Dry Distiller’s Grains: Process, Use and Impacts
Do I Know Any More About This Than You?

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U.S. Fuel Ethanol Feedstocks

- Corn - 93%
- Corn/Milo - 2%
- Corn/Wheat Starch - 2%
- Milo/Wheat Starch - 1%
- Wheat - 1%
- Other - 1%

Source: IBB International Media 2006
Ethanol Plant
Consumption/Production

(2.8 gal ethanol and 17 lbs DDGS per bu)

- 114 plants in operation = 5.6 billion gal.
  - 2.0 billion bushels of corn (about 20% of our corn)
  - 34 billion pounds of DDGS

- 85 plants under construction = 6.2 billion gal.
  - 2.2 billion bushels of corn
  - 37.4 billion lbs of DDGS

- Combined 11.8 billion gal.
  - 4.2 billion bushels of corn (35-40% of our corn)
  - 71.4 billion lbs of DDGS
Ethanol Production Technologies

- Dry-grind, Most Facilities
- Wet-milling
- New Emerging Technologies
  - Quick Germ
  - Quick Germ, Quick Fiber
  - Enzymatic Milling
  - Corn fiber to ethanol
Processing Methods or Technologies

- Conventional dry grind
- Modified dry grind
  - Recovers germ and pericarp fiber with a horizontal drum degeminator
- Quick germ quick fiber
  - Recovers germ and pericarp fiber by soaking corn in water for 6 to 12 hours with alpha-amylase
- Enzymatic Dry Grind (E-Mill)
  - Uses enzymes to recover additional endosperm fiber
Corn Dry-Grind Process

- Corn grain
- Size reduction (hammer-mill)
- Liquefaction & Saccharification (alpha-amylase and glucoamylase enzymes)
- Fermentation (Yeast- Saccharomyces cerevisiae)
- Heat (Gas or Coal)
- Evaporator
- Centrifuge
- Dryer
- Distillation & Dehydration
- Ethanol
- CO₂ to Dry Ice
- Distillers Dried Grains with Solubles - DDGS
- whole stillage
- thin stillage
- TS syrup
- wet cake
New Fractionation Processes Will Change DDGS Nutritional Value

- **Degerming**
  - Press the oil to human or Bio-diesel
  - Reduces oil and may reduce P
- **Dehulling**
  - Reduces fiber
- **Separation post-fermentation**
  - Fiber and/or oil removed
- **Syrup levels used and fractioning or recycling**
Co-Products from Modified Dry Grind and Quick Germ Quick Fiber Processes

One bushel Corn

- Dry Degerm Process
- Defiber Process

Corn Dry Grind Facility

- 2.8 gal Ethanol
- 7.0 lb Residual DDGS

+ 4 lb Germ
+ 4 lb Pericarp Fiber

V. Singh, UIUC
## Comparison of Conventional DDGS and Fractionated Products

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Fractionated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>2.8 gal</td>
<td>2.8 gal</td>
</tr>
<tr>
<td>DDGS</td>
<td>17 lb</td>
<td>7 lb</td>
</tr>
<tr>
<td>Germ</td>
<td>---</td>
<td>4 lb</td>
</tr>
<tr>
<td>Fiber/ hull</td>
<td>---</td>
<td>4 lb</td>
</tr>
<tr>
<td>Corn Oil</td>
<td>---</td>
<td>2 lb</td>
</tr>
</tbody>
</table>
Potential Uses for DDGS

- Land Fills
- Crop fertilizer - pelletized
- Further refinement
  - Pyrolysis
  - Gasification
  - Component fractionation
  - Industrial
- Co-fire in power plants
- Livestock Feed
  - Domestic
  - International
DDGS Feed Quality Issues

- Feed nutritionists have concerns about using DDGS for feed formulations due to its inconsistency in nutrient composition and overall quality.

- Studies have shown variability of product within batches in a plant and also from plant to plant.
How is DDGS Quality Defined?

- Color?
- Nutrient availability to livestock?
- End-use, different measures?
- Who should do this, the industry?
- ?????????
Visual Variability of DDGS

## Nutritional Variability of DDGS

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Mean</th>
<th>Range</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>89.3</td>
<td>87.3 - 92.4</td>
<td>-</td>
</tr>
<tr>
<td>Crude Protein, %</td>
<td>30.9</td>
<td>28.7 - 32.9</td>
<td>4.7</td>
</tr>
<tr>
<td>Crude Fat, %</td>
<td>10.7</td>
<td>8.8 - 12.4</td>
<td>16.4</td>
</tr>
<tr>
<td>Crude Fiber, %</td>
<td>7.2</td>
<td>5.4 - 10.4</td>
<td>18.0</td>
</tr>
<tr>
<td>Ash, %</td>
<td>6.0</td>
<td>3.0 - 9.8</td>
<td>26.6</td>
</tr>
<tr>
<td>Swine ME, kcal/kg</td>
<td>3810</td>
<td>3504 - 4048</td>
<td>3.5</td>
</tr>
<tr>
<td>Lysine, %</td>
<td>0.90</td>
<td>0.61 - 1.06</td>
<td>11.4</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.75</td>
<td>0.42 - 0.99</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Data reported for samples from 32 DDGS sources (100% DM basis)

## Potential US Livestock Use of DDGS

<table>
<thead>
<tr>
<th>Category</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finishing Cattle</td>
<td>18.25 billion lbs</td>
</tr>
<tr>
<td>Beef Cows</td>
<td>20.34 billion lbs</td>
</tr>
<tr>
<td>Dairy Cows</td>
<td>16.75 billion lbs</td>
</tr>
<tr>
<td>Heifers and calves</td>
<td>18.20 billion lbs</td>
</tr>
<tr>
<td>Cattle Total</td>
<td>73.54 billion lbs</td>
</tr>
<tr>
<td>Swine</td>
<td>17.58 billion lbs</td>
</tr>
<tr>
<td>Broilers &amp; Turkeys</td>
<td>6.02 billion lbs</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>97.14 billion lbs</strong></td>
</tr>
</tbody>
</table>

100% of the livestock category using DDGS at current recommended levels
Indiana Proposed Ethanol Plants

- Dry grind – possible fractionation
- Estimated 1.4-1.9M tons DDGS
- Typical inclusion rates
  - Beef & Dairy 20%
  - Swine 10%
  - Poultry 5%
- Maximum IN utilization:
  - 1.33M tons (70-90%)
- Realistic Utilization in Indiana
  - 0.60 M tons (30-50%)
Handling, Storage & Transportation

- **Wet system**: frequent delivery of wet DGs
  - Flat storage
  - Cost of transporting water
  - 3-7 day shelf-life
  - Ensiling (corn stover, silage, soyhulls, straw)

- **DDGS**
  - Bridging in bins and rail cars
  - Separation
  - Particle size ≤ 400 microns
  - Pellets (limited to 5-7% inclusion rate)
Animal Performance, DDGS Quality & Nutrient Management

- Historical use has been WDG by beef feedlots (proj. 25-30% of by-product)
- Excess N, P and S
  - Amino acid imbalance
  - Environmental implications
- Limited data across species
  - ADG, G/F, reproductive impacts, longevity
  - Fiber digestibility, milk quality,
  - Carcass composition, marbling, FA profile
Potential DDGS Use in Beef

- Beef industry prefers dry product.
- Research is clear concerning the utilization of DDGS in feedlot diets.
  - Max. of 40% DM intake, 15-20% may increase performance.
  - > than 25% may decrease marbling.
- Excess N, P and S.
  - Atmospheric emissions.
  - Increased land base for P.
  - Must add Ca to diet.
### DDGS Inclusion Rate Impacts on 1000 Head of Feedlot Steers

<table>
<thead>
<tr>
<th>% DDGS</th>
<th>0</th>
<th>15</th>
<th>25</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Crude Protein</td>
<td>12.6</td>
<td>12.6</td>
<td>14.6</td>
<td>17.8</td>
</tr>
<tr>
<td>% P</td>
<td>0.35</td>
<td>0.42</td>
<td>0.47</td>
<td>0.55</td>
</tr>
<tr>
<td>N excret/an</td>
<td>60</td>
<td>60</td>
<td>72</td>
<td>89</td>
</tr>
<tr>
<td>P excret/an</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Acres needed for P</td>
<td>769</td>
<td>923</td>
<td>1077</td>
<td>1308</td>
</tr>
</tbody>
</table>
Dairy Cattle Feeding Guidelines

- Young Calves: up to 50% of the grain mix
- Older calves: could be greater than 50%
- Max. of 20% DMI in Lactation Rations
- Check particle size of final ration to ensure adequate effective fiber
- Balance for RUP and RDP
- Determine Fat, P, and mycotoxin levels of purchased distillers products
Potential Issues for Ruminates

- Storage
- Transportation
- Upper limits for cow and creep diets
- Reproductive efficiencies
- Variability of product
- P and S content
- N and P Excretion
- Fat level
- Effective fiber
- Long term issues
Ensiling/Storage of DDGS

- Many small producers
  - Can’t utilize semi-load lots of product
  - Need a longer term storage method
- 100% wet product
  - Will bust ag bag seams
    - Need a “diluter” for density and N (CP)
- Potential “diluters”
  - Corn silage, corn stalks, straw, soyhulls, hay
Swine and Poultry Nutrient Excretion Issues with DDGS

- N excretion increases 15-200+%  
  - Ammonia emissions?
- P may be managed by decreased MCP/DCP
- Increased DM Excretion/Increased solids? Increased Sludge?
- Crust formation? Flies? Ammonia?
Feeding DDGS to Poultry

Dry Product Only

- **Broilers:** 5-7.5% typical, 10% max.
- **Layers:** 10% could be used, 15% in non-peak production
- **Turkeys:** 5-15% inclusion rates
- Sodium content a big concern
Swine Feeding Issues

- Reproductive performance (sows and boars)?
  - Any effects on sow longevity?
  - Effects on fatty acid composition of milk?
  - Feeding level during high energy demands of lactation and Paylean feeding?
Recent Research With Pigs

- Hastad et al., 2005 (grower pigs)
  - Palatability Study
  - 30% DDGS vs Corn-soy
  - Corn and sorghum DDGS resulted in decreased feed consumption
  - Drying process did not impact the reduced feed intake of DDGS
Recent Research

- Decreased carcass yield may decrease DDGS value in swine
  - For each 10% inclusion in the diet carcass yield went down 0.6%
  - That is 1.6 lb of lost carcass wt. at 10% inclusion
  - $1.05/pig lost income at 10% inclusion
  - At 10% inclusion 1 ton of DDGS could be fed to 33 pigs for all of grow-finish = $34.65/ton lower value of DDGS to swine
Swine Feeding Issues

- **Ingredient shifts**
  - Oil in DDGS displaces animal fat
  - Less need for inorganic P and/or less phytate P available for phytase activity?

- Fiber content and energy availability from fiber
DDGS and Pork Quality

- Processing/Handling issues
  - Fat firmness
  - Shelf life
  - Export marketing: decrease in marbling score
  - Increased problems with processed products

- Potential health issues
  - Fatty acid composition
DDGS Impact on Bacon Quality

0% DDGS

20% DDGS

10% DDGS

30% DDGS
DDGS Impact on Brat Quality

100% Corn for last 14 days

100% DDGS for last 14 days
Use of DDGS in Swine Diets  
(Dry Product Only)

- Brian Richert's Recommendations

<table>
<thead>
<tr>
<th></th>
<th>0% DDGS</th>
<th>5% DDGS</th>
<th>10% DDGS</th>
<th>20% DDGS</th>
<th>40% DDGS</th>
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</thead>
<tbody>
<tr>
<td>Gestation</td>
<td></td>
<td></td>
<td></td>
<td>XX</td>
<td></td>
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<tr>
<td>Lactation</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursery</td>
<td></td>
<td>XX</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Grower</td>
<td></td>
<td></td>
<td></td>
<td>XX</td>
<td></td>
</tr>
<tr>
<td>Finishing</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
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</tbody>
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Overall Issues with DDGS

- Product Variation
- Handling, Storage, Transportation
- Effect on Animal Performance
- Effect on Product Quality
- Effect on Nutrient Management
- Antibiotic contamination
- Producer Education
- Food vs. Fuel National Policy
Proper Production/Utilization

- Increase value of co-products
  - Mitigate negative environmental effects
  - Separate phosphorus, fat, protein, fiber
- Potentially make livestock industry
  - More competitive
  - More attractive
College of Agriculture - DDGS Rapid Response Team

- COA Agricultural Research Programs ($100k)
- COA Cooperative Extension Service ($100k)
- Animal Sciences ($50k)
- Agricultural & Biological Engineering ($50k)
- Agricultural Economics ($50k)
- Agronomy ($50k)

- In partnership with Indiana stakeholders:
  - Indiana State Department of Agriculture ($200k)
  - Indiana Soybean Association ($200k)
Project Objectives

1. Processing, Handling, Storage and Digestibility of DDGS
2. Animal Performance and Product Quality
3. Environmental Impact of DDGS Ration Inclusion

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

- Infrastructure does not exist in Indiana
  - Handling, storing, distribution
- Cost of livestock production could increase
  - By-products shipped out of state
  - Rising corn price
  - Diverting soybean acres to corn
- Opportunities for alternative processing or fractionation
Questions?