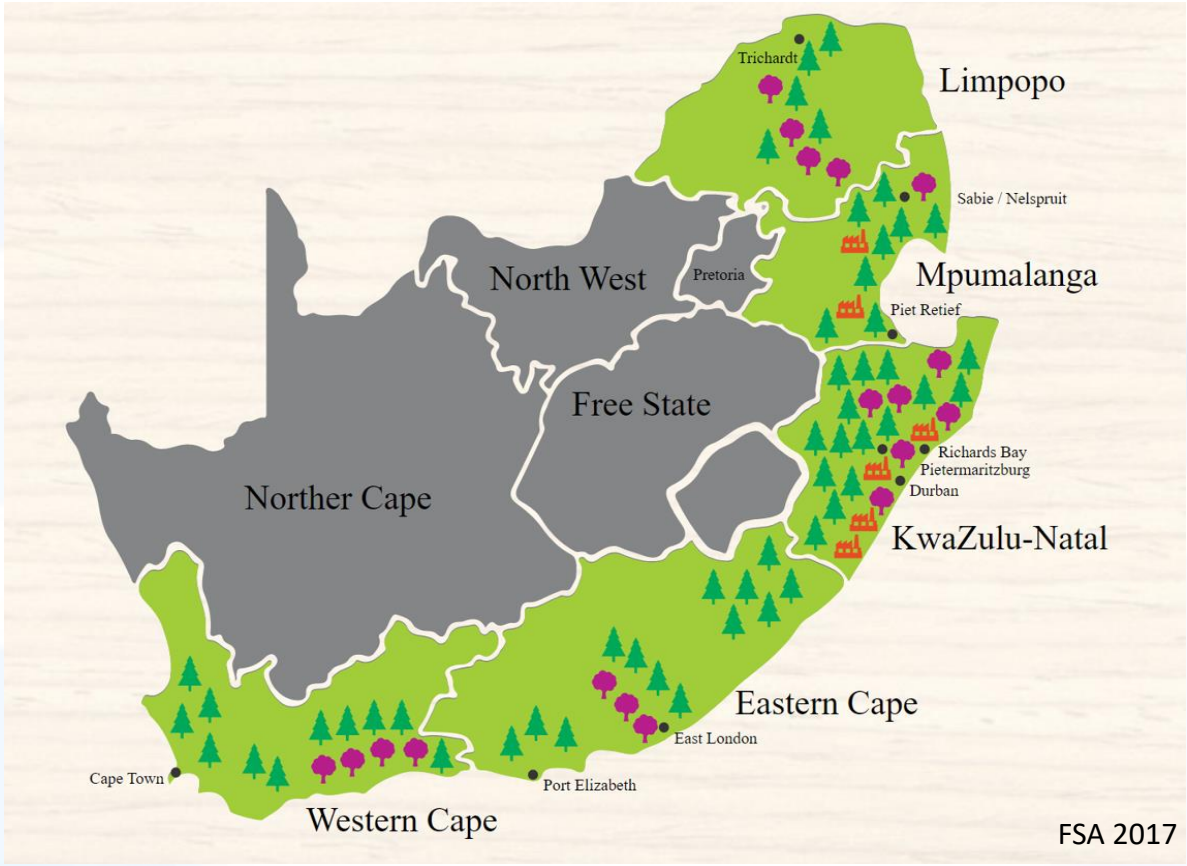


FABI

Forest Molecular Genetics Programme

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

SA Forestry



Plantation forestry ~1,3 million ha (1.1% of SA land area)

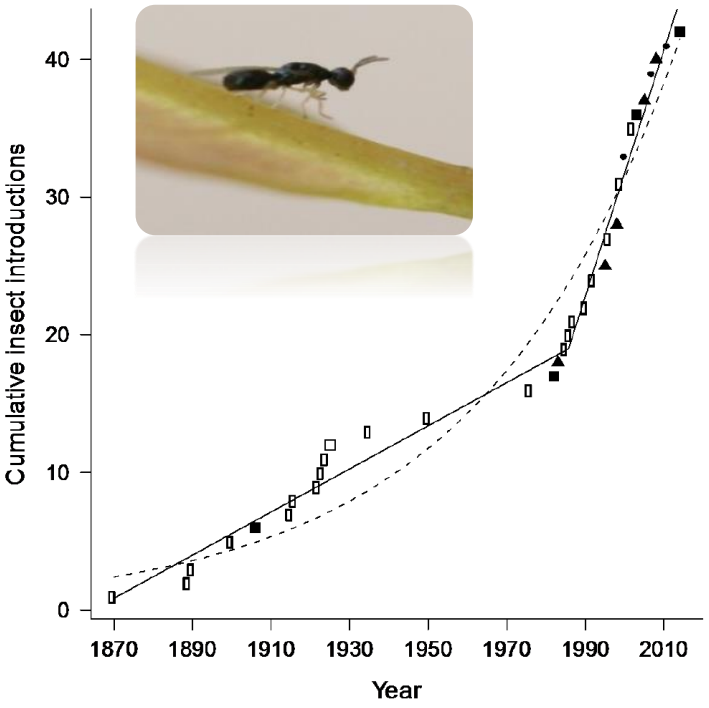
17,5 million m^3 wood harvested annually

Eucalyptus and Pine species

Pulp & Paper, saw timber, plywood, panel board & woodchips

Production value > R9.5 bn

Threats to forestry



Hurley et al. 2016 Biological Invasions

11.5% of annual losses ~R392 million losses in hardwoods

Advances in GM Forestry

- Increased yield of 20% compared to the non-GMO variety
- Economic, environmental and social benefits
  - Economic = Increased competitiveness for Brazilian Forestry sector
  - Environmental = Use less land to produce more fibre
- Approved for commercial use in Brazil
- New era for sustainable forest management

FuturaGene
Yielding the Future™

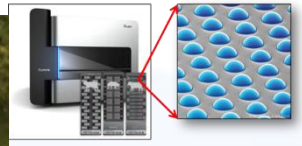
Advances in GM Forestry

ARBORGEN®

- Developed freeze tolerant tropical Eucalyptus (AGEH427)
- Currently going through review process for deregulation in the US.
- Thought to have the fast-growing and highly desirable fiber quality characteristics + ability to withstand freezing temperatures.
- Other products: improved growth and wood quality, increased density and drought tolerance, bioenergy

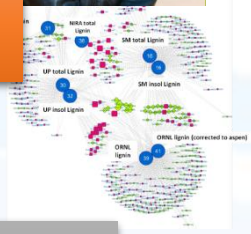
South Africa lags behind in the development of GM technology, which may become an important avenue to protect yields in future

The Forest Molecular Genetics Programme



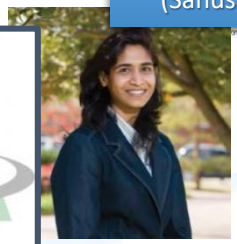
Population Genomics and Molecular Breeding
(Zander Myburg)

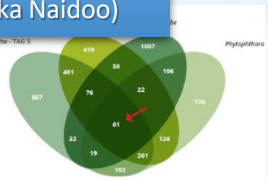
Systems Biology and Modelling
(Eshchar Mizrachi)



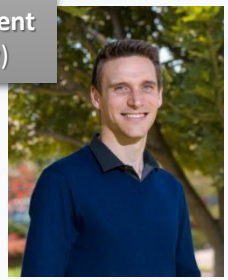
Forest Molecular Genetics Programme

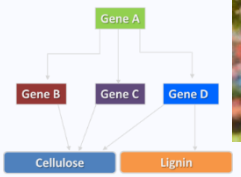
Pest and Pathogen Defenses
(Sanushka Naidoo)



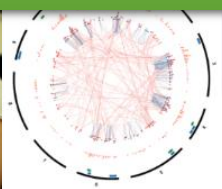


Transcriptional Regulation and Epigenetics of Wood Development
(Steven Hussey)





Bioinformatics and Statistics
(Nanette Christie)



tpcp

Forestry Sector Innovation Fund

Development of a genetically modified tree platform for engineering growth, development and disease resistance

to develop a platform for the application of genetic modification (GM) technology in Eucalyptus trees and set up capacity for propagation and testing of GM trees in South Africa for the forestry sector

Infrastructure Development

Capacity Development

Technology Development

Micropropagation cycle
Regeneration cycle
Transformation cycle

Nursery

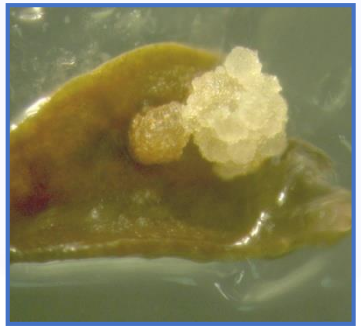
Develop an *in vitro* micropropagation system

Identify regenerable cells from plant parts such as leaves, internodes, nodes, stems

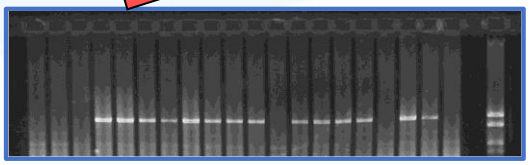
Identify suitable medium for callus formation and shoot regeneration.

Transform with *Agrobacterium*

In vitro rooting



Select for transformed cells on medium containing selective agent such as kanamycin or hygromycin.



Characterization of transformed plants using molecular biology techniques such as PCR

Collaboration with FuturaGene

- As part of the consortium, selected clones have been sent to UP for transformation
- FuturaGene has developed constructs for pest resistance using RNAi technology
- Our clones will be transformed with such constructs
- Returned to UP for maintenance, and evalutation against *Leptocybe invasa*

Collaboration with OSU

Over-expression lines (FT)

- Early flowering

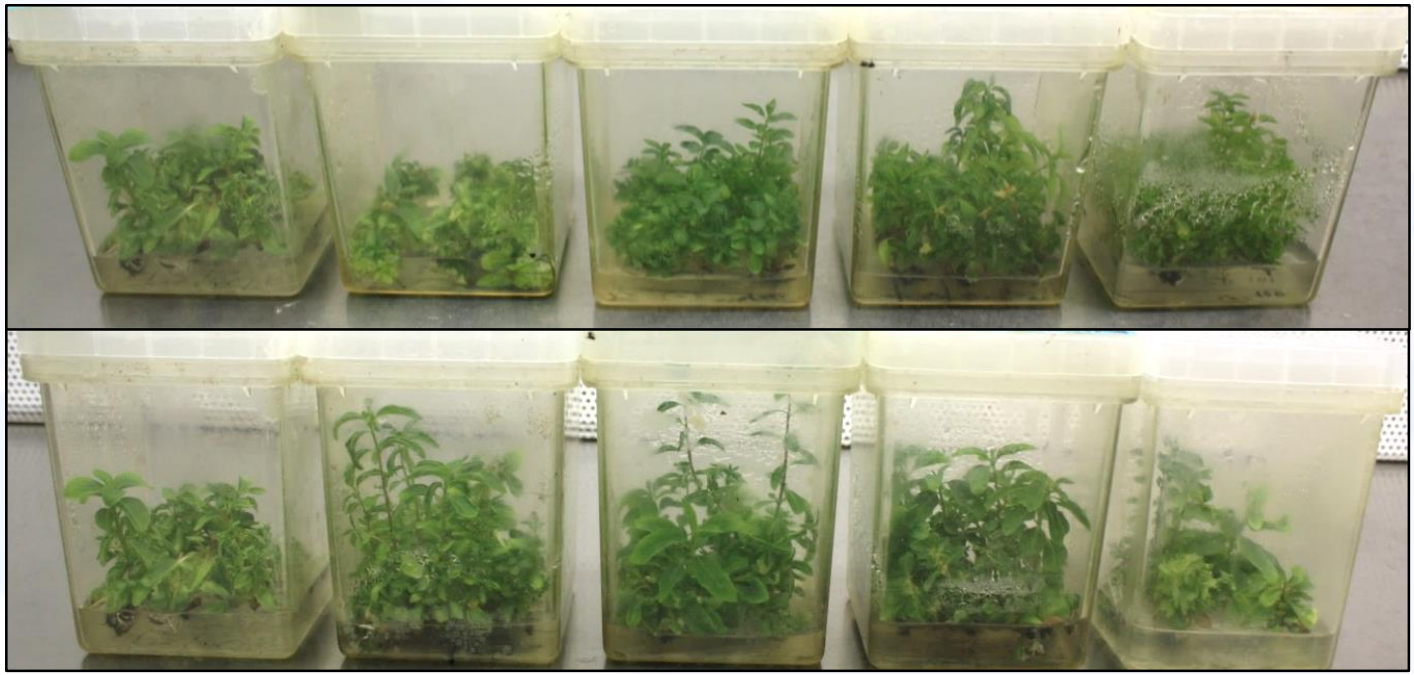
- *CRISPR-Cas9 mutants in Eurograndis clone*
  - Knock-out constructs of flower development genes
  - Complete sterility
  - Male sterile
  - Focus on late floral development (gamete formation genes) to preserve nectar production

CRISPR Eucalyptus lines at FMG

WT // Transgenic events

FT OX +LFY CRISPR

WT + LFY CRISPR



New Phytologist

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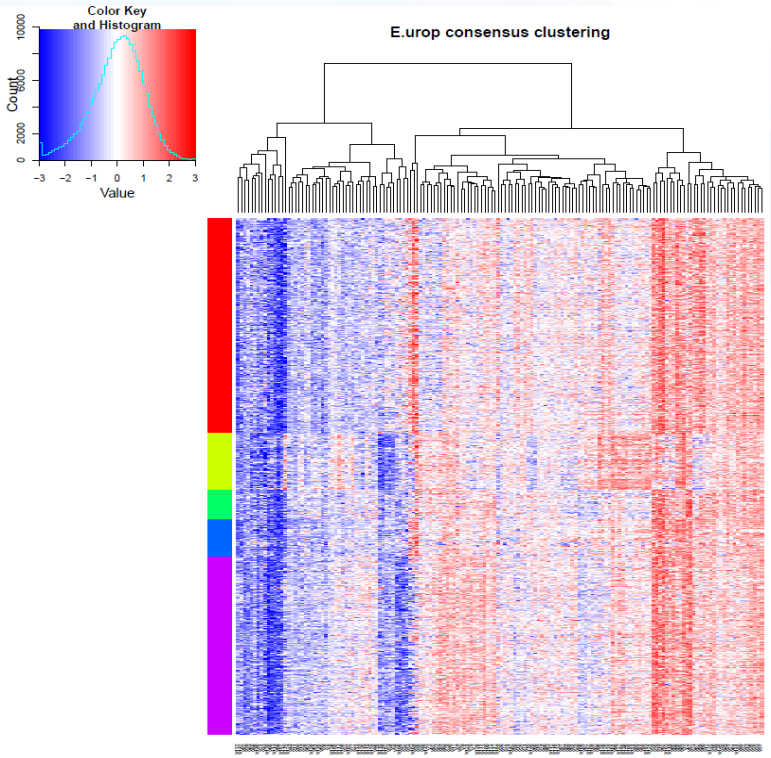
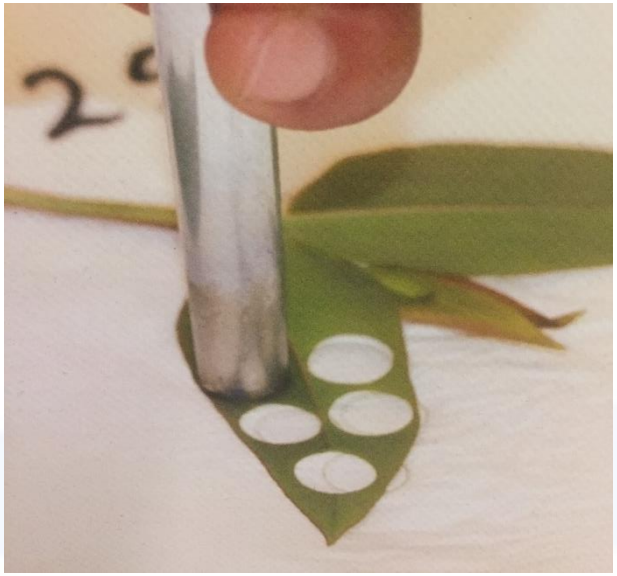
Letters

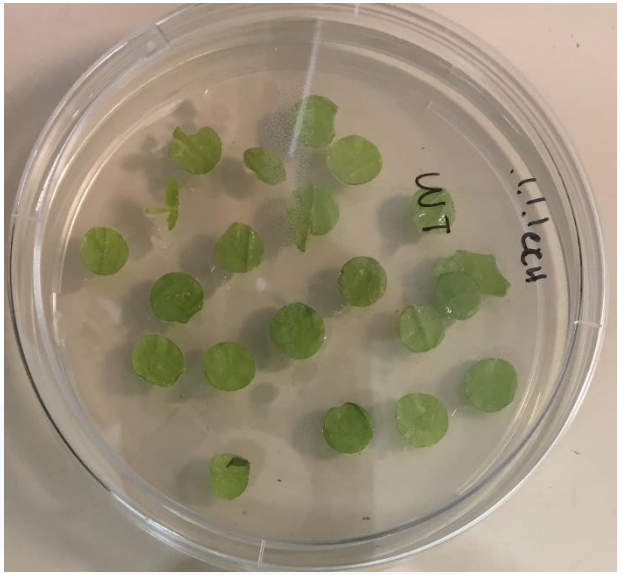
Exploiting SNPs for biallelic CRISPR mutations in the outcrossing woody perennial *Populus* reveals 4-coumarate:CoA ligase specificity and redundancy

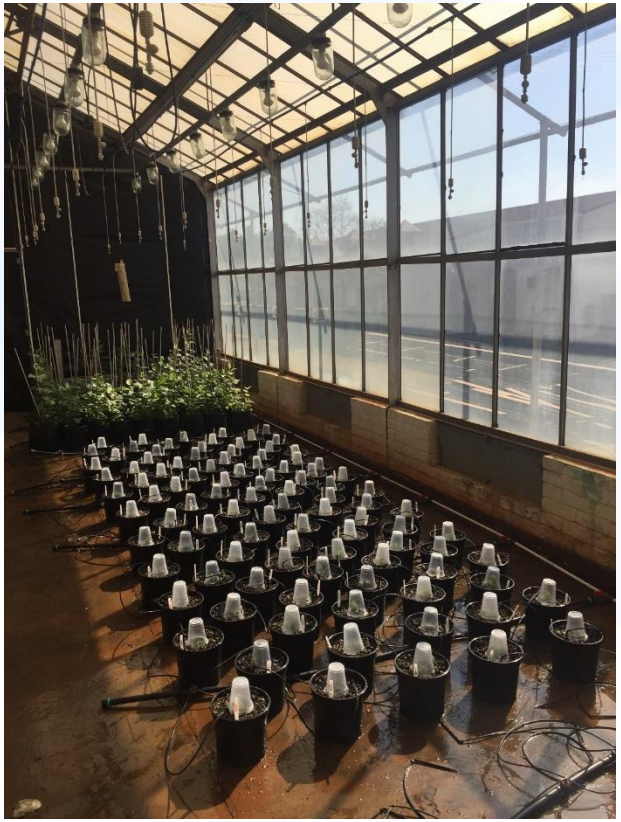
Xiaohong Zhou, Thomas B. Jacobs, Liang-Jiao Xue, Scott A. Harding, Chung-Jui Tsai



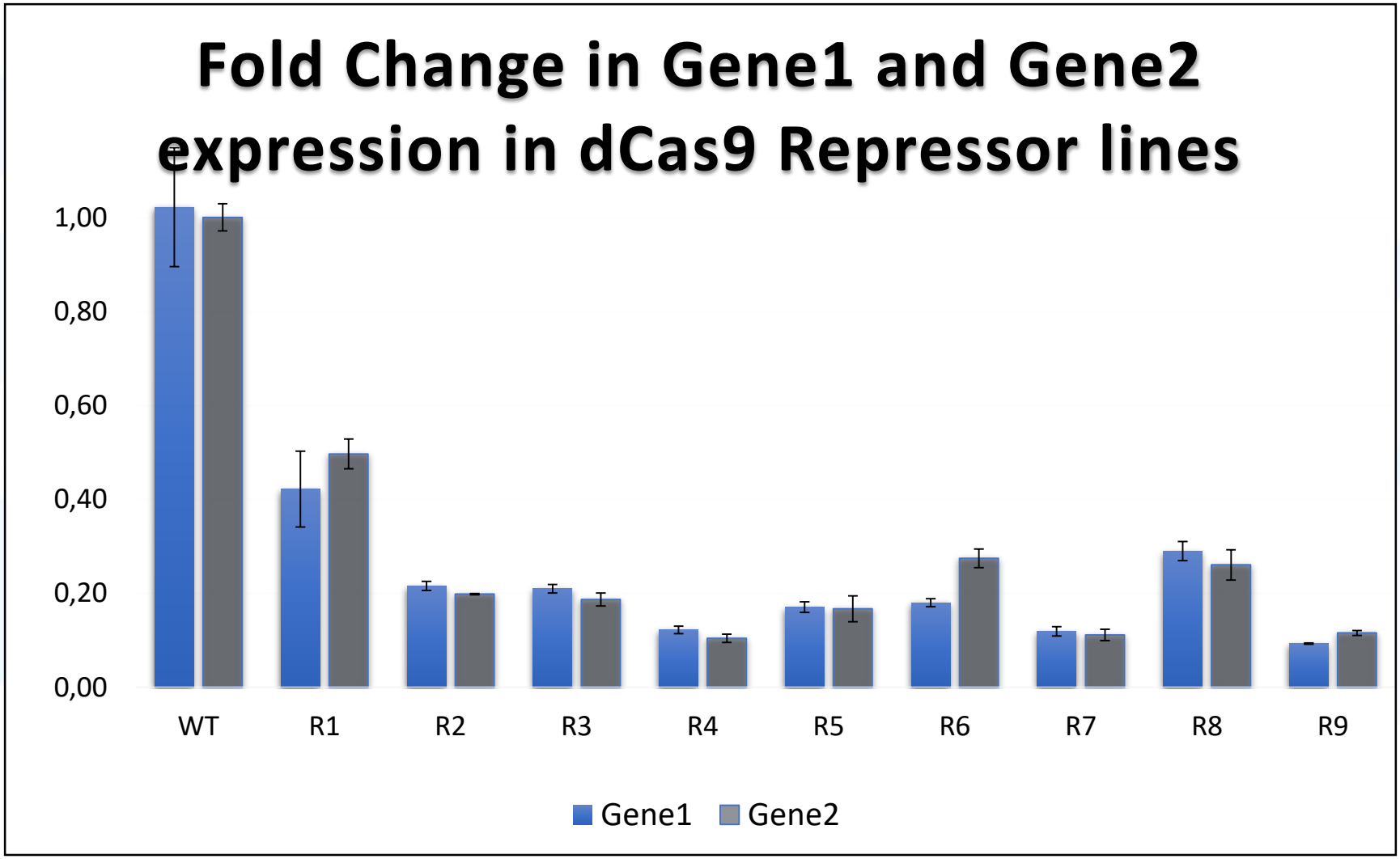
CRISPR Poplar lines




WT

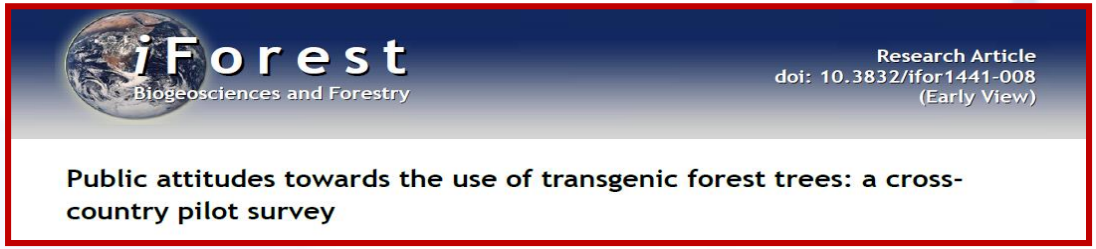


Screening for gene expression in CRISPR-dCas9 constructs



Anticipated Challenges / uncertainties

- Public Perception



- Regulation of new technology in SA
- Field trials (Eucalyptus surrounded by Pine)
- Forestry Stewardship Council (FSC)

"Research into and planting of GE trees is allowed provided the wood does not end up in a product carrying the FSC label"