Environmental Effects of Bioenergy Feedstocks

Renewable Fuels Standard

U.S. Fuel Consumption

Life Cycle Assessment

CO₂

Longer cycling time

Shorter cycling time

CO₂ produced annually (lb/acre)

Adler et al., 2007

Switchgrass  RC  C/S NT  Hybrid poplar
Got Algae?

How does its life cycle compare?

Adler et al., 2007

Switchgrass RC C/S NT Hybrid poplar

CO₂ produced annually (lb/acre)

Adler et al., 2007

Switchgrass RC C/S NT Hybrid poplar

Greenhouse gas reduction (%)

Adler et al., 2007

Switchgrass RC C/S NT Hybrid poplar

Got Algae?

How does its life cycle compare?

Clarens et al., 2010

Algae Corn Canola Switchgrass

Energy requirement (MJ x 10⁴)

Clarens et al., 2010

Algae Corn Canola Switchgrass

GHG emission (kg CO₂ equiv) x 10⁴

Clarens et al., 2010

Algae Corn Canola Switchgrass

Water requirement (m³) x 10⁴

Clarens et al., 2010

Algae Corn Canola Switchgrass
Identify priorities
1. Feedstocks that produce lower life-cycle GHG emissions than fossil fuels
2. Feedstocks with little or no competition with food production

What can we do?
- Perennial plants grown on degraded lands abandoned from agricultural use
- Crop residues
- Sustainably harvested wood and forest residues
- Double crops and mixed cropping systems

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<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Electricity</th>
<th>Fuel</th>
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<tbody>
<tr>
<td></td>
<td>Gallons/GJ</td>
<td>Gallons/Gallon</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>12,144</td>
<td>1,388</td>
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<tr>
<td>Corn</td>
<td>13,200</td>
<td>2,570</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>13,200</td>
<td>2,516</td>
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<td>Wheat</td>
<td>24,552</td>
<td>4,946</td>
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<td>Soybean</td>
<td>45,672</td>
<td>13,676</td>
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<td>Sorghum</td>
<td>47,520</td>
<td>9,812</td>
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<tr>
<td>Rapeseed (Canola)</td>
<td>101,112</td>
<td>14,201</td>
</tr>
</tbody>
</table>

*Gerbens-Leenes et al., 2009*
Further information

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http://www.extension.org/ag_energy