



Sugar Research
Australia

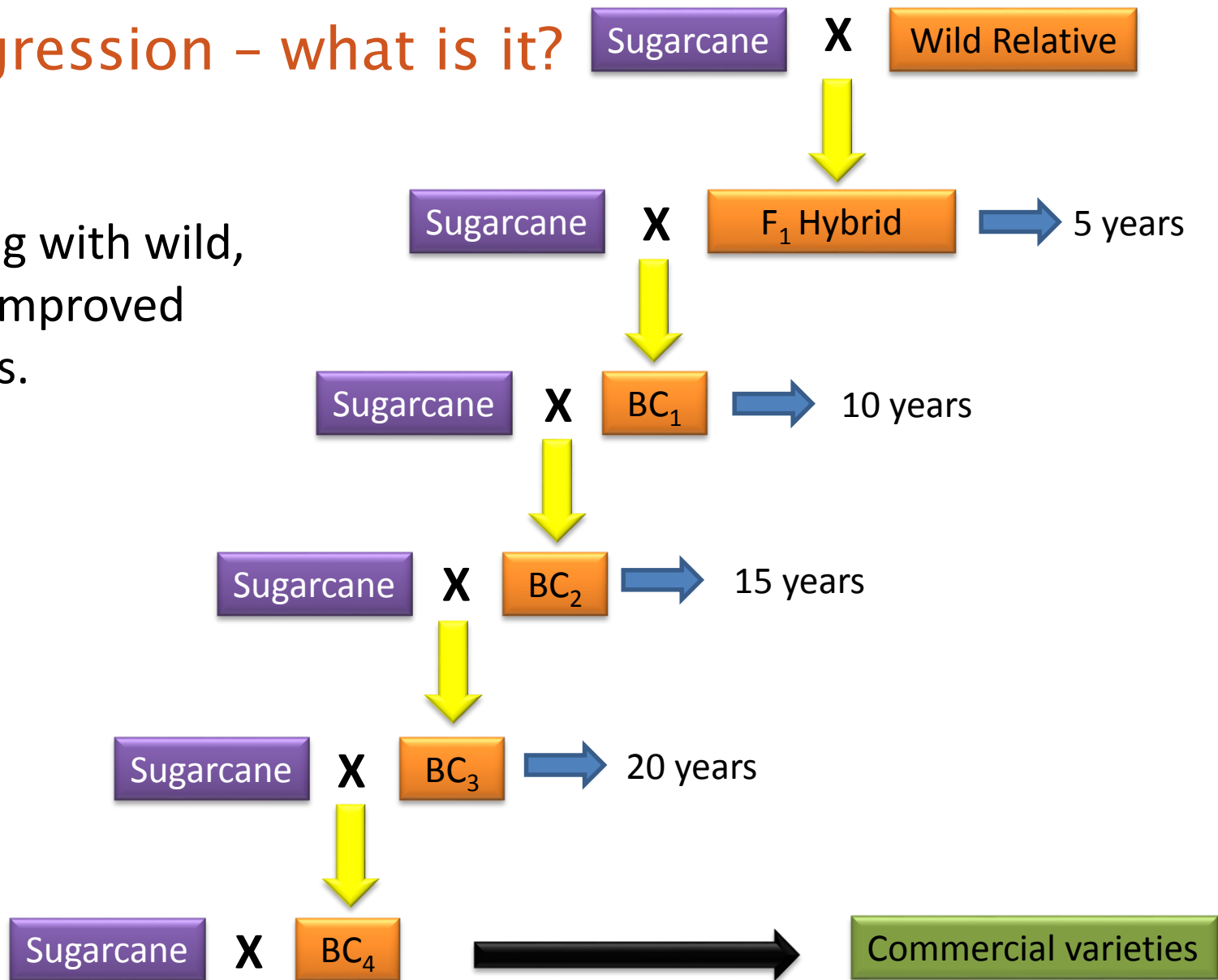
Introgression Research

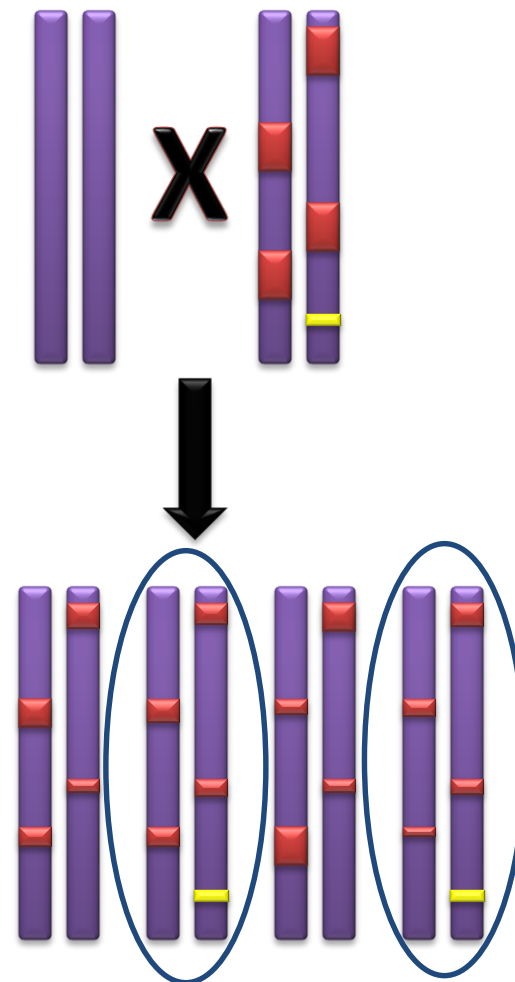
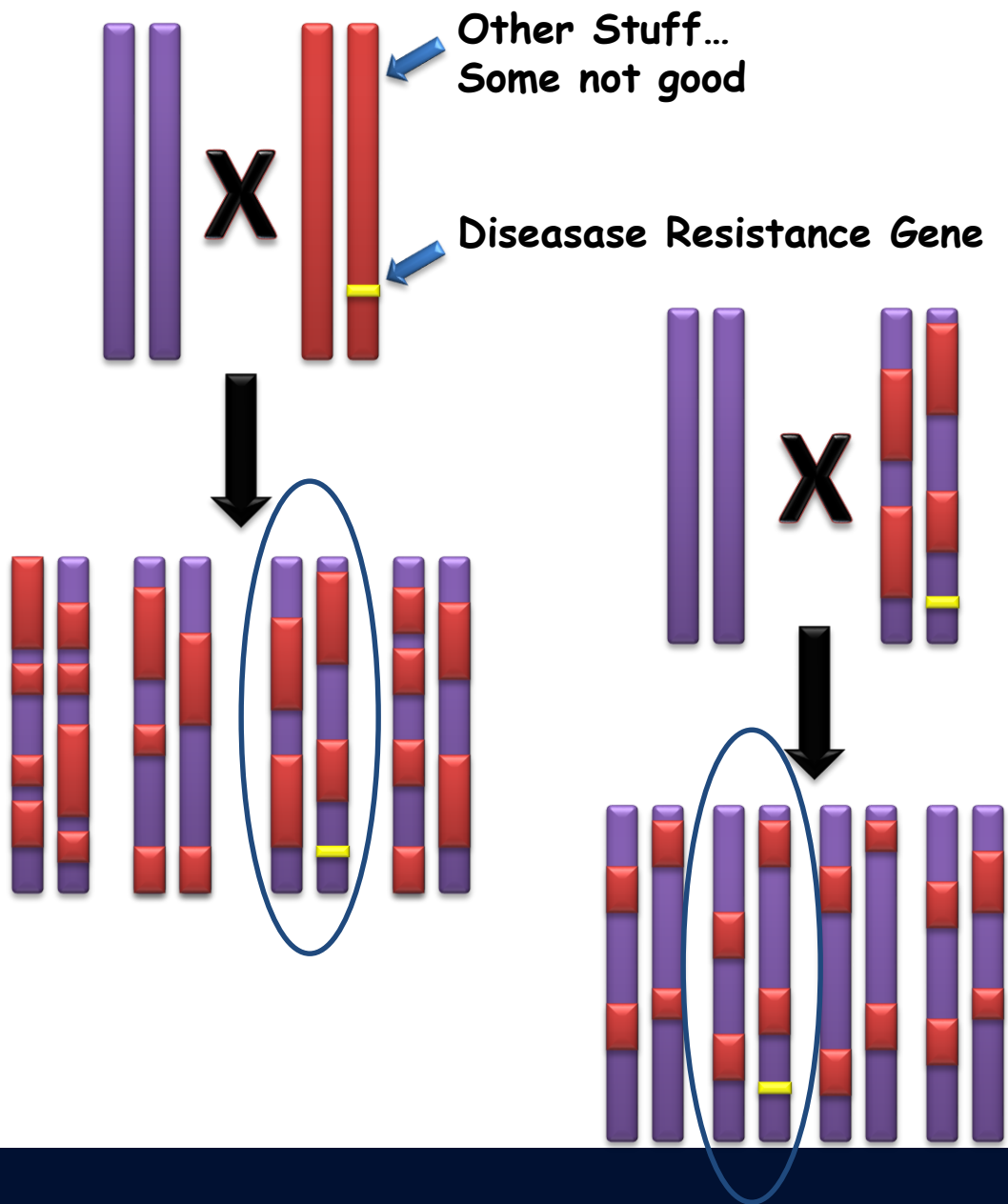
George Piperidis

10 March 2015

Introgression – what is it?

Breeding with wild,
and unimproved
relatives.





Scientific classification/Taxonomy

- Genus *Saccharum*
 - *S. officinarum*
 - *S. spontaneum*
 - *S. robustum*
 - *S. edule*
- Related genera
 - *Miscanthus*
 - *Narenga*
 - *Sclerostachya*
 - *Erianthus*
- Sugarcane cultivars are interspecific hybrids
 - *S. officinarum* ~80%
 - *S. spontaneum* ~20%
 - *S. robustum*

S. officinarum

- Chewing or noble canes
- Thick stalks
- Broad leaves
- High sugar, low fibre
- High maintenance
- Poor ratooning
- Disease susceptibility
- Poor adaptability



S. spontaneum

- Mostly thin stalks and leaves
- Low sugar, high fibre
- Good ratooning
- Disease resistance
- Highly variable and adaptable
- It's a weed!!



Where do sugarcane varieties come from?

Before 1900



Famous sugarcane collectors



Columbus
sugarcane
to Americas



Henry Tryon
expedition to PNG
1895 collected Badila

1920 Java Indonesia - Eureka moment changed sugarcane world



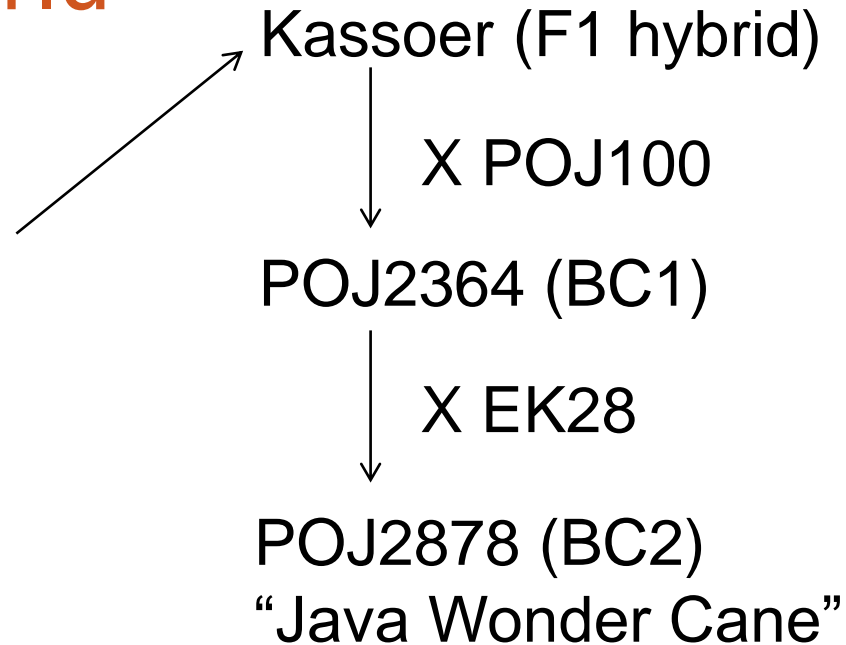
S. officinarum

X

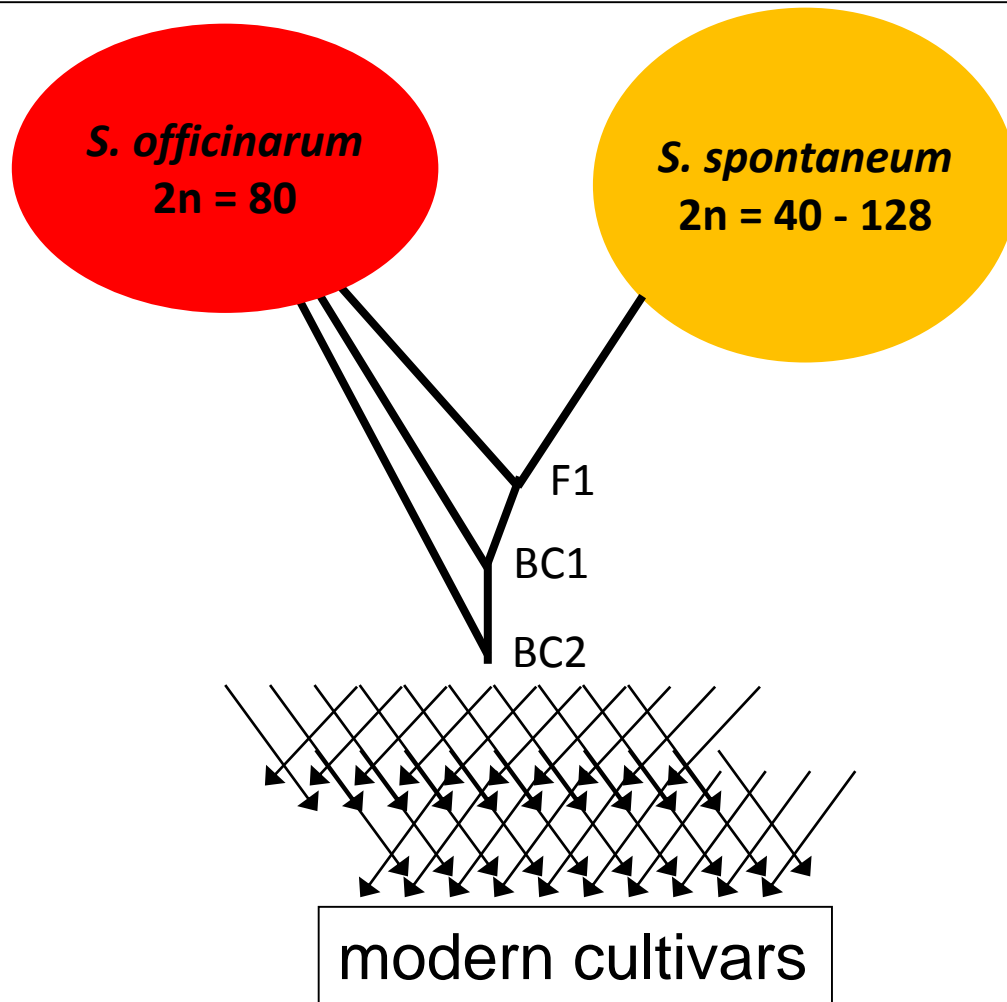


S. spontaneum

POJ2878 appears in the ancestry
of most breeding programs!



After 1920



- Very few clones used
- Narrow genetic base

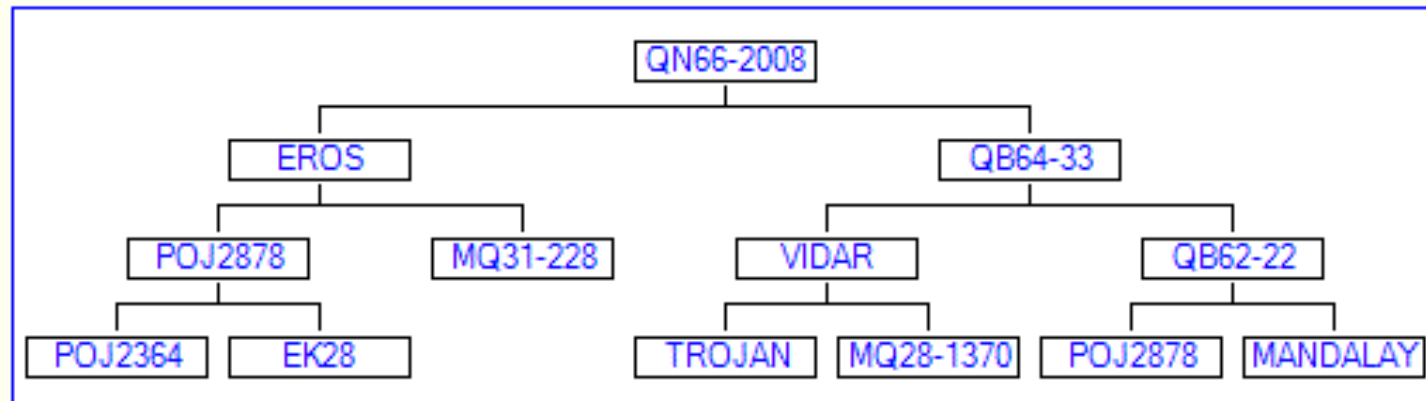
History of Introgression

- Early 1900s
 - resulted in improved productivity, adaptation, vigour, ratoonability, and increased resistance to some major diseases.
- In the 1960s
 - Realisation of the narrow genetic base
 - New introgression initiatives commenced

Australian example

Mandalay resulted in 25 varieties and a new source of resistance to pachymetra root rot.

Clone Pedigree



MPar of Q202[♂], Q221[♂], Q227[♂], Q217[♂], Q234[♂], Q138, Q154, Q157, Q158, Q162, Q164, Q166[♂], Q167[♂], Q170[♂], Q174[♂], Q179[♂], Q181[♂], Q186[♂], Q187[♂], Q192[♂], Q196[♂], Q197[♂], Q198[♂], Q200[♂], Q209[♂]

USA example

LCP85-384 – BC4 released in 1993

- Dominated the Louisiana industry late 1990's
- *S. spontaneum* US56-15-8
- 30 years after cross was made

Top 4 varieties in Louisiana 2013:

Variety	% State Total (160,000ha)	Generation
HoCP 96-540	39	BC5
L 99-226	17	BC5
L 01-299	15	BC5
L 01-283	10	BC5

E. arundinaceus

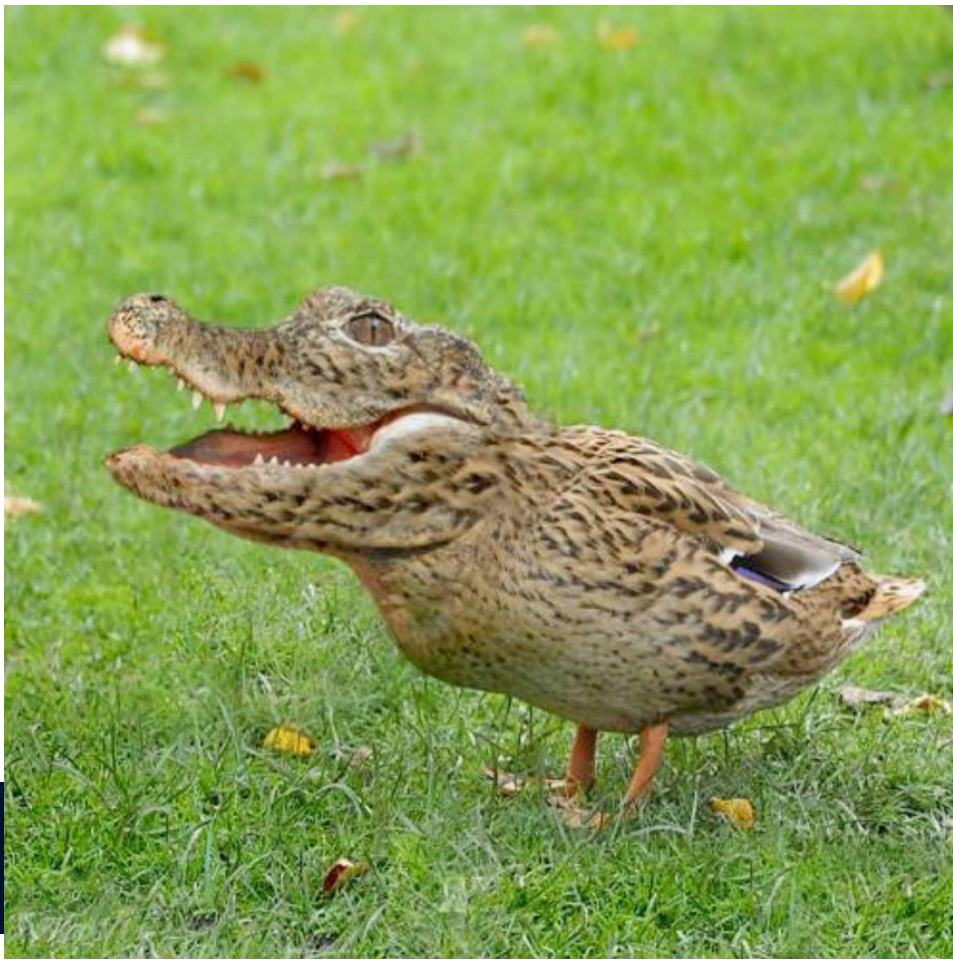
- Vigorous growth, relatively thick stalks, massive root system
- Almost immune to *Pachymetra*
- Highly resistant to nematodes
- Grows in harsh conditions
 - drought, waterlogging
- Almost no sugar
- High fibre
- Very difficult to cross with sugarcane
 - Genetically dissimilar – **wide hybrids**
- Fertile hybrids are very rare!!
- No commercial varieties with *Erianthus*



Taxonomy

Common Name	Human	Chimpanzee
Domain	Eukaryota	Eukaryota
Kingdom	Animalia	Animalia
Phylum	Chordata	Chordata
Class	Mammalia	Mammalia
Order	Primates	Primates
Family	Hominidae	Hominidae
Genus	Homo	Pan
Species	Homo sapiens	Pan troglodytes

Wide hybrids....



History of recent funding

- SRDC: 1996 – 2004
 - BS115, BS139, CTA047
- ACIAR: 2002 – 2007 (China, CSIRO, BSES)
- CRC-SIIB: 2003 – 2009
- SRDC/SRA/QDAFF: 2011 – 2016/2020
 - 2011344; 2013022; 2013058
- SRA/QDAFF: 2014 – 2017
 - 2014053

China-Australia Cooperative Projects

- Australian Centre for International Agriculture Research funded a project in 2002 to make new crosses with wild sugarcane relatives from China
- Joint project CSIRO, BSES, Yunnan & Guangzhou Sugar Research Institutes
- Subsequent funding also from CRC Sugarcane Biotechnology
- Chinese collaborators made a major breakthrough - first confirmed fertile crosses with wild relative *Erianthus*
- Clones and seeds from crosses with *Erianthus* and *S. spontaneum* imported to Australia through quarantine 2003-2006
- New crosses made with imported clones in Australia with Australian parents

History:

- Large number of *S. spontaneum* (BC1, BC2, BC3) and *Erianthus* crosses (BC1, BC2, BC3, BC4)
- Many introgression clones screened for:
 - Biomass, cane yield, fibre, sugar content
 - Diseases and nematode resistance (>500)

Future:

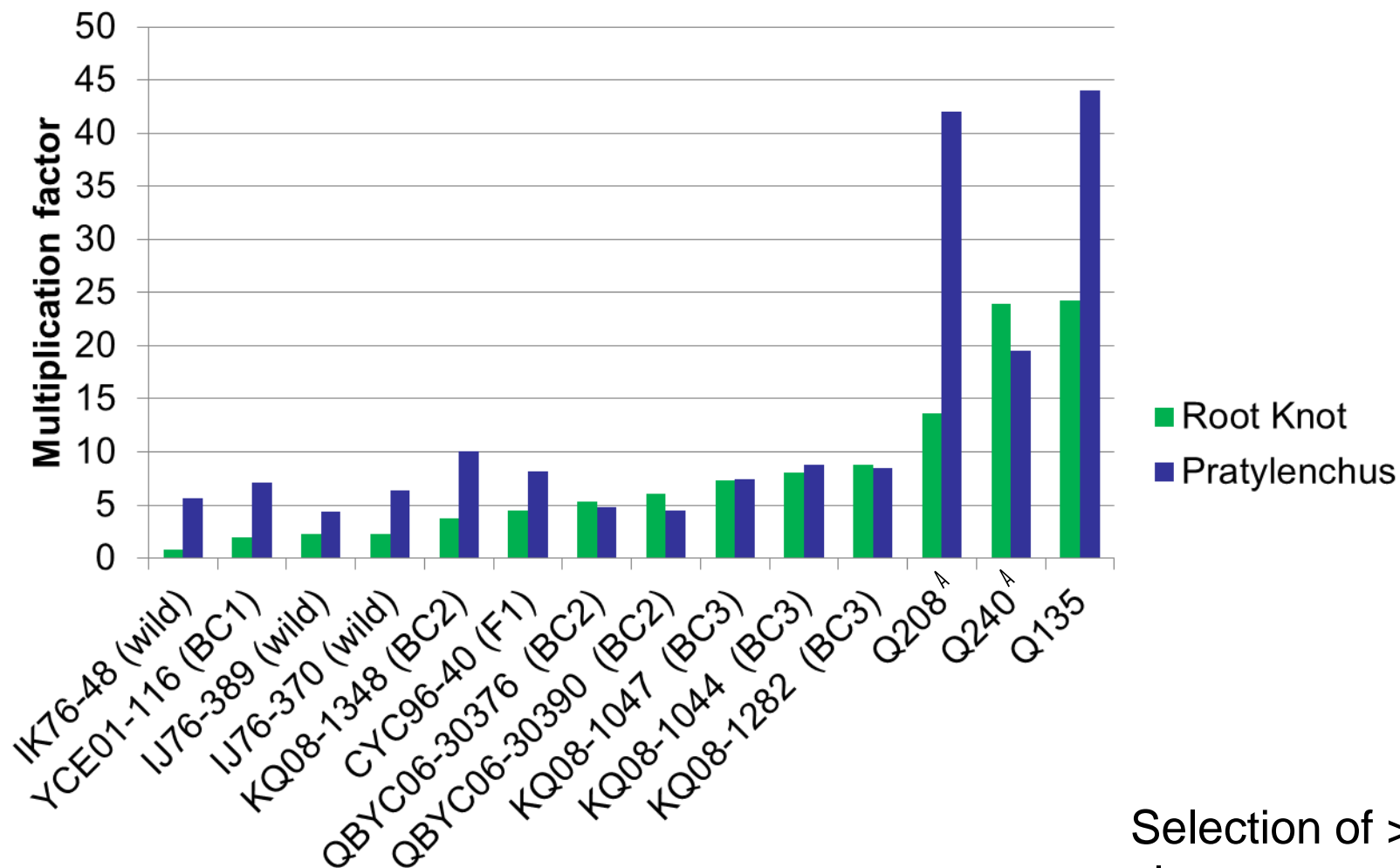
- Frost tolerance, yield and ratooning under harsh conditions

Nematode resistance

- Two important nematodes
 - root knot nematode (*Meloidogyne*)
 - root lesion nematode (*Pratylenchus*)
- Commercial varieties are susceptible to nematodes
- Only controls are crop rotation and nematicides
- Important factor in root health
- Glasshouse screening trials started at Bundaberg 2011 and Woodford 2012

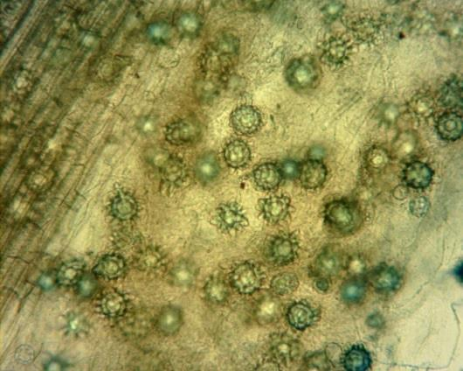


Nematode resistance - *Erianthus*

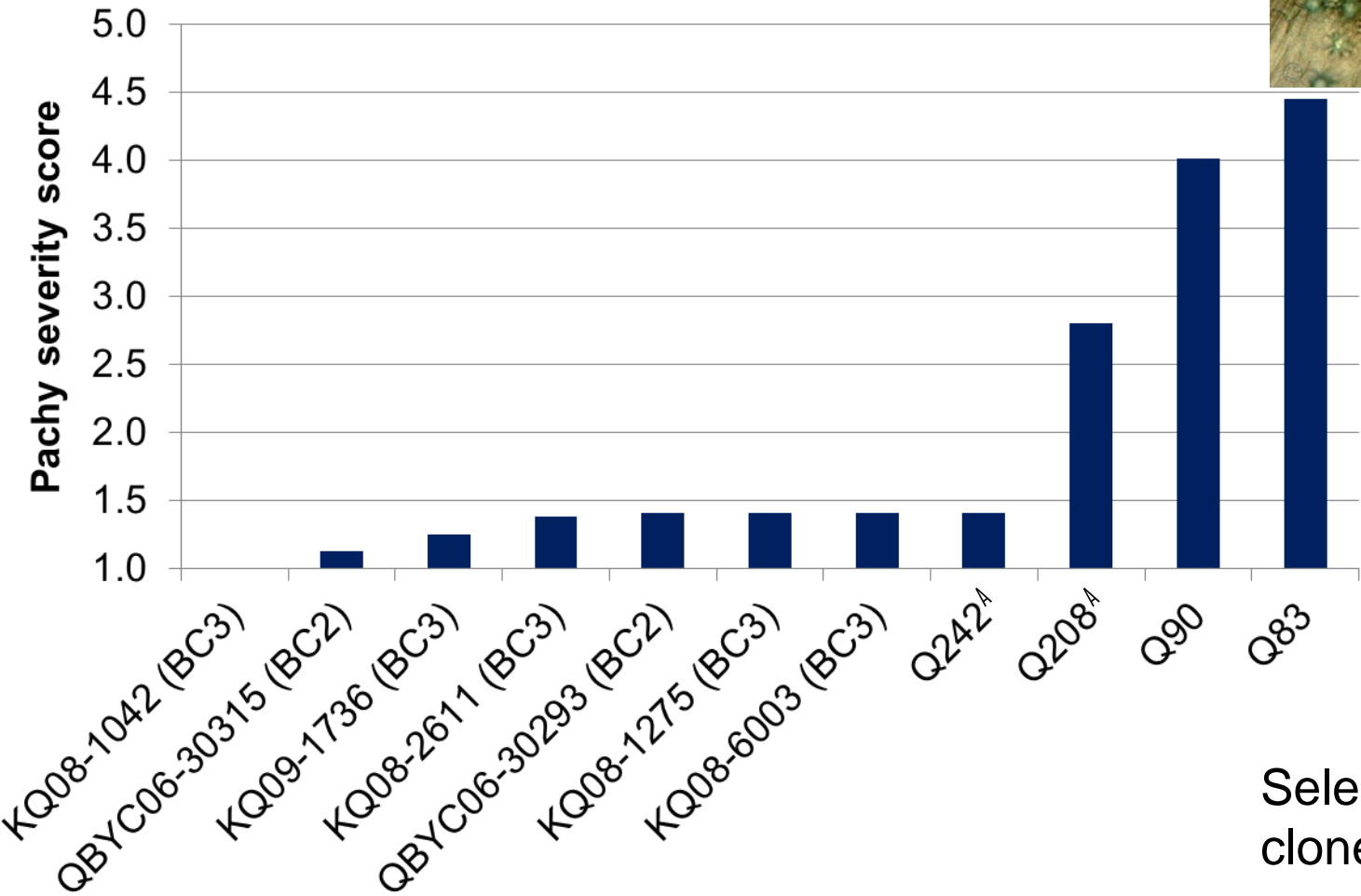


Selection of >250
clones screened

Pachymetra root rot



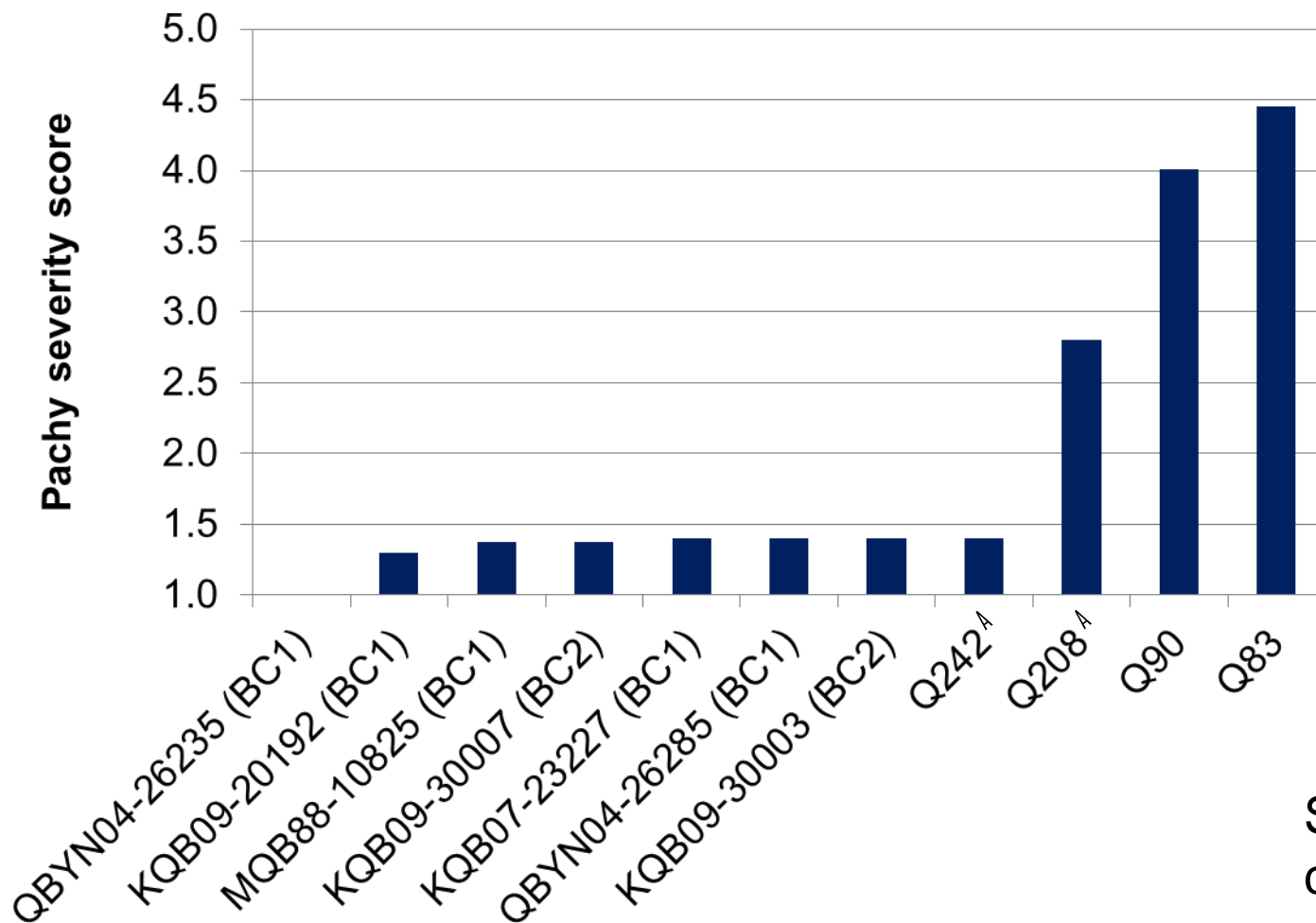
Erianthus



Selection of >600 clones screened

Pachymetra root rot

S. spontaneum



Selection of >600 clones screened

	Number of trials – 2014 FATs				
Clone	Burdekin	Central	Southern	NSW	Clone type
KQ08-1031	3	4	4	2	Ea BC3
KQ08-1040		3			Ea BC3
KQ08-1046		3			Ea BC3
KQ08-1053		4			Ea BC3
KQ08-1073		3			Ea BC3
KQ08-1140	3				Ea BC3
KQ08-1144		3			Ea BC3
KQ08-1158	3				Ea BC3
KQ08-1201		4	4	2	Ea BC3
KQ08-1231	3		4	2	Ea BC3
KQ08-1287	3				Ea BC3
KQ08-1296		4			Ea BC3
KQ08-1306	3	3			Ea BC3
KQ08-1329	3	3			Ea BC3
KQ08-1348		4			Ea BC3
KQ08-1389	3				Ea BC3
KQ08-1391		3	4	2	Ea BC3
KQ08-2408	3				Ea BC3
KQ08-2552	3	3			Ea BC3
KQ08-2664	3	4	4	2	Ea BC3

	Number of trials – 2014FATs				
Clone	Burdekin	Central	Southern	NSW	Clone type
KQ08-2838	3	4	4	2	Ea BC3
KQ09-1736	3				Ea BC3
KQ09-1744	3				Ea BC3
KQB07-23864	3				Ss BC2
KQB07-23976	3				Ss BC2
KQB07-23989	3		4	2	Ss BC2
KQB07-24524	3		4	2	Ss BC1
KQB07-24887	3				Ss BC2
KQB07-33647	3	3	4	2	Ss BC2
KQB07-34350	3	4			Ss BC2
KQB07-34476	3				Ss BC2
KQB09-20048	3		4	2	Ss BC1
KQB09-20290			4	2	Ss BC1
KQB09-20328			4	2	Ss BC1
KQB09-20432	3		4	2	Ss BC1
KQB09-20481	3				Ss BC1
KQB09-20485			4	2	Ss BC1
KQB09-20624			4	2	Ss BC1
KQB09-30014	3				Ss BC2
KQB09-30107	3	3			Ss BC2
KQB09-30117	3				Ss BC2

New Introgression Project 2014053 Aims:

- Identify and exploit new sources of genes:
 - better ratooning,
 - resistance to nematodes & pachymetra root rot
- Select clones under harsh environments
 - higher yield
 - high ratooning ability
- Examine (ground-truth)
 - testing nematodes ratings (from glasshouse) in field
- Establish a clear pathway for future direction and investment in introgression breeding

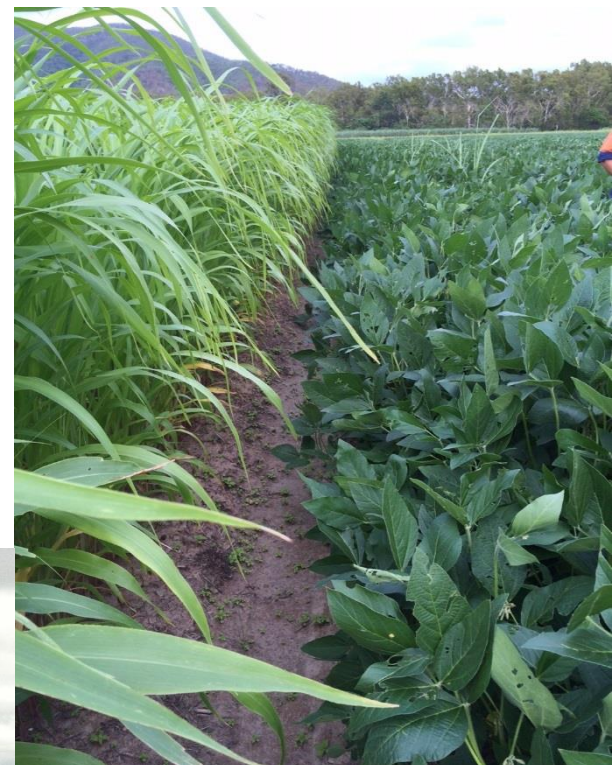
Field Trials:

- **Seedling trials**
 - in 2 regions: Herbert, Burdekin
 - 5 introgression clones derived from E.a & S.s BC1 to BC4, used in at least 5 crosses
 - 80 seedlings per cross (125 crosses) ~ 10,000 total
 - planting trials in 2015
- **Trialling introgression clones in stressful environments for yield and ratooning**
 - 3 trials: Herbert, Mackay, NSW
 - trial design: 50 clones x 4-row x 10m x 2 reps (slashing designed)
 - planting trials in 2015
- **Nematode Trials (Root knot nematode, RKN & lesion nematode, RLN)**
 - RKN in Herbert & Bundaberg
 - RLN in Herbert & Mackay
 - trial design ~ 15 clones x 4-row x 10m x 5 reps x 2 treatments
 - planting trials in 2015

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graph LR; A[trial design ~ 15 clones x 4-row x 10m x 5 reps x 2 treatments] --> B[High nematodes]; A --> C[Low nematodes];
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- **Support from HCPSL, Wilmar, MAPS, ISIS, NSW Sugar**

RLN trial site - Joe Muscat
Planted 20/12/2014
Soybean A6785
Sorghum – Sweet Jumbo

Plot 1	Soy	Soy	Sorg	Soy	Sorg
Plot 2					
Plot 3					
Plot 4					
Plot 5					
Plot 6					
Plot 7					
Plot 8					
Plot 9					
Plot 10					
Plot 11					
Plot 12					
Plot 13					
Plot 14					
Plot 15					
Plot 16	Sorg	Sorg	Soy	Sorg	Soy
Plot 17					
Plot 18					
Plot 19					
Plot 20					
Plot 21					
Plot 22					
Plot 23					
Plot 24					
Plot 25					
Plot 26					
Plot 27					
Plot 28					
Plot 29					
Plot 30					



Next steps

- Sub sample trial site for nematode counts
 - Sample from each rep and each
 - treatment
- Planting trials in 2015



Introgression Seed Exchange

- Japan and Thailand seed exchange
 - Issues with importing seed from Thailand (high risk ~ White Leaf Disease)
- USA has now formulated conditions for import of seed, opening the way for seed exchange
- In Australia need to:
 - Germinate seed in quarantine glasshouse
 - Apply molecular tests
 - Grow for six months in isolated area

Introgression: IT WORKS!!

