Current technologies and status of grain-based biofuels in Iowa

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Ethanol Production & Corn Use

Sources: USDA, National Corn Growers, and Renewable Fuels Association

IOWA STATE UNIVERSITY
University Extension

Sources: USDA, National Corn Growers, and Renewable Fuels Association
US Ethanol Plants

Operating plants
184 Plants in USA in 26 states 11.7 BGY
40 Plants in Iowa 3.2 BGY

Construction/expansion
21 Plants in USA 1.4 BGY
2 Plants in Iowa 0.4 BGY
# Iowa Ethanol Production and Corn Usage

## Summary Statistics - July 2009

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Ethanol Produced mil gal/yr</th>
<th>Corn Used mil bu/yr</th>
<th>DGS 000 tons/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current Dry-grind Plants</strong></td>
<td>35</td>
<td>2,706</td>
<td>982</td>
<td>8,278</td>
</tr>
<tr>
<td><strong>Expansions and new construction</strong></td>
<td>2</td>
<td>375</td>
<td>134</td>
<td>1,139</td>
</tr>
<tr>
<td><strong>Wet Mills</strong></td>
<td>5</td>
<td>490</td>
<td>175</td>
<td>1,487</td>
</tr>
<tr>
<td><strong>Nearby Iowa</strong></td>
<td>11</td>
<td>636</td>
<td>227</td>
<td>1,931</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>53</td>
<td>4,207</td>
<td>1,518 (~65%)</td>
<td>12,835</td>
</tr>
</tbody>
</table>
U.S. Corn Ending Stocks
(million bushels)

Sources: USDA - National Ag Statistics Service and Economic Research Service
Ethanol Margins

Source: CARD, ISU
What About the Acreage Split?

<table>
<thead>
<tr>
<th>Year</th>
<th>DDGS (mln ton)</th>
<th>SBM (mln ton)</th>
<th>Protein (mln ton)</th>
<th>Oil (bln lb)</th>
<th>Lysine (bln lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>17.4</td>
<td>11.3</td>
<td>9.9</td>
<td>9.8</td>
<td>1.14</td>
</tr>
<tr>
<td>2007</td>
<td>20.8</td>
<td>9.8</td>
<td>10.1</td>
<td>9.7</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Issues: Protein quality (amino acids)  
Energy content (starch, oil)
What’s fractionation? A process by which bran, germ, and endosperm are separated, usually at the beginning of the process.

- We have a distribution issue.
- Not a total quantity issue.

Source: Cereal Process Technologies, Bridgeton, MO
# Corn Composition

Looking for:
- Improved efficiency
- Reduced energy usage
- Reduced water usage
- Diversified product stream

<table>
<thead>
<tr>
<th></th>
<th>Starch</th>
<th>Protein</th>
<th>Oil</th>
<th>Ash</th>
<th>Sugar</th>
<th>Fiber</th>
<th>Total</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Corn</td>
<td>73.4</td>
<td>9.1</td>
<td>4.4</td>
<td>1.4</td>
<td>1.9</td>
<td>9.8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Endosperm</td>
<td>87.6</td>
<td>8.0</td>
<td>0.8</td>
<td>0.3</td>
<td>0.6</td>
<td>2.7</td>
<td>100</td>
<td>82.9</td>
</tr>
<tr>
<td>Germ</td>
<td>8.3</td>
<td>18.4</td>
<td>33.2</td>
<td>10.5</td>
<td>10.8</td>
<td>18.8</td>
<td>100</td>
<td>11.0</td>
</tr>
<tr>
<td>Bran</td>
<td>7.3</td>
<td>3.7</td>
<td>1.0</td>
<td>0.8</td>
<td>0.3</td>
<td>86.9</td>
<td>100</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Why Fractionate?

Source: 2009 FEW Conference presentation by Reg Ankrom (CPT)
Fractionation Technologies

- MOR Technologies
- Corn Value Products
- Langhauser Associates
- FC Stone Carbon LLC and Maize Processing Innovations
- Buhler Inc.
- Cereal Process Technologies
- FWS Technologies
- American Milling Group
- ICM Inc.
- POET
- Renessen LLC
- Delta-T Corporation
**Capital Costs**

- Range from $10 million to $40 million for a 50 million gallon ethanol plant
- The inclusion of corn oil extraction technologies moves costs to the higher end of the spectrum
- Most vendors point to a payback period of under 3 years

**Variable Costs**

- Decreased energy needs per gallon for:
  - Liquidification and cooking
  - Distillation
  - Drying of distillers grains and solubles
- Possible energy generation from bran
- Could reduce energy demand by nearly 50%
Product Streams

Corn costs: $3.75 per bushel, Illinois ethanol plant report (USDA-AMS, as of Nov. 20, 2009)

Traditional ethanol plant:
- 2.8 gallons of ethanol @ $2.17/gallon = $6.08
- 17.75 lbs. of DDGS @ $130/ton = $1.15
Revenues per bushel = $7.23

Ethanol plant w/ fractionation:
- 2.72 gallons of ethanol @ $2.17/gallon = $5.90
- 13.5 lbs. of high protein DG @ $140/ton = $0.95
- 5 lbs. of germ @ $155/ton = $0.39
- 3 lbs. of bran @ $80/ton = $0.12
Revenues per bushel = $7.36
## Distillers Grains Properties

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Typical Value*</th>
<th>Fractionation Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>90%</td>
<td>No change</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>26%</td>
<td>Increase</td>
</tr>
<tr>
<td>Crude Fat (germ)</td>
<td>9%</td>
<td>Decrease</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>15%</td>
<td>Decrease (bran)</td>
</tr>
<tr>
<td>Ash</td>
<td>5.5%</td>
<td>Decrease (bran)</td>
</tr>
<tr>
<td>Flowability</td>
<td>Poor</td>
<td>Better (oil out)</td>
</tr>
<tr>
<td>Ethanol Yield (cook)</td>
<td>2.8 g/bu</td>
<td>Less (0.1-0.2)</td>
</tr>
<tr>
<td>Ethanol Yield (cold)</td>
<td>3.0 g/bu</td>
<td>Less (0.1-0.2)</td>
</tr>
</tbody>
</table>

*Source: Hawkeye Renewables, Iowa Falls, IA
US Biodiesel Production

Operating Plants
150 Plants in USA
2.4 bg y capacity
15 operating in Iowa
322.5 mgy production
Iowa Biodiesel Production

15 soy biodiesel plants
322 mgy total capacity

Production capacity for 64% of the maximum biodiesel that could be made from Iowa’s soybean oil production (June 2008 – May 2009)
### What Could Corn Oil Add?

<table>
<thead>
<tr>
<th></th>
<th>Grain Yield (bu/acre)</th>
<th>Oil Yield (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>46</td>
<td>501</td>
</tr>
<tr>
<td>Corn</td>
<td>171</td>
<td>342</td>
</tr>
</tbody>
</table>

#### 2008 Avg. Yields
- 10.9 lb oil/bu soybeans
- 2.0 lb oil/bu corn
# What Could Corn Oil Add?

<table>
<thead>
<tr>
<th></th>
<th>Max. Oil (MM lbs)</th>
<th>Biodiesel (MM gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>4845 (4870)</td>
<td>497 (499)</td>
</tr>
<tr>
<td>Corn</td>
<td>4377 (4583)</td>
<td>449 (587)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9222</strong></td>
<td><strong>946 (1086)</strong></td>
</tr>
</tbody>
</table>

**Plant capacity** 322 mgy, 34% (30%)

Assume 7.8 lb/gal oil and 80% biodiesel yield

USDA – NASS:
- 9.67 mil ac soybeans; 12.80 mil ac corn harvested in 2008
- 9.72 mil ac soybeans estimated, 13.40 mil ac corn estimated in 2009
Supporting the Industry

- On Dec 3, 2009, US-EPA stated that its testing so far showed no problems with 15% Ethanol Blends
- Decision in May but signs favorable.

- E15 means 50% more ethanol with blender credit (45 cents/gal = $1.20/bu).
- Agronomics and traits to support ethanol……..