Assessing the likelihood of gene flow from sugarcane (*Saccharum* hybrids) to wild relatives in South Africa

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SUGAR

Introduction

- Sources of sugar are: 80% + 20%

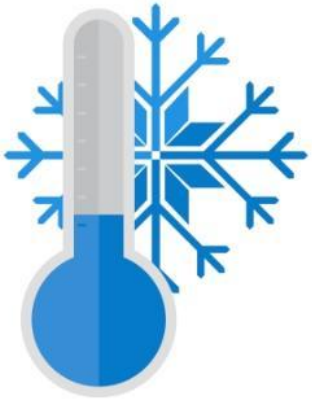
- Sugarcane (Saccharum hybrids) is globally the leading sugar-producing crop (Dillon et al. 2007)
- But, nutrition is just one of many important benefits from sugarcane
- Fuel, energy and fertiliser are produced from sugarcane by-products (Cheavegatti-Gianotto *et al.*, 2011)

Introduction

- Initial sugarcane production in South Africa relied on imported varieties (Zhou 2013)
- South African Sugarcane Research Institute (SASRI) breeding programmes initiated (Zhou 2013)
- Challenges by -cytological incompatibility and

  -environmental constraints:

Cold winter °C



Asynchronous flowering

Substantiation

- Cultivar improvement using genetic modification (GM) technology is being explored (Meyer and Snyman, 2013)
- Commercial cultivation of GM sugarcane has only been approved in Brazil and Indonesia (Xue et al., 2014)
- One aspect of GM crop cultivation that requires assessment prior to commercial release is establishing the likelihood of lateral gene flow between related plant species (Légère, 2005)

Substantiation

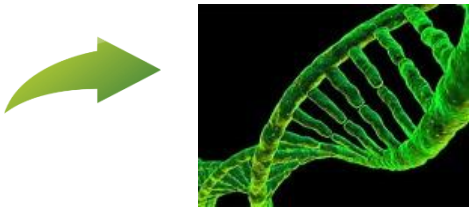
- Successful gene transfer requires plant populations to: (a) overlap spatially; (b) overlap temporally (flowering periods); and (c) be sufficiently close genetically (Légère, 2005)

- Hybridization with transgenic plants could increase the potential invasiveness and weediness of a species (e.g. by conferring traits such as herbicide tolerance) (Andow & Zwahlen 2006)

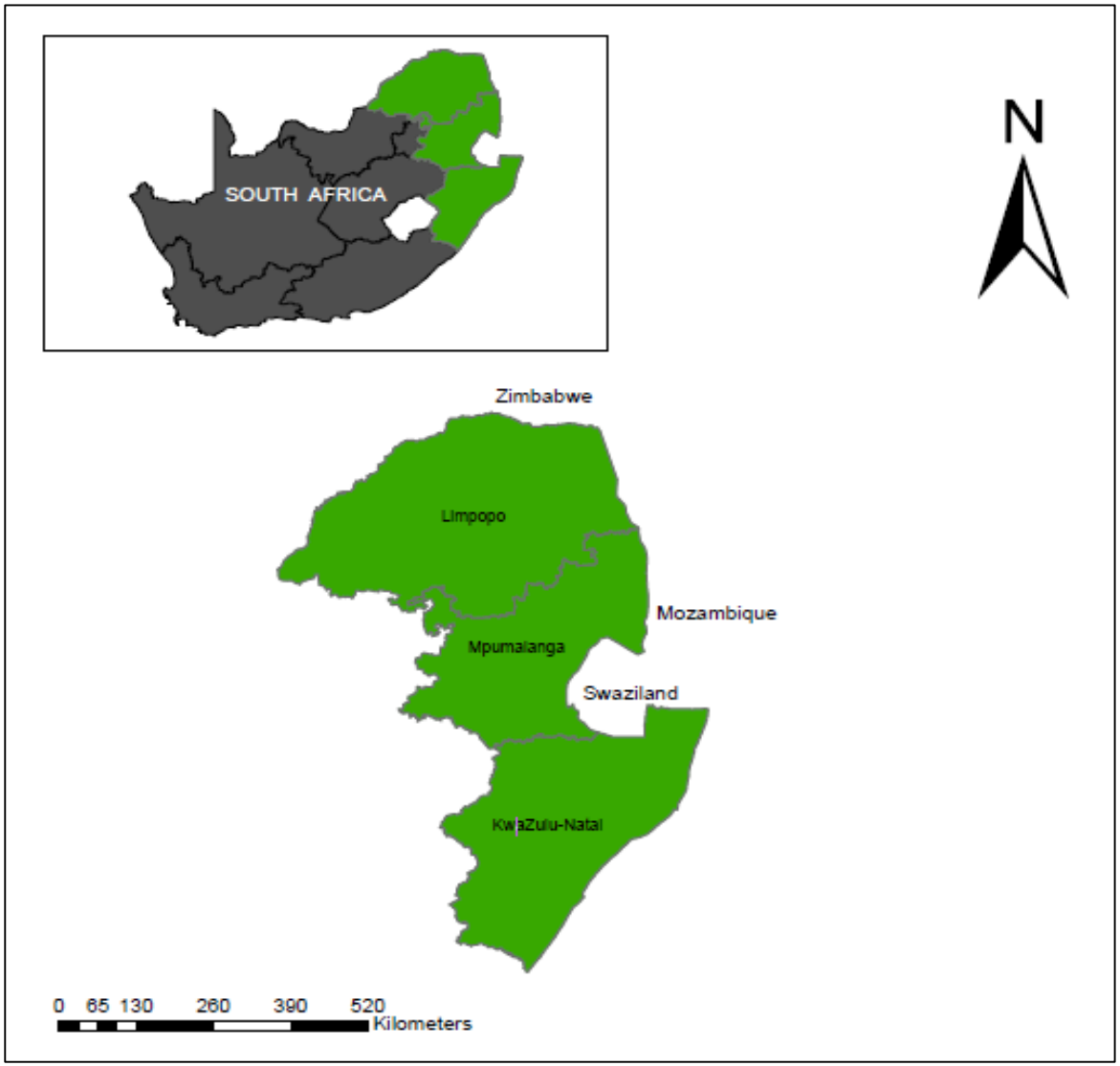
- Gene flow from transgenic crops to wild relatives may be considered a form of biological invasion (Petit, 2004)

AIM

- Assess the gene flow potential from sugarcane (*Saccharum* hybrids) to wild relatives in the sugarcane production regions of Mpumalanga and KwaZulu-Natal, South Africa



Study area



Source: H Khanyi

Methodology

- Related species: Eleven species of the Sorghinae and Saccharinae subtribes of the Andropogoneae were selected for spatial analyses

- Genetic relatedness: Phylogenetic analysis of the ITS genomic cassette (18s rRNA partial, ITS1 complete, 5.8s rRNA complete, ITS2 complete and 28s rRNA partial)

- Spatial assessment:
  - Prevalence
  - Spatial overlap
  - Distribution potential
  - Proximity
  - Gene flow potential
  - Flowering times

Methodology

- All target species were assessed and ranked per factor, whereby species with highest rank was scored 11 and species with lowest rank was scored 1

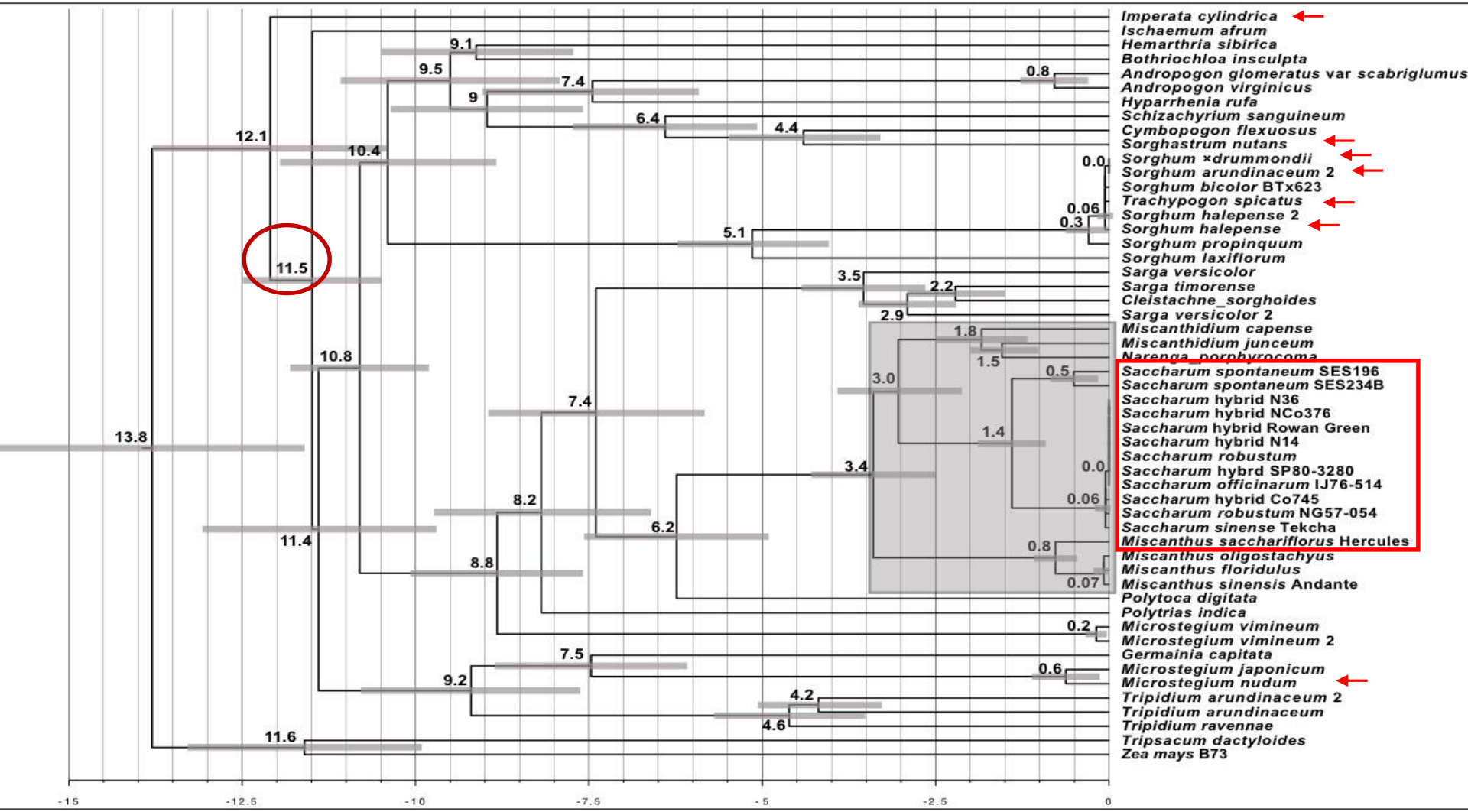
❖ Relatedness + spatial assessment = Gene flow likelihood

- Pollen viability: triphenyl tetrazolium chloride (TTC) staining method

Results and discussion

Biological relatedness

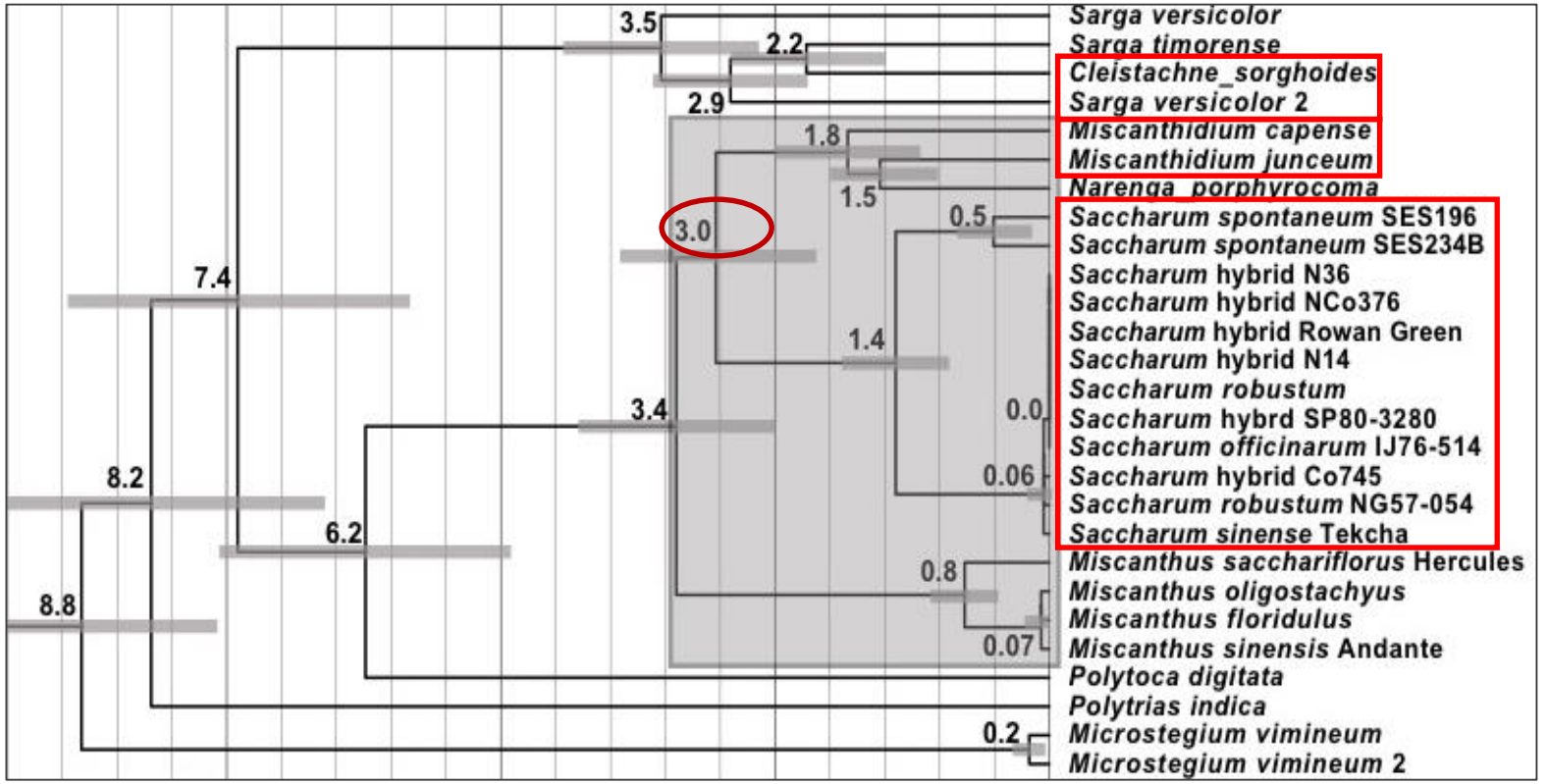
Phylogenetic tree



scale = millions of years before the present

Source: D Lloyd Evans

Chronogram



scale = millions of years before the present

Source: D Lloyd Evans

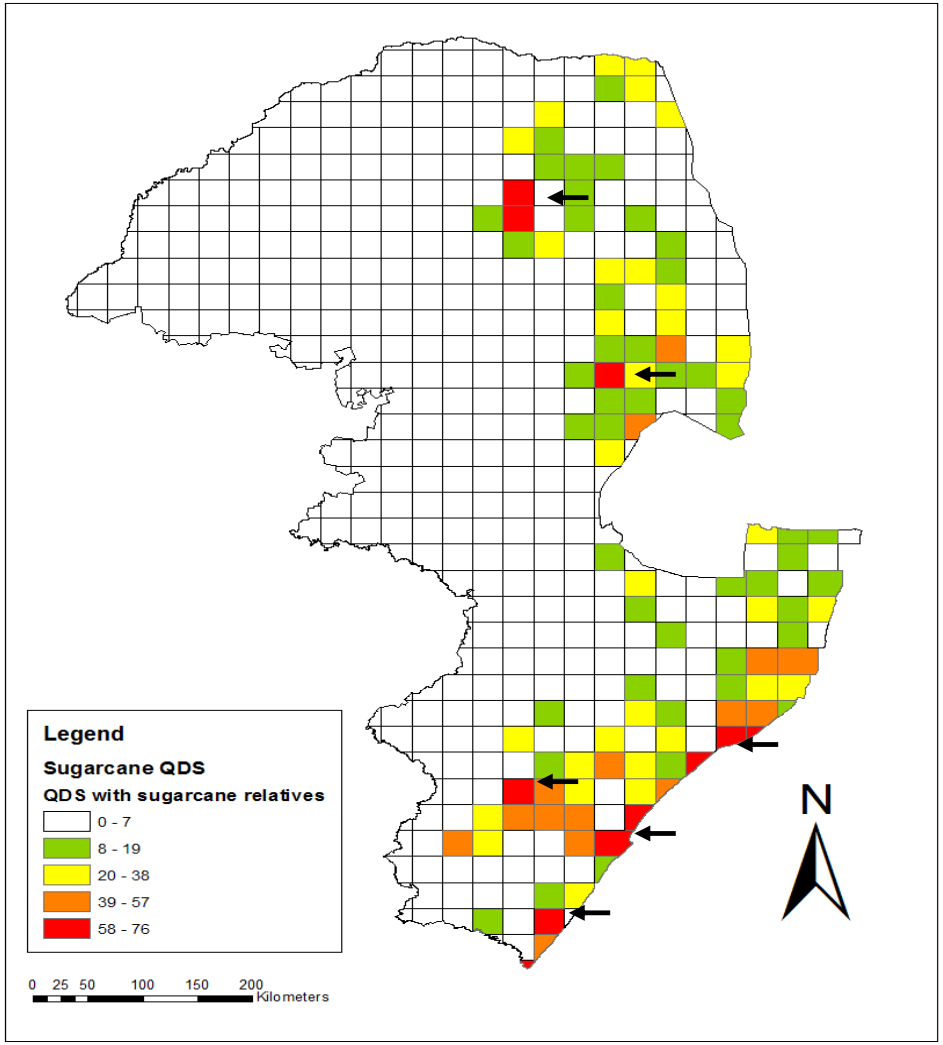
Spatial assessment

Wild relative	Prevalence	Spatial overlap	Proximity	Flowering times	Gene flow	Distribution potential	Spatial asses. Avg	Relatedness
Imperata cylindrica	11	11	10	11	9	11	**10.5**	1
Sorghum arundinaceum	10	10	11	11	9	9	**10**	6
Miscanthidium capense	9	9	7	9	11	7	**8.5**	11
Miscanthidium junceum	7	5	6	7	11	10	**7.5**	11
Sorghum halepense	4	8	9	7	9	6	**7**	6
Sorghum ×drummondii	2	3	9	9	9	3	**6**	6
Sarga versicolor	8	8	0	3	0	8	**4.5**	9
Sorghastrum stipoides	7	6	0	7	0	4	**4**	3
Microstegium nudum	5	4	0	7	0	5	**3.5**	7
Cleistachne sorghoides	3	2	0	2	0	1	**1.5**	9

Colour codes Low Medium High

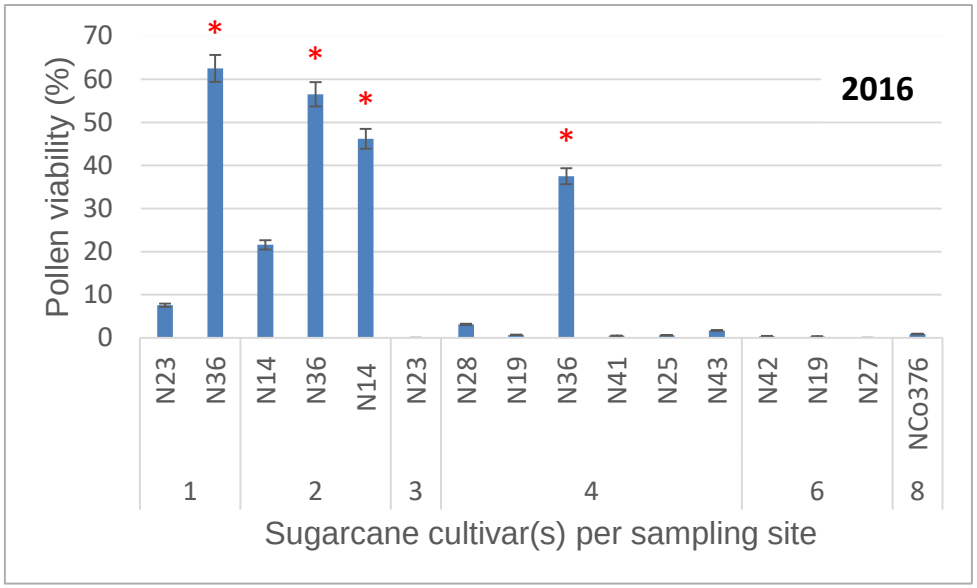
Source: D Komape

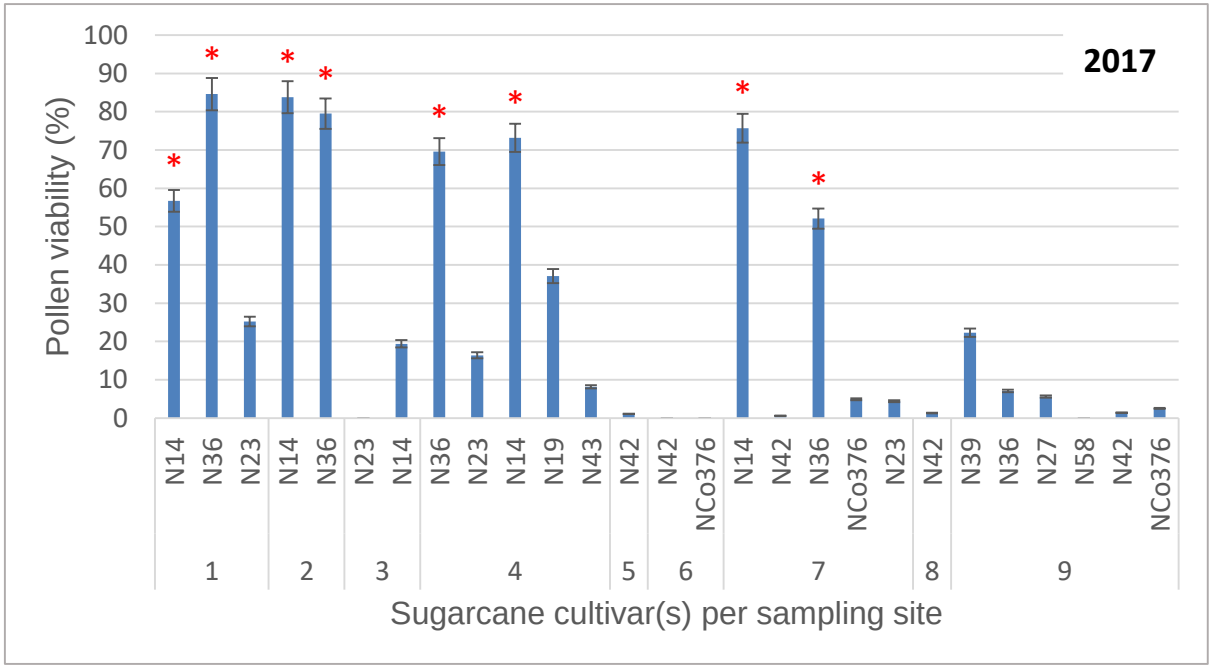
Highest likelihood for gene flow



Source: D Komape

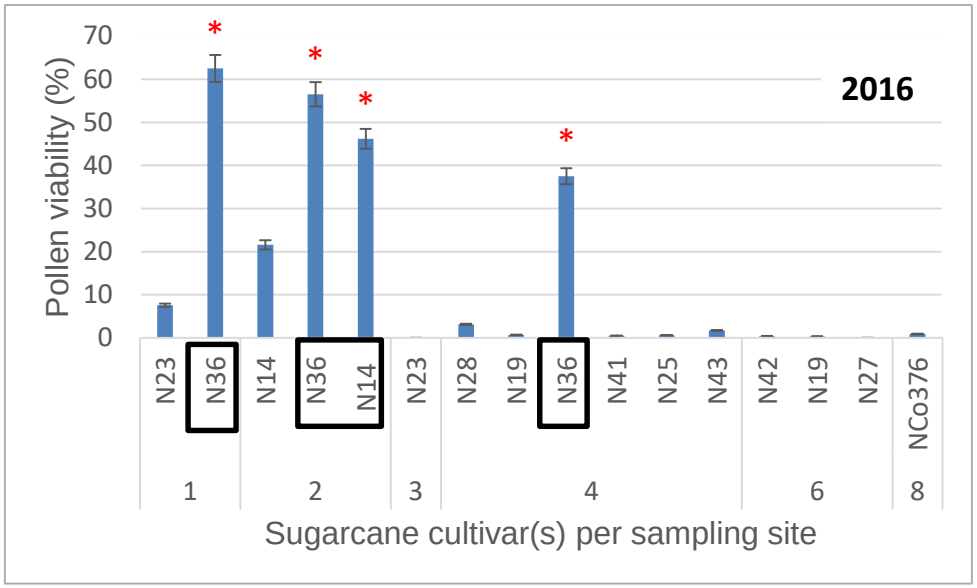
Pollen viability

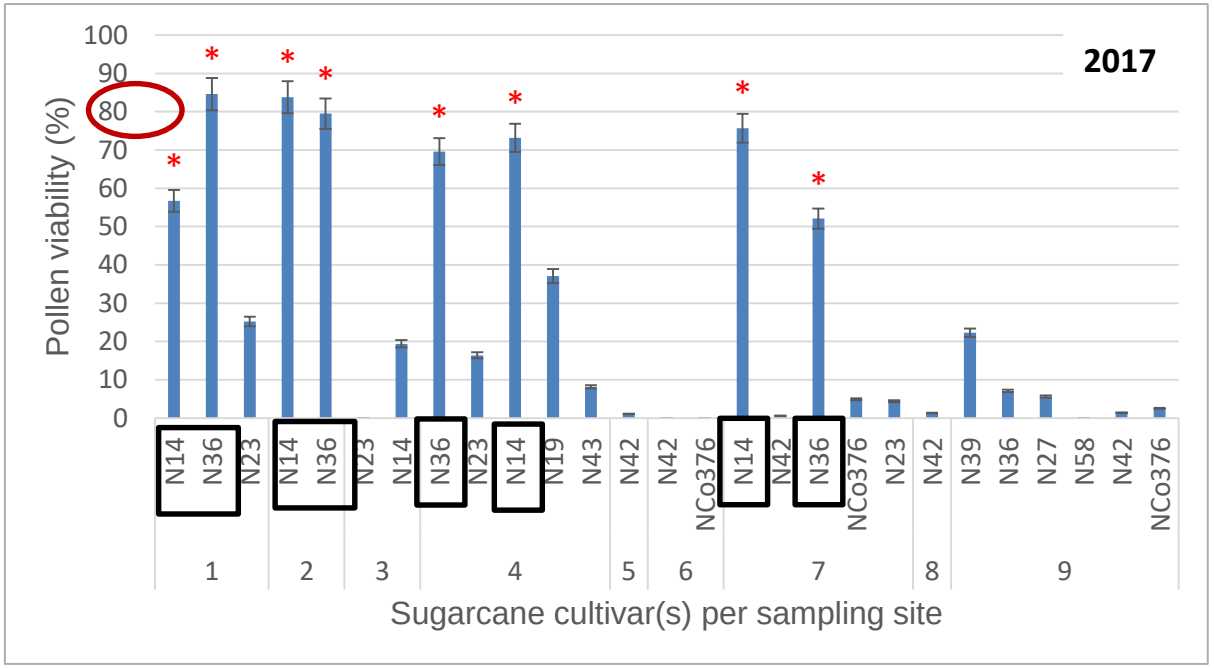




Source: H Khanyi

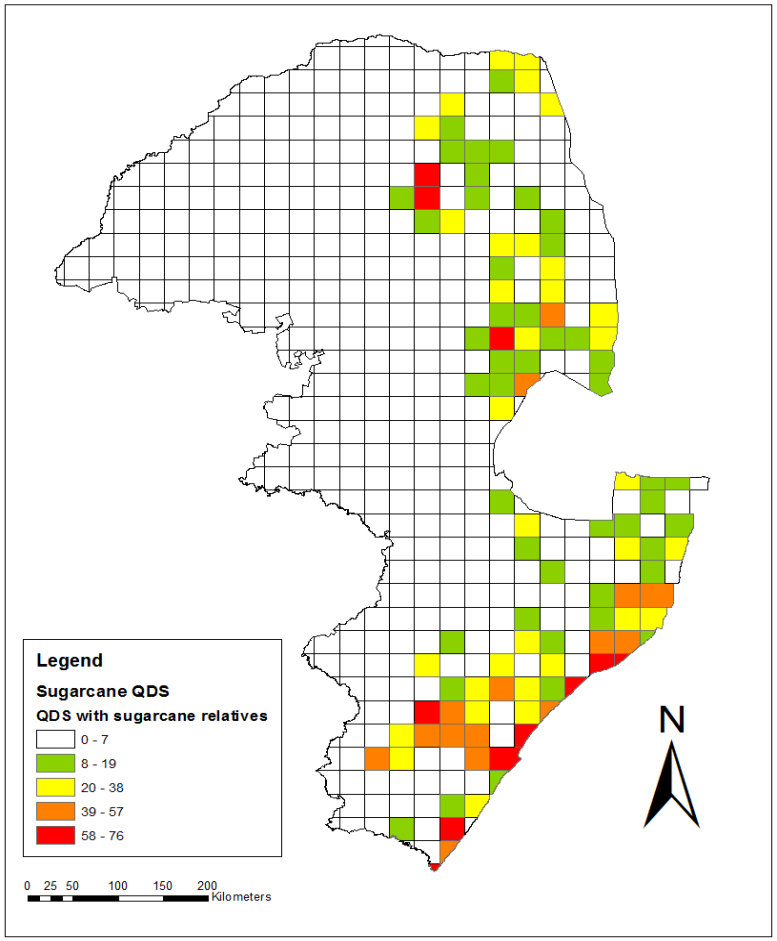
Pollen viability





Source: H Khanvi

Likelihood for gene flow



Pollen viability decreases

Source: D Komape

Conclusions

- *Miscanthidium capense* - weed in cultivated sugarcane plantations, most vulnerable to transgene exchange based on genetic relatedness and spatial assessment
- Some commercial sugarcane cultivars do produce fertile pollen – especially in northern irrigated areas, providing low likelihood of gene flow
- Future studies - risk of gene flow between GM sugarcane and the species highlighted in this study

Thank you!