Varieties for modern sugarcane production
Synopsis

1  Case studies:

   Southern Africa
   - Swaziland (RSSC) and South Africa (Tsb)

   Papua New Guinea
   - Ramu Sugar (RAIL)

2  Other considerations:

   - Changing needs
   - Future developments
Part 1
Southern Africa
Case study 1: South Africa and Swaziland
Common features

Environment

- 700 to 800 mm rain
- Net irrigation requirement 1000 mm
- Potential yield 140 tc/ha/annum
- Predominant soil type
- Pest and disease threats

Tsb

- Mills at Komatipoort and Malelane
- 1.2 million tons MCP cane

RSSC

- Mills at Simunye and Mhlume
- 1.8 million tons MCP cane

Same source of varieties - SASRI
Differences

Regulation

- Tsb – South African Sugar Association (SASA)
- RSSC – Swaziland Sugar Association (SSA)

SASA

- South African Sugar Research Institute (SASRI)
- Plant breeding programme (N varieties)
- Variety selection and testing, pre and post release

SSA

- Varieties imported from SASRI
- £900 per ton of seed for post 2000 releases
- Second tier of post release testing
Differences in variety adoption

Variety released in South Africa

Variety imported to Swaziland, small quantity

Variety bulked for replicated trials

Replicated trial programme commences

Replicated trial programme continues for up to 5 ratoons

Seed material bulked at central nursery

Clean seed supplied to estates (including RSSC)

Commercial adoption

Commercial observation

Commercial adoption
Variety selection – common goals

Pest and disease resistance/tolerance:
- Smut
- Sugarcane Mosaic Virus

Production traits
- Sucrose content, seasonal
- Cane yield, transport costs
- Milling qualities, ‘processability’ - pith:fiber ratio and colour

Growth traits
- Adaptability
- Tolerance of adverse soil conditions
- Note that suitability to mechanical harvesting not considered important

Ideally no more than 25% of a single variety
Smut
Mosaic
## Variety traits

<table>
<thead>
<tr>
<th>Variety</th>
<th>NCo376</th>
<th>N14</th>
<th>N19</th>
<th>N23</th>
<th>N25</th>
<th>N32</th>
<th>N36</th>
<th>N40</th>
<th>N41</th>
<th>N46</th>
<th>N49</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smut</strong></td>
<td>Sus*</td>
<td>Int</td>
<td>Res</td>
<td>Int</td>
<td>Int</td>
<td>Sus</td>
<td>Int</td>
<td>Res</td>
<td>Int</td>
<td>Int</td>
<td>Res</td>
</tr>
<tr>
<td><strong>Mosaic</strong></td>
<td>Sus**</td>
<td>Int</td>
<td>Sus</td>
<td>Int</td>
<td>Int</td>
<td>Sus</td>
<td>Int</td>
<td>Res</td>
<td>Int</td>
<td>Res</td>
<td>Res</td>
</tr>
<tr>
<td><strong>RSD</strong></td>
<td>Sus</td>
<td>Sus**</td>
<td>Sus</td>
<td>Int</td>
<td>Sus**</td>
<td>Sus</td>
<td>Int</td>
<td>Int</td>
<td>Sus</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Salinity tolerance</strong></td>
<td>Good</td>
<td>Mod</td>
<td>Good</td>
<td>Mod</td>
<td>Mod</td>
<td>Mod</td>
<td>Poor</td>
<td>Poor</td>
<td></td>
<td></td>
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<tr>
<td><strong>Season</strong></td>
<td>Mid late</td>
<td>Mid late</td>
<td>Early mid</td>
<td>Early mid</td>
<td>Mid late</td>
<td>Early mid</td>
<td>Early mid</td>
<td>Early</td>
<td>Early</td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td><strong>Milling qualities</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

*NCo376 and N32 unavailable in South African irrigated areas*
## Incremental plant improvement

<table>
<thead>
<tr>
<th>T RV/ha as %</th>
<th>NCo376</th>
<th>N14</th>
<th>N19</th>
<th>N23</th>
<th>N25</th>
<th>N32</th>
<th>N36</th>
<th>N40</th>
</tr>
</thead>
<tbody>
<tr>
<td>N25</td>
<td>110</td>
<td>108</td>
<td>109</td>
<td></td>
<td>X</td>
<td></td>
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<tr>
<td>N32</td>
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<td>103</td>
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<td>N36</td>
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<td></td>
<td>107</td>
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<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N40</td>
<td></td>
<td>110</td>
<td>114</td>
<td>110</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N41</td>
<td>114</td>
<td></td>
<td></td>
<td>102</td>
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<td></td>
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<tr>
<td>N46</td>
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<td>112</td>
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<td>101</td>
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<tr>
<td>N49</td>
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<td></td>
<td></td>
<td>103</td>
<td>105</td>
<td>105</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*From SASRI variety information sheets*
RSSC variety disposition

Others under test include: N24, N26, N28, N30, N36
## SSA Smut Regulations

<table>
<thead>
<tr>
<th>Inspection No.</th>
<th>Smut %</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;15</td>
<td>Immediate plough out order</td>
</tr>
<tr>
<td>1</td>
<td>5 to 15</td>
<td>Plough out decision deferred to next inspection</td>
</tr>
<tr>
<td>2</td>
<td>&gt;10</td>
<td>Immediate plough out order</td>
</tr>
<tr>
<td>2</td>
<td>&gt;5</td>
<td>Plough out deferred to next season</td>
</tr>
<tr>
<td>1, following year</td>
<td>&gt;5</td>
<td>Immediate plough out order</td>
</tr>
</tbody>
</table>
Others: mainly N36
Tsb variety disposition

Others include: N40, N41, N46, N49
N25 plough out order at Tsb
Tsb future variety disposition

Others include: N40, N41, N46, N49
Objectives of Tsb variety plan

- Increase production performance by 0.43 t RV/ha
- Maintain total variety disposition below 20% per variety - reduce P&D risk
- Reduce tonnage by 38 000 t (reduce transport costs)
- Improved mill efficiencies & throughput
- None of this would be possible without the availability of new varieties
Why the difference?

South Africa:
- Supply of new varieties, SASRI plant breeding
- Ready to embrace new varieties
- Ready to degazette – NCo376 (1983) and N32 (2010)
- Quick to benefit from incremental plant improvement

Swaziland:
- Supply of varieties restricted by cost, plant breeders rights
- Conservative approach – extra evaluation and time
- NCo376 still available, ‘easy option’ but regulated
- Smut infection pressure on newer varieties
- Delayed benefit from incremental plant improvement
- 8 % yield penalty at RSSC
- Does this have to be the case?
Variety selection trials sites

Two soil types represented at Pongola and Ubombo
## REML (Restricted Maximum Likelihood)

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Komatidraai - SA</td>
<td>Mhlati - SA</td>
<td>Ubombo - Swazi</td>
<td>Mhlume - Swazi</td>
<td>Tonga - SA</td>
</tr>
<tr>
<td>Komati SASRI</td>
<td>Ubombo S - Swazi</td>
<td>Pongola SASRI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simunye - Swazi</td>
<td>Malkerns - Swazi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pongola P - SA</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

![Map of SWAZILAND showing locations](map.png)
Differences in variety adoption

Variety released in South Africa → Variety imported to Swaziland, small quantity

- Variety bulked for replicated trials
- Replicated trial programme commences
- Replicated trial programme continues for up to 5 ratoons
- Seed material bulked at central nursery
- Clean seed supplied to estates (including RSSC)
- Commercial observation
- Commercial adoption
Case study 2: Papua New Guinea
Ramu Agri Industries Limited (RAIL)
Ramu Sugar – project features

Environment
- 10400 ha
- Rainfed project - 2,000 mm/year
- Mean cane yield - 65 to 70 tc/ha

Pest and disease
- Papua New Guinea - origin of wild cane
- Significant pest and disease threats expected
- Some previously unknown diseases
- Resistant varieties a central component of pest and disease control
<table>
<thead>
<tr>
<th>Common Name</th>
<th>Causal Agent</th>
<th>Activity</th>
<th>Economic Importance</th>
<th>Control Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramu Stunt</td>
<td>Phytoplasma</td>
<td>Systemic</td>
<td>Very significant</td>
<td>Resistant varieties</td>
</tr>
<tr>
<td>Downy Mildew</td>
<td>Fungal</td>
<td>Systemic</td>
<td>Very significant</td>
<td>Resistant varieties, chemical</td>
</tr>
<tr>
<td>Leaf Scald</td>
<td>Bacterial</td>
<td>Systemic</td>
<td>Very significant</td>
<td>Resistant varieties</td>
</tr>
<tr>
<td>Fiji disease</td>
<td>Virus</td>
<td>Systemic</td>
<td>Very significant</td>
<td>Resistant varieties</td>
</tr>
<tr>
<td>Ratoon Stunting Disease</td>
<td>Bacterial</td>
<td>Systemic</td>
<td>Very significant</td>
<td>Resistant varieties, HWT</td>
</tr>
<tr>
<td>Ramu Streak</td>
<td>Unknown</td>
<td>Leaf</td>
<td>ns</td>
<td>Unknown</td>
</tr>
<tr>
<td>Ramu Orange Leaf</td>
<td>Fungal</td>
<td>Leaf</td>
<td>Unknown</td>
<td>Roguing</td>
</tr>
<tr>
<td>Ramu Scorch</td>
<td>Unknown</td>
<td>Leaf</td>
<td>ns</td>
<td>Unknown</td>
</tr>
<tr>
<td>Brown Rust</td>
<td>Fungal</td>
<td>Leaf</td>
<td>ns</td>
<td>Resistant varieties</td>
</tr>
<tr>
<td>Orange Rust</td>
<td>Fungal</td>
<td>Leaf</td>
<td>ns</td>
<td>Resistant varieties</td>
</tr>
<tr>
<td>Golden Leaf Syndrome</td>
<td>Unknown</td>
<td>Systemic</td>
<td>Emerging</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
Sesamia grisescens
Top shoot borer, *Scirpophaga excerptalis*
Top shoot borer
Golden Leaf Syndrome
## Ramu Sugar – variety history

<table>
<thead>
<tr>
<th>Variety</th>
<th>Resistant</th>
<th>Intermediate</th>
<th>Susceptible</th>
<th>Expanded</th>
<th>Phased out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ragnar</td>
<td>Leaf Scald, Fiji, Downy Mildew</td>
<td></td>
<td>Ramu Stunt</td>
<td>1983</td>
<td>1986</td>
</tr>
<tr>
<td>Cadmus</td>
<td>Leaf Scald, Ramu Stunt</td>
<td>Downy Mildew</td>
<td>Sesamia</td>
<td>1985</td>
<td>1995</td>
</tr>
<tr>
<td>Cassius</td>
<td>Downy Mildew, Ramu Stunt, Fiji</td>
<td></td>
<td>Leaf Scald, Sesamia</td>
<td>1987</td>
<td>1992</td>
</tr>
<tr>
<td>Q107</td>
<td>Leaf Scald, Ramu Stunt</td>
<td></td>
<td>Weevil Borer, White Grub</td>
<td>1987</td>
<td>1993</td>
</tr>
<tr>
<td>Q127</td>
<td>Leaf Scald, Ramu Stunt</td>
<td></td>
<td>Top Shoot Borer, GLS</td>
<td>1992</td>
<td>2010</td>
</tr>
<tr>
<td>BT65152</td>
<td>Fiji, Ramu Stunt</td>
<td></td>
<td>Rust</td>
<td>1993</td>
<td>2002</td>
</tr>
<tr>
<td>R570</td>
<td>Leaf Scald</td>
<td>Ramu Stunt</td>
<td>Top Shoot Borer, Herbicides</td>
<td>1998</td>
<td></td>
</tr>
</tbody>
</table>

**Q127** – high sucrose but unsuitable for mechanical harvesting
Ramu variety disposition
Ramu summary

- Variety choice driven by pest and disease issues
- Balanced with productivity and growth traits
- Average ‘life’ of a variety is 10 years
- Constant supply of new candidates
- Own breeding programme, PN varieties
- Ability to change variety rapidly and maintain a broad spread of varieties has been essential to the project’s survival
- Future policy:
  - In house breeding programme … ?
  - Reaction to latest threat – Golden Leaf Syndrome?
  - Top shoot borer – solution may not be varietal but linked to Sesamia control
  - Essential to maintain supply of new varieties
Conclusions - case studies

- Forward thinking and uninterrupted supply of new varieties is essential for long term success of projects.
- Pest and disease as well as productivity and growth traits should be considered.
- Important to maintain balanced variety disposition with no more than 25% of a single variety.
- Need a constant supply of varieties to achieve this.
- Static variety policy is undesirable – must take advantage of continuous plant improvement.
- Must overcome regulatory bottlenecks in industries that do not have their own plant breeding programme.
- Relevance? New and existing projects.
- New projects: variety sourcing an important aspect of planning.
- Existing projects: use new varieties to improve production while minimising risk; avoid stagnation.
Part 3
Other Considerations
**Other considerations**

- **Changing needs**
  - Mechanisation
  - Ethanol and biomass

- **Future developments**
  - Energy canes
  - Biotechnology
  - Other end uses for sugarcane
Mechanisation

Mechanical harvesting
- Existing projects, changing from manual harvesting
- New projects, designed for mechanical harvesting
- Non-brittle varieties with erect growth habit
- Control of harvest losses and machine productivity
- Productivity and pest and disease management

Examples
- Peru – re-emerging industry, limited availability of varieties from existing industry, Mex 73-523
- Colombia – emphasis of plant breeding programme on machine harvesting qualities
- Sudan - >80% Co6806 but 100% mechanical harvesting
- Australia – Q170 and Q124
Future developments

Requirements

- Need for varieties with different end use
- Breeding to date focussed on sucrose production
- Concept of ‘Total Energy in Cane’ – sum of energy recovered in cogeneration, ethanol and sugar – West Indies and Reunion

Meeting requirements

- Alter management of existing varieties
- Biotechnology to accelerate plant improvement
- Genetic markers (smut, rust, yellow spot)
- DNA fingerprinting
- GM? Drought tolerance (Brazil), herbicide resistance (South Africa)
- Market acceptance??
Thank you

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www.booker-tate.co.uk
Parasitism of Top Shoot Borer
Ratoon Stunting Disease
Eumetopina flavipes, insect vector of Ramu Stunt
Downy Mildew
Leaf Scald
Fiji Disease
Brown Rust