Purdue’s Efforts on Sustaining the Bioeconomy

Sonny Ramaswamy

Project Justification

- 15 Indiana ethanol plants in next 2-3 years
  - >1 billion gallons of ethanol
  - 4 million tons of distillers grains
- Challenges of DDGS:
  - Inclusion in animal rations not widely accepted
  - Nutritional quality not consistent or standardized
  - DDGS difficult to handle, transport, store
  - Oversupply could have several negative effects
**State Totals**

<table>
<thead>
<tr>
<th>State Totals</th>
<th>2006</th>
<th>2009</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Plants</td>
<td>2</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>Corn Production</td>
<td>844.7</td>
<td>963.8</td>
<td>1,071.4</td>
</tr>
<tr>
<td>Corn for Livestock</td>
<td>148.8</td>
<td>148.8</td>
<td>148.8</td>
</tr>
<tr>
<td>Corn for Processing</td>
<td>209.6</td>
<td>209.6</td>
<td>209.6</td>
</tr>
<tr>
<td>Ethanol</td>
<td>54.6</td>
<td>536.5</td>
<td>1,160.0</td>
</tr>
<tr>
<td>Total Indiana Usage</td>
<td>412.9</td>
<td>894.9</td>
<td>1,518.3</td>
</tr>
<tr>
<td>Available for Export</td>
<td>414.6</td>
<td>49.5</td>
<td>-468.7</td>
</tr>
</tbody>
</table>

**Purdue Agriculture Rapid Response Teams**

- Purdue Agriculture - $370,000
  - Agricultural Research Programs/Cooperative Extension Service
  - Animal Sciences
  - Agricultural & Biological Engineering
  - Agricultural Economics
  - Agronomy
- In partnership with Indiana stakeholders:
  - Indiana State Department of Agriculture $200,000
  - Indiana Ethanol Processors (The Andersons Clymers Ethanol Plant)
    - Source of DDGS for all proposed treatment studies
  - Other stakeholders
    - Indiana Soybean Alliance
    - Indiana Pork Producers Board
    - Indiana Corn Marketing Board
  - Indiana Department of Transportation $150,000
• DDGS
• CAFOs
• Transportation
• Sustainability

Processing, Handling and Utilization of DDGS
An Integrated Ethanol Co-Product Research and Extension
Effort at Purdue University
Phase I Projects with a 9-12 Month Time Horizon
Project Objectives

- Processing, Handling, Storage and Digestibility of DDGS
- Animal Performance and Product Quality
- Environmental Impact of DDGS Ration Inclusion

- Phase I: next 9-12 months
- Phase II: 9 months & beyond

Project Deliverables

- Quarterly Project Research Reporting Meetings
  - open to stakeholders
- Indiana DDGS Research and Education Summit
  - Spring 2008 for producer/industry groups
- Project website links to our publications & other resources
- Extension publications
  - fact sheets that tie in with the new Bioenergy Fact Sheet series
  - media releases to transfer knowledge to our stakeholders
- IP video training for Indiana county educators proposed
  - In late 2007
- Presentations at tri-state/Midwest commodity and animal nutrition meetings and other producer/industry conferences
  - late 2007 and early 2008
- Research manuscripts to peer reviewed journals
Project Management

- Dirk Maier (ABE)
- Klein Ileleji (ABE)
- Scott Radcliffe (ANSCI)
- Todd Applegate (ANSCI)
- Paul Preckel (AGEC)
- Brad Joern (AGRY)

- Monthly mtgs of project mgmt team
- Quarterly mtgs of all staff to report project updates
  - Open to stakeholders
  - First held in March 2007; next in July and Nov 2007
- Over 40 faculty, staff and students are contributing to this project

Objective 1: Processing, Handling, Storage and Digestibility of DDGS

- Effect of Particle Segregation in DDGS on Nutrient Uniformity, Sampling and Flowability
  - Ileleji, Stroshine, Clementson (ABE)
- Standard Methods for Moisture Content Determination
  - Ileleji, Stroshine, Garcia (ABE)
- Effect of Process Parameters on DDGS Quality
  - Ileleji, Clementson, Probat (ABE)
- Ensiling of Distillers Grains
  - Buckmaster (ABE), Lemenager, Lake, Claeyys, Gunn (ANSC)
- Storage of Dry Distillers Grains and Temporary Holding of Wet Distillers Grains
  - Stroshine, Maier (ABE), Woloshuk (BTNY)
- Pelletization of DDGS
  - Ileleji, Maier (ABE)
Objective 2: Animal Performance and Product Quality

- Swine Performance
  - Radcliffe, Richert (ANSC)
- Fat Quality Issues in Swine Fed DDGS
  - Latour, Richert, Schinckel (ANSC)
- Poultry Performance
  - Applegate, Adeola (ANSC)
- Ruminant Performance
  - Lake, Lemenager, Donkin, Johnson (ANSC)
- Valuation of DDGS as a Feed Ingredient
  - Preckel, Hubbs, Tyner (AGEC), Richert (ANSC)
Objective 3: Environmental Impact of DDGS Ration Inclusion

- Analysis of DDGS Feed Rations and Excreta/Manures
  - Joern (AGRY), Applegate, Lake, Radcliffe, Richert (ANSC)
- Whole Farm Management: Feeding DDGS to Grow-Finish Swine
  - Foster, Hollas, Preckel (AGEC), Joern (AGRY), Richert (ANSC)
Phase II Projects

- Economic evaluation of alternative potential uses of DDGS
  - Preckel, Foster (AGEC), Richert (ANSCI), Joern (AGRY), Ileleji (ABE)
- Evaluate the effects of pre-treatment on DDGS quality
  - Co-PIs: Mosier, Ladisch (ABE), Tyner (AGEC)
- Economic evaluation of design and operation options for ethanol plants and the implications for the value and use of DDGS
  - Co-PIs: Preckel, Tyner (AGEC) and others
- Evaluate the effects of drying on DDGS quality
  - Co-PIs: Maier (ABE), Richert, Applegate, Schinkel, Radcliffe (AGEC)
- Development of rapid tests for P and elemental analysis of DDGS
  - Co-PIs: Joern (AGRY) and others

Phase II Projects

- On-farm storage of wet distillers grains
  - Co-PIs: Lemenager, Claeys, Lake (ANSCI), Buckmaster (ABE)
- Integrated farm system model evaluation of distillers grains storage and feeding
  - Co-PIs: Buckmaster (ABE) and others
- Effect of inclusion of pelleted DDGS in feed rations
  - Applegate, Brian Richert (ANSCI), Maier (ABE)
- Evaluate the effects of drying on DDGS quality
  - Co-PIs: Maier (ABE), Richert, Applegate, Schinkel, Radcliffe (AGEC)
- Effect of antibiotic agents added during ethanol processing on animal rations with DDGS
  - Ebner, Applegate, Richert (ABE)
Phase II Projects

- Variability of DDGS on swine product quality and cost to producers
  - Schinkel, Richert, Latour, Adeola (ANSCI), Foster, Preckel (AGEC)
- Variability of DDGS on cattle/dairy reproduction and dairy products
  - Lake, Lemenager, Claesys, Donkin, Shutz, Johnson (ANSCI)
- Levels, forms and variation of nutrients in manure (swine, poultry and dairy and beef)
  - Adeola, Richert (ANSCI), Joern (AGRY)
- Nutrient availability of DDGS when land applied to cropland and determination of potential environmental risks
  - Camberato, Joern (AGRY)
- Utilization of distillers grains as a fuel
  - Ileleji (ABE), Tyner (AGEC), Latour (ANSCI)
- Handling, storage, utilization, marketing of low fat/fiber DDGS

INDOT/Purdue Ethanol Transportation Efforts

Frank Dooley
Wally Tyner
Justin Quear
Nadia Gkritza
Kumares Sinha
More grain to haul from farms

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th></th>
<th>2006</th>
<th>2007</th>
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</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>5700</td>
<td>5000</td>
<td>Corn</td>
<td>5500</td>
<td>6200</td>
</tr>
<tr>
<td>Acres (000)</td>
<td>50</td>
<td>51</td>
<td>Yield/A</td>
<td>157</td>
<td>159</td>
</tr>
<tr>
<td>Production (000 Bu)</td>
<td>285,000</td>
<td>255,000</td>
<td>Production (000 Bu)</td>
<td>863,500</td>
<td>985,800</td>
</tr>
<tr>
<td>Change in bushels (000)</td>
<td>-30,000</td>
<td></td>
<td>Change in bushels (000)</td>
<td></td>
<td>+121,500</td>
</tr>
</tbody>
</table>

Inbound transportation effects

- Shift will increase volume of grain from farms by 8% in 2007 or 92.3 million bushels
  - An equivalent of 26,000 rail cars
- By 2009, distance to market will also rise, increasing ton-miles
- Virtually all of this traffic is by truck on local and state highways
Movement of corn from elevator to market

<table>
<thead>
<tr>
<th>Destination for corn:</th>
<th>Transport via</th>
<th>2006</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Million bushels</td>
<td></td>
</tr>
<tr>
<td>For Feed in Indiana</td>
<td>Mainly move by truck on Indiana highways</td>
<td>149</td>
<td>149</td>
</tr>
<tr>
<td>For Processing in Indiana</td>
<td>No change</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>For Ethanol in Indiana</td>
<td>Increase in truck</td>
<td>55</td>
<td>537</td>
</tr>
<tr>
<td>Shipped from Indiana</td>
<td>Rail loses 300 M bu, Water loses 44 M bu</td>
<td>414</td>
<td>49</td>
</tr>
</tbody>
</table>

Offsets to lost corn shipments -ethanol

1. Roughly 300 million gallons of ethanol is consumed in state
2. Remainder of ethanol is shipped by rail or truck, primarily to eastern or southern markets
   • Annual rail carloads doubled from 40,000 to 82,000
3. Usage of pipeline is not likely in the near term, insufficient volumes and concerns with water absorption
Offsets to lost corn shipments - DDGS

1. Each bushel of corn yields 17.4 lbs of DDGS
   - 917 tons per day for a 100 MGY plant
2. DDGS probably going west or southwest (to cattle)
   - Bans by western railroads because of flowability problems
3. 25% to 30% of DDGS by rail – 1680 miles
4. 70 to 75% by truck – 125 miles

Ongoing Work

- Finishing draft of phase 1, complicated by dynamic nature of the industry
- Adding ethanol plants to GIS rail and highway maps
- Have information about trucking costs, looking for data on rail and barge costs for ethanol and DDGS. Coordinating with project at NDSU
- Work on costing
Purdue Extension BioEnergy Series

- How Ethanol Is Made from Corn
- The Effect of Ethanol on Grain Transportation and Storage
- The Value of Distillers Grains as a Livestock Feed
- Use of Dry Distillers Grains with Solubles by Poultry
- Value of Distillers Grain Ethanol Co-Products to Dairy Replacements
- Feed Ingredient Co-Products of Ethanol Fermentation from Corn
- Value of Distillers Grains to Lactating Dairy Cows
- Cellulosic Ethanol Biofuel Beyond Corn
- Meeting the Ethanol Demand: Consequences and Compromises Associated with More Corn on Corn in Indiana
- What Is Biodiesel?
- Biodiesel Quality: Is All Biodiesel Created Equal?
- Economics of Ethanol
- Ethanol and Energy Policy
- Is Biodiesel as Attractive an Economic Alternative as Ethanol?
- U.S. Ethanol Policy: Possibilities for the Future

http://www.ces.purdue.edu/bioenergy/index.html