Corn quality and agronomic issues relating to ethanol production

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Corn Quality

• Positive factors:
  – Increase or decrease ethanol yield or value but not negative in all uses.
  – Protein, oil, etc.

• Negative factors:
  – Decrease ethanol yield or value and negative in all uses.
  – Toxins, mold damage, etc.
Typical Ethanol Corn Specs

• Base US Grade #2 Yellow Corn
• Moisture limit: 17% (a few take 18%)
• Test Weight low limit: 54 lb/bu
• Damage limit: 10% max (discount from 5%)
• Broken Corn: 12% max

Source: Hardy et al 2006.
NIRS-Based Equation for Ethanol Yield

- Validation set pooled with initial data
  - 293 samples
  - SECV = 0.03 gal/bu
  - $R^2 = 0.74$
  - ISU protein, oil, and density calibrations

- Others have not been studied

<table>
<thead>
<tr>
<th>Component</th>
<th>Final Equation Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0</td>
<td>3.23</td>
</tr>
<tr>
<td>Protein</td>
<td>-0.062</td>
</tr>
<tr>
<td>Oil</td>
<td>-0.030</td>
</tr>
<tr>
<td>Density</td>
<td>0.104</td>
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</tbody>
</table>
Ethanol Yield Trends - Iowa

2005-2008

Ethanol Yield Increase

Protein decrease

* Indicates significant increase (p<0.05)

Ethanol yield mean over 4 years

* Indicates significant decrease (p<0.05)

Protein mean over 4 years
Planting Date – Elmore/Abendroth Study

- 3 northern Iowa locations
- Delayed Planting

- Protein
- Grain yield
- Starch
- Ethanol Yield
Planting Date - Grain Yield

- Converted to percent of maximum yield
- Normalized for location differences

Compiled percent maximum grain yield vs. planting date for 3 northern Iowa locations

\[ y = -0.0002x^2 + 17.382x - 3439.15 \]

\[ R^2 = 0.9241 \]
Planting Date – Ethanol Yield

Percent maximum ethanol yield vs. planting date for 3 Northern Iowa locations - 2008

\[ y = -7E-06x^2 + 0.5397x - 10676 \]
\[ R^2 = 0.6331 \]
### Planting Date

<table>
<thead>
<tr>
<th>Location</th>
<th>Planting Date</th>
<th>Grain Yield Loss (bu/acre)</th>
<th>Ethanol Yield Loss (gal/bu)</th>
<th>Ethanol Amount Loss (gal/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>6/1/2008</td>
<td>22.8</td>
<td>0.020</td>
<td>64.1</td>
</tr>
<tr>
<td>North West</td>
<td>5/28/2008</td>
<td>25.1</td>
<td>0.034</td>
<td>80.5</td>
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<tr>
<td>North East</td>
<td>6/11/2008</td>
<td>61.6</td>
<td>0.049</td>
<td>173.8</td>
</tr>
<tr>
<td>Average Loss</td>
<td>Latest</td>
<td>36.5</td>
<td>0.034</td>
<td>106.1</td>
</tr>
</tbody>
</table>

**Average loss at latest planting date 106.1 gal/acre**
- 6.3 gal/acre loss due to reduced ethanol yield per bushel
  - Average grain yield (186.3 bu/acre) * average ethanol yield loss (0.034 gal/bu)
- 99.7 gal/acre loss due to decreased grain yields

**Loss in corn quality not as important as grain yield loss**

Ethanol plants would experience loss in quality more directly
Economic Loss

- **$0.05 loss per bushel**
- **100 million gallon per year ethanol plant**
  - 2.8 gal/bu
  - 35,714,286 bushels/year
  - **$1.79 million** loss in ethanol production due to corn quality
  - Plus cost to acquire additional grain
  - **Note:** **$2.77 million** 12/2009

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<table>
<thead>
<tr>
<th>Planting Date</th>
<th>$/bu loss of ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td>4</td>
<td>0.02</td>
</tr>
<tr>
<td>5</td>
<td>0.05</td>
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</table>

Ethanol Price March 2009 = $1.42/gal

Iowa State University Extension model ‘Ethanol Profitability’, 2009
Hail damage, Sac County, 8-09-2009

Photos courtesy: Mark Licht, ISU Extension
Ear rot assessments – percent severity; rot present

- Cladosporium
- Gibberella
- Fusarium
- Penecillium
- Trichoderma
DON and ZEN present in hail samples

Vomitoxin (DON) and Zearalenone (ZEN), Hail Study Corn 2009

\[ y = 0.1745x + 0.0408 \]

\[ R^2 = 0.5437 \]
Test Weight did not predict DON well

$$y = -0.2636x + 15.701$$

$$R^2 = 0.1257$$
Low Test Weight is not low protein

Test Weight and Protein, Hail Study Corn 2009

\[ y = -0.0874x + 12.158 \]

\[ R^2 = 0.1375 \]
Agronomic Decisions affect Users

- Maturity choices – moisture, field mold
- Fungicide? – Stay green, reduce field mold???
- Hybrid matched to use (Feed or Ethanol?)
- Others?

- Supply chain agronomics
Summary

- Grain-based biofuel volume is still rising
- Grain revenues encourage productivity; higher input costs encourage efficiency
- Feed-food uses of corn are not falling
- New processing technologies will distribute grain components more efficiently and reduce process inputs.
- System/supply chain agronomics to optimize decisions to end use.