Sugar/Energy Canes as Feedstocks for the Biofuels Industry

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Feedstock Considerations:

✓ Climates/growing seasons differ (temperatures, rainfall patterns, etc.). Can’t expect the same crops to do well in all parts of the U.S.

✓ Optimum conversion process for one crop may not be the optimum for other crops/materials delivered to biorefinery. (need feedstock commonality).

✓ Efficiencies of conversion processes differ. (starch/sugar easier than cellulosic conversion).
Goal: High-yield, multi-feedstock, low cost cellulosic ethanol.
Feedstock Considerations (Cont’d):

✓ Yield of feedstock (tons and compositional quality) with low inputs
✓ Harvest and transport infrastructure
✓ Processing season – cost to operate 360 days/yr (storage, just in time harvest) benefits the processor and the grower
  e.g. grain growers can plant and harvest wheat, then corn, than beans with same equipment. This also allows the growers to spread their risks.
Biomass density (tons/ha) is critical for economic feasibility

Delivered cost of biomass feedstock is the largest cost element in producing biofuels (includes production, harvest and transportation costs)

Energy crops

Distance ~ $ $ $ $ $ 

Storage = $$
Why Not Sugarcane??????
What is the PERFECT cane feedstock for a bio-refinery?

- Molasses (237 L Etoh/t)
- Bagasse (240 L Etoh/t)
- Raw Sugar (463 L Etoh/t)
- Leaf Litter (240 L Etoh/t)
Released in 2007

three “high fiber” sugarcane varieties:
A starting point
Delivered cost of biomass feedstock is the largest cost element in producing biofuels (includes production, harvest and transportation costs)

Storage = $$

Biomass density (tons/ha) is critical for economic feasibility
## Comparisons of high fiber sugarcane varieties

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<th>L</th>
<th>HoCP</th>
<th>Ho</th>
<th>LCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (t/ha)</td>
<td>79-1002</td>
<td>91-552</td>
<td>00-961</td>
<td>85-384</td>
</tr>
<tr>
<td>Cane (wet)</td>
<td>82.2</td>
<td>87.1</td>
<td>77.5</td>
<td>70.6</td>
</tr>
<tr>
<td>Cane (dry)</td>
<td>31.3</td>
<td>28.7</td>
<td>26.7</td>
<td>22.8</td>
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<tr>
<td>Brix</td>
<td>10.5 (13%)</td>
<td>14.8 (17%)</td>
<td>13.7 (17%)</td>
<td>13.2 (18%)</td>
</tr>
<tr>
<td>Fiber</td>
<td>20.8 (26%)</td>
<td>13.9 (16%)</td>
<td>13.0 (16%)</td>
<td>9.6 (13%)</td>
</tr>
<tr>
<td>Ethanol (L/ha)*</td>
<td>13,400</td>
<td>12,300</td>
<td>11,400</td>
<td>9,800</td>
</tr>
</tbody>
</table>

*Ethanol yield based on 429 L/t of Brix and 240 L/t of fiber.*
Current Research

Cold Tolerance
Energy Cane – What is it?

- Early generation lines (F$_1$’s, BC$_1$’s)
- Vigor = high biomass yields (30 + dry Mg/ha) with reduced inputs (90-100 kg/ha of N)
- Ratooning – perennial growth and consistent yields over 5 to 6 annual harvests
- Cold tolerance - shoot and stalk
- High fiber (18 – 24%)
- Moderate soluble solids – Brix (17 – 18%)
Sugar Cane

1st Ratoon sugarcane harvested December, 2005
Energy Cane

L 79-1001 (L)

L 79-1002 (R)

(9/12/06)
Energy Cane Yield (2006 – 2007)

Biomass Yield (Mg/ha)

- L 79-1002: 28 (Brix), 10 (Fiber)
- US 02-113: 32 (Brix), 13 (Fiber)
- US 03-19: 18 (Brix), 11 (Fiber)
- US 03-48: 29 (Brix), 14 (Fiber)
- US 99-51: 30 (Brix), 13 (Fiber)
- US 99-58: 24 (Brix), 12 (Fiber)
Sweet Sorghum

Non-flowering sorghum x sudangrass

Sweet sorghum (Sorghum bicolor)
Planted early-May

(9/12/06)
Theoretical Ethanol Yield (138 DAP)

Variety

Yield (L/ha)

- MMR 333/27
- MMR 333/47
- Dale
- M 81-E
- Theis
- Topper

Hexose sugars  |  Cellulose  |  Total
Miscanthus cut back late 2005

(9/12/06)
Erianthus cut back late 2005

(9/12/06)
Hybrids
Sugar Cane x Miscanthus
Sugar Cane x Erianthus
Integrated/In-Time Delivery System

✓ Aug. – Sep.: Harvest sweet sorghum
✓ Oct. – Mar.: Harvest sugar and/or energy canes
✓ Apr. – Jun.: Harvest *Miscanthus/Erianthus*
✓ Jul.: Facility repairs if needed

All of these species can be grown and harvested with conventional sugarcane equipment and, with the exception of sorghum, all are perennials.

*Tropical Maize ??*