Potential of Sweet Potato and Sweet Sorghum as Advanced Biofuel Crops for Low Input Production on Small Farms

Michael Bomford and Tony Silvernail
US Biofuel Mandates

Energy Independence and Security Act of 2007, Section 202
US Biofuel Mandates

Billion gallons

- advanced biofuel
- cellulosic biofuel
- conventional biofuel

Conventional biofuel: Ethanol derived from corn starch

Energy Independence and Security Act of 2007, Section 202
US Biofuel Mandates

Cellulosic biofuel: Renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions that are at least 60 percent less than the baseline.

Energy Independence and Security Act of 2007, Section 202
US Biofuel Mandates

Advanced biofuel:
Renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions that are at least 50 percent less than baseline.

Billion gallons

Energy Independence and Security Act of 2007, Section 202

KENTUCKY STATE UNIVERSITY
Small, organic, sustainable

• Smaller farms tend to use land more efficiently
• Organic farms tend to use energy more efficiently
  – Synthetic fertilizers and pesticides can account for 30-50% of energy involved in grain production
• Need alternative feedstock crops
  – Compatible with small farms, organic farms, southern farms
  – Higher ethanol yield than corn
  – Compatible with decentralized processing
Small farms are more productive

Production per unit area

“Because of its reduced energy inputs, organic agriculture is the ideal production method for biofuels.

[...]  
As the aim of biofuels is to reduce dependency on non-renewable energy sources and to mitigate environmental damage of fossil fuel emissions, organic production of biofuels furthers these goals in a way that conventional agriculture does not.”
Objectives

• Compare sweet sorghum and sweet potato to corn in terms of
  – Potential ethanol yield (land use efficiency)
  – Energy use efficiency
  – Labor use efficiency

• Compare efficiencies at three small organic farm scales
  – Biointensive
  – Market garden
  – Small farm
## Crops

<table>
<thead>
<tr>
<th>Common name</th>
<th>Image</th>
<th>Latin name</th>
<th>Food</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td><img src="image1.png" alt="Corn Image" /></td>
<td>Zea mays</td>
<td>Sweet corn, grain</td>
<td>Ethanol</td>
</tr>
<tr>
<td>Soybean</td>
<td><img src="image2.png" alt="Soybean Image" /></td>
<td>Glycine max</td>
<td>Edamame, grain</td>
<td>Biodiesel</td>
</tr>
<tr>
<td>Sweet sorghum</td>
<td><img src="image3.png" alt="Sorghum Image" /></td>
<td>Sorghum bicolor</td>
<td>Sorghum syrup, grain</td>
<td>Ethanol</td>
</tr>
<tr>
<td>Sweet potato</td>
<td><img src="image4.png" alt="Potato Image" /></td>
<td>Ipomoea batatas</td>
<td>Sweet potato</td>
<td>Ethanol</td>
</tr>
</tbody>
</table>
Small Farm Scales

• Biointensive
  – Human-powered; no fossil fuels
  – Smallest scale

• Market garden
  – Walk-behind tractor is largest fossil fuel powered machine

• Small farm
  – Conventional 4-wheeled tractors
Biointensive mini-farming

“Biointensive mini-farming techniques make it possible to grow food using

– 99% less energy in all forms - human and mechanical,
– 66-88% less water, and
– 50-100% less fertilizer, compared to commercial agriculture.

They also produce two to six times more food and build the soil.”

Yield (kg/m², log scale)
Theoretical EtOH yield

Theoretical EtOH yield (l/ha)

- **Corn**
- **Dale**
- **M81E**
- **Sweet potato**

- Biointensive
- Market Garden
- Small Farm
Conclusions

• Yields under low input, small-scale organic production systems
  – Field corn about 33% below average
  – Sweet potato about average
  – Sweet sorghum about 50% higher than average
• Field corn and sweet sorghum yields lower in Biointensive-scale system; sweet potato yields similar across scales
• Biointensive scale gives highest energy efficiency; small farm gives highest land and labor use efficiency
• Sweet sorghum and sweet potato more compatible with low-input small farm systems than corn
Contact:
Michael Bomford
502-597-5752
Michael.Bomford@KYSU.edu

Learn more:
EnergyFarms.net
Organic.KYSU.edu

Thanks to
• Harold Benson
• Kimberley Holmes
• Robert Barney
• John Rodgers
• Joelle Johnson
• Brian Geier
• KSU Farm crew
• CASS program
• Post Carbon Institute