Specialty Animal Feed Products: A New Market for the Biofuels Industry

Steve Hartig, VP Technology Development
ICM COMPANY PROFILE

Founded in 1995 with an industry history dating back to 1970’s

Privately-held company headquartered in Colwich, Kansas

Focus on innovation integration & optimization, a technology clearing house

350 employees...
108 ethanol plants designed & built globally

2/3 of the market in North America

30% of the worldwide fuel ethanol production
ETHANOL IN A CHANGING ENVIRONMENT

US Fuel Ethanol Production

Industry Key Success Factors

• Operational excellence

• Continual improvements in efficiency and carbon index

• Developing new, more specialty markets and products

Data from US EIA
DISTILLERS GRAINS (DDGS)

- A 50 mln gpy ethanol plant produces over 120,000 tons of DDGS

- DDGS is a mixed ration that has:
  - Too much protein for cattle
  - Too much fiber for poultry and swine

- This wastes over 4 mln tons of protein a year which destroys value and hurts sustainability

US DDGS Consumption

- Beef
- Dairy
- Swine
- Poultry
- Fish

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FIRST OPTION--FRONT END FIBER SEPARATION

FST NEXT GEN™

Simplified counter-flow washing
  • Solids (fiber) with low residual starch bypasses downstream process
  • Liquids (mash) with low fiber forms a free-flowing stream for fermentation

Main benefits:
  • Up to 10% increased throughput
  • Oil recovery enhancement up to 25%
  • Production of FST Next Gen™ Feed Products: High Protein Distillers grain, fiber plus syrup

Seven units in commercial operation
FST™ FEED PRODUCTS

DDGS  FST™ High Pro  FST™ Fiber + Syrup
**VALUE CREATION – FST™ FEED PRODUCTS**

<table>
<thead>
<tr>
<th>5 lbs FST™ High Pro</th>
<th>10 lbs FST™ Fiber + Syrup</th>
<th>$1.14 / bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.375 ¢/lb</td>
<td>6.25 ¢/lb</td>
<td></td>
</tr>
</tbody>
</table>

**- BASED ON -**

- $3.50 BUSHEL CORN
- $100 TON DDGS
- HI PRO - (158% OF DDGS)
- DDGS - (100% OF CORN)

**15 LBS DDGS**

| 6.25 ¢/LB |

**10-15% INCREASED VALUE**

**$1.02 / bushel**

**FEED PRODUCTS**
SECOND OPTION--CORN FIBER TO CELLULOSIC ETHANOL

ICM Fiber Separation Technology Next Gen™ is protected by US Patent Number 9376504. ICM Fiber to Cellulosic Ethanol Technology™ is Patent Pending. © 2017 ICM, Inc.

SECOND OPTION--CORN FIBER TO CELLULOSIC ETHANOL

GEN 1.5™ BENEFITS

- About 10% increase in ethanol volume and up to 20% increase in corn oil
- Cellulosic ethanol eligible for CI credits and D3 RINS which can be up to $2.00 per gallon
- Distillers grains increases in protein 28 → 38% bringing focus towards poultry and swine

ICM ELEMENT plant in Colwich, Kansas will be first adopter of this starting up in late 2018
HIGHER PROTEIN = HIGHER VALUE

- Adult leghorn males used to determine TME and AA digestibility
- 8% Gen 1.5 DDGS inclusion with TME and AA equivalence in total mixed ration
- No significant difference in growth performance vs. control

<table>
<thead>
<tr>
<th></th>
<th>Control Diet</th>
<th>Gen 1.0 DDGS</th>
<th>Gen 1.5 DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>57.37%</td>
<td>52.42%</td>
<td>54.74%</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>35.75%</td>
<td>31.94%</td>
<td>30.39%</td>
</tr>
<tr>
<td>Soy Oil</td>
<td>2.55%</td>
<td>3.30%</td>
<td>2.47%</td>
</tr>
<tr>
<td>Gen 1.0 DDGS</td>
<td>0.00%</td>
<td>8.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Gen 1.5 DDGS</td>
<td>0.00%</td>
<td>0.00%</td>
<td>8.00%</td>
</tr>
<tr>
<td>Corn+Soybean Ingredients price/ton</td>
<td>$200.69</td>
<td>$185.75</td>
<td>$179.02</td>
</tr>
<tr>
<td>Delta from Control Diet</td>
<td>$14.94</td>
<td>$21.67</td>
<td></td>
</tr>
<tr>
<td>Value of the DDGS ($/ton)</td>
<td>$186.65</td>
<td>$270.84</td>
<td></td>
</tr>
<tr>
<td>Relative Value of Gen 1.5 DDGS to Gen 1.0 DDGS</td>
<td></td>
<td></td>
<td>145%</td>
</tr>
</tbody>
</table>
OPTION THREE—BACK END STILLAGE SEPARATION

THIN STILLAGE SOLIDS SEPARATION SYSTEM™

• Maximize evaporator efficiency and dryer throughput while eliminating excess syrup
• Clean up backset
• Customized energy integration
• Increased corn oil availability and new feed products

First installation underway
• About one pound of thin stillage solids/bushel can be separated without impacting DDGS quality

• This is a 40% high protein distillers grain yeast product and can be separated and dried very cost effectively. Post processing can be added for increased value.

• Market focus is specialty animal feed applications such as aquaculture and young animals
## ULTRAMAX™– PROTEIN DIGESTIBILITY STUDY

<table>
<thead>
<tr>
<th></th>
<th>Ultramax™ % Comp</th>
<th>Rooster Digestibility Coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>2.02</td>
<td>92.4</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.83</td>
<td>92.9</td>
</tr>
<tr>
<td>TSAA</td>
<td>1.53</td>
<td>90.0</td>
</tr>
<tr>
<td>Threonine</td>
<td>1.57</td>
<td>92.2</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.37</td>
<td>94.0</td>
</tr>
<tr>
<td>Valine</td>
<td>2.30</td>
<td>92.6</td>
</tr>
<tr>
<td>Arginine</td>
<td>2.29</td>
<td>96.5</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>1.70</td>
<td>91.0</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>41.4</td>
<td>N/A</td>
</tr>
</tbody>
</table>

- Ultramax has an excellent amino acid balance and is highly digestible in tests with roosters. Further animal tests underway.
OPTION FOUR—ADDED FERMENTATION

- Ethanol plant streams such as syrup can be an excellent low cost feedstock for aerobic or anaerobic fermentation.

- A key technology development is around producing consistent quality syrup volumes coming from stillage.

- We have worked with a wide variety of organisms producing high protein feed products
BENEFITS OF ADDED FERMENTATION

• Aerobic fermentation is more expensive than anaerobic but has the ability to bring added nutritional functionality

• The technology fits well with an ethanol plant infrastructure and operations

• A 60 MGPY plant could add revenues of over $20 mln per year of high margin business and paybacks from the investment in 2-4 years

• Using our 7000 gallon fermenters at our pilot plant to demonstrate
• The key success factors in the ethanol industry are changing. Scale and operational excellence are becoming qualifiers rather than differentiators

• One opportunity for creating added value is focusing on more specialty animal feeds diversifying from distillers grains

• A focus on this will require investment in the plant and also in people to operate it and bring in the marketing focus

• These investments can bring significant value
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