Origin and Spread of Sugarcane

6000 BC  Domestication of sugarcane in New Guinea
1000 BC  Traders began spreading sugarcane westward

1493    Brought by Columbus to Hispaniola from Canary Islands
1500s   Spanish and Portuguese explores bring sugarcane to Americas

“Creole,” a noble sugarcane, grown for 250 years in the Americas

1750s  Jesuits brought sugarcane to Louisiana “Otaheite”
1794   First commercial sugarcane in Louisiana
• 1800s Noble varieties such as “Louisiana Purple”, “Louisiana Stripe,” and “D74” grown in Louisiana

• Early 1900s Devastating crop failures in Louisiana sugarcane industry

• 1919 Dr. Elmer W. Brandes, USDA, identified mosaic as major cause of poor yields

• 1922 Interspecific hybrid P.O.J. varieties imported from Java, key to saving industry

• 1924 Supply of P.O.J. 234 available for distribution through the American Sugarcane League

• 1928 85% of the state’s acreage was P.O.J. varieties
Flagging plots for harvest operator
Breeding

- Participating with the LSU Ag Center and the American Sugar Cane League in developing new commercial varieties

- Using wild relatives of sugarcane to broaden the genetic base of our parental material

- Developing “energy cane” varieties

- Developing and utilizing DNA-based molecular markers to fingerprint varieties and to improve selection efficiencies.
Energycanes

- Hybrids ($F_1$ and $BC_1$) between cultivated sugarcane and wild relatives (*Saccharum, Miscanthus, Erianthus*)
- Vegetatively propagated perennial with better cold tolerance than sugarcane
- Higher fiber and better ratooning ability
- Developed specifically as a bioenergy crop
  - Type I – Dual-purpose sugar and lignocellulosic crop
  - Type II – Primarily lignocellulosic
Breeding with wild relatives:
- *Saccharum spontaneum*
- *Miscanthus*
- *Erianthus*
# Common Energycane Germplasm

<table>
<thead>
<tr>
<th>Germplasm Line*</th>
<th>Pedigree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho 02-147</td>
<td>$F_1$ (Wild Cane x Sugarcane)</td>
</tr>
<tr>
<td>Ho 02-144</td>
<td>$F_1$ (Wild Cane x Sugarcane)</td>
</tr>
<tr>
<td>US 72-114</td>
<td>$BC_1$ with Sugarcane</td>
</tr>
<tr>
<td>Ho 06-9001</td>
<td>$BC_1$ with Wild Cane</td>
</tr>
<tr>
<td>Ho 06-9002</td>
<td>$BC_1$ with Wild Cane</td>
</tr>
<tr>
<td>Ho 00-961</td>
<td>R-MS, Be-TX &amp; HI</td>
</tr>
<tr>
<td>Ho 95-988</td>
<td>HI</td>
</tr>
<tr>
<td>Ho 00-07</td>
<td>HI</td>
</tr>
</tbody>
</table>

*from USDA-ARS-SRU, Houma, LA
Second Year Field

Ho 01-07
Ho 00-961

Ho 06-9001

Starkville, MS; Aug 2008
Second Year Field

Ho 01-07

Ho 06-9002

Ho 02 - 147

US 72-114

Courtesy of Brian Baldwin, MSU

Starkville, MS; Aug 2008
Second Year Field

Ho 06-9002

L99-233 ★

US 72-114 ★

Ho 02-144

Starkville, MS; Aug 2008

Courtesy of Brian Baldwin, MSU
• Louisiana sugarcane receives 90-180 kg N/ha

• Biological N fixation (BNF) may reduce requirement

• In one nitrogen balance study in sugarcane, 70% of biomass from BNF
Research Objectives

- Attempt to isolate diazotrophic, endophytic bacteria from Louisiana-grown sugarcane

- Measure how much N can the isolates “fix”

- Determine if we can inoculate commercial varieties with N-fixing bacteria
BNF Process

- Endophytic bacteria (live among cells of plant tissue)
- Convert atmospheric N to plant-available N
- Some may be antagonistic to pathogens
• Isolate bacteria on nitrogen-free medium (LGI-P) from stalks

Centrifugation, 8000 rpm for 5 minutes

Incubation at, 27 °C for 72 hours
Procedures

• Isolate bacteria on nitrogen-free medium (LGI-P) from stalks

• Identify isolates through rDNA sequences analysis and blasted in NCBI

• Nitrogen-fixation capability testing

• Inoculation studies

• Test effect of N-fixing bacteria on pathogens
Current Progress

- Isolated approx. 100 bacterial isolates from commercial Louisiana varieties
- Isolates grew on N-deleted media
- The identity of some is the same as those from Brazilian sugarcane
# Bacterial Isolation

<table>
<thead>
<tr>
<th>Egyptian Isolates (20)</th>
<th>Louisiana Isolates (85)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gluconacetobacter*</td>
<td>Gluconacetobacter*</td>
</tr>
<tr>
<td>Burkholderia</td>
<td>Burkholderia</td>
</tr>
<tr>
<td>Herbaspirillium</td>
<td></td>
</tr>
<tr>
<td>Panocea</td>
<td>Panocea</td>
</tr>
<tr>
<td>Enterobacter</td>
<td>Enterobacter</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>Pseudomonas</td>
</tr>
<tr>
<td>Frateauria or Dyella</td>
<td></td>
</tr>
<tr>
<td>Aneurinibaciilus</td>
<td></td>
</tr>
<tr>
<td>Pectobacterium</td>
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</tr>
<tr>
<td></td>
<td>Xanthomonas oryzae oryzae</td>
</tr>
</tbody>
</table>

* Including G. diazotrophicus
Two *Gluconacetobacter diazotrophicus* isolates demonstrated nitrogen-fixation capability.

Isolates of *G. diatrophicus* exhibited moderate levels of nitrogenase activity (2 nmol C$_2$H$_4$ per hour).
Industry Benefits

• Lower nitrogen fertility rates

• Inoculating tissue-culture propagated plants with endophytic, N-fixing bacteria could:
  – improve seed cane germination
  – reduce effects of systemic diseases
Thank You