COPRODUCTS: OVERVIEW AND OPPORTUNITIES FOR EUROPEAN DISTILLERS

Kurt A. Rosentrater, Ph.D.
Distillers Grains Technology Council
Iowa State University, Ames, IA USA
OVERVIEW

1. Why?
   – Motivations

2. What?
   – Processes & coproducts

3. How?
   – Economics & markets
   – Evolving processes & new opportunities
   – Other issues
   – Opportunities for Europe
MOTIVATIONS
MOTIVATIONS

- Ruminants or monogastrics
MOTIVATIONS

• Ruminants or monogastrics

O₂ → Feed → Animal → Water

→ Other gases
→ CO₂
→ Water vapor
→ Methane (CH₄)
→ Feces
→ Urine
MOTIVATIONS

• As ethanol industry goes, so goes the supply of coproducts
• Balance = key to sustainability
PROCESSES & COPRODUCTS
MANUFACTURING
Dry Grind Process

40 MG/Y = 150 ML/Y

120 MG/Y = 450 ML/Y
ETHANOL COPRODUCTS

Condensed Distillers Solubles

Distillers Dried Grains with Solubles

Distillers Wet Grains
FERMENTATION PRODUCTS

Theoretical Yields
1 kg glucose = 0.51 kg ethanol
+ 0.49 kg carbon dioxide

Practical Yields
90 – 95% of theoretical
+ yeast cell mass
+ secondary products

Anecdotally:
1 kg corn =
1/3 kg ethanol
+ 1/3 kg CO₂
+ 1/3 kg DDGS
COPRODUCT COMPOSITION

• DDGS
  – Dry matter: 86-92% wb
  – Protein: 25-34% db
  – Lysine: 2-4% db
  – Fat: 6-16% db
  – Fiber: 18-47% db
  – Ash: 3-10% db

Source: http://www.feedipedia.org/
COPRODUCT COMPOSITION

• DWG
  – Dry matter: 35% wb
  – Protein: 44% db
  – Lysine: 3% db
  – Fat: 5% db
  – Fiber: 29% db
  – Ash: 3% db

Source: http://www.feedipedia.org/
ECONOMICS & MARKETS
U.S. ETHANOL GROWTH

Nov. 1, 2016: 214 plants, 15,608 MG/y
RFS: 15,000 MG/y of corn ethanol by 2015

Ethanol Production
Coproduct Generation
Corn oil extraction

Fuel Ethanol (L) x 10^6
Coproducts (t) x 10^6

Year
Number of U.S. Plants
0 50 100 150 200 250

0 5 10 15 20 25 30 35 40 45

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## MARKETS

<table>
<thead>
<tr>
<th>Co-products and Products</th>
<th>Dec 2014</th>
<th>Jan 2014</th>
<th>Feb 2015</th>
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<tbody>
<tr>
<td><strong>Dry Mill</strong></td>
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<tr>
<td>Condensed distillers solubles (CDS-syrup)</td>
<td>172,082</td>
<td>162,626</td>
<td>128,057</td>
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<tr>
<td>Corn oil</td>
<td>97,380</td>
<td>105,356</td>
<td>96,347</td>
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<td>Distillers dried grains (DDG)</td>
<td>448,551</td>
<td>438,936</td>
<td>405,025</td>
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<td>Distillers dried grains with solubles (DDGS)</td>
<td>1,919,823</td>
<td>1,862,550</td>
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<td>Modified distillers wet grains (DWG) &lt;65% moisture</td>
<td>1,411,411</td>
<td>1,341,938</td>
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<td><strong>Wet Mill</strong></td>
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<td>Corn germ meal</td>
<td>75,031</td>
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<td>329,431</td>
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<td>94,777</td>
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<td>44,551</td>
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<td>41,020</td>
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<td>Wet corn gluten feed 40-60% moisture</td>
<td>338,077</td>
<td>313,400</td>
<td>274,763</td>
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<table>
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<tr>
<th>Co-products and Products</th>
<th>May 2015</th>
<th>April 2016</th>
<th>May 2016</th>
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<tr>
<td><strong>Dry Mill</strong></td>
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<tr>
<td>Condensed distillers solubles (CDS-syrup)</td>
<td>148,757</td>
<td>130,324</td>
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<td>Corn oil</td>
<td>117,049</td>
<td>111,077</td>
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<td>Distillers dried grains (DDG)</td>
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<td>374,750</td>
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<td>Distillers dried grains with solubles (DDGS)</td>
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<td>1,717,024</td>
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<td>Modified distillers wet grains (DWG) &lt;65% moisture</td>
<td>1,368,926</td>
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<td><strong>Wet Mill</strong></td>
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<tr>
<td>Corn germ meal</td>
<td>69,274</td>
<td>67,530</td>
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<td>Corn gluten feed</td>
<td>348,355</td>
<td>306,464</td>
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<td>Corn gluten meal</td>
<td>97,139</td>
<td>84,916</td>
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<td>Corn oil</td>
<td>53,208</td>
<td>51,455</td>
<td>50,262</td>
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<tr>
<td>Wet corn gluten feed 40-60% moisture</td>
<td>323,436</td>
<td>301,283</td>
<td>306,424</td>
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NASS/USDA MONTHLY CO-PRODUCTS PRODUCTION
Current Feedings Rates in the U.S.

- 1 tonne of DDGS can replace > 1.22 tonnes of corn/soybean meal (or more)

- Potential consumption rates are based on the price of DDGS not being a barrier to use
Current Feedings Rates in the U.S.

- **Beef Cattle:**
  - Maximum potential inclusion rate: 20-50%
    - 2007 recommendations: 22%

- **Dairy Cows:**
  - Maximum potential inclusion rate: 10-30%
    - 2007 recommendations: 8%

- **Swine:**
  - Maximum potential inclusion rate: 10-50%
    - 2007 recommendations: 10%

- **Poultry (Layers, Broilers, Turkeys):**
  - Maximum potential inclusion rate: 10-15%
    - 2007 recommendations: N/A
DDGS IN THE MARKETS

Based on data provided by Cheryl Anderson, DTN
DDGS IN THE MARKETS

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DDGS IN THE MARKETS

Based on Hoffman and Baker (2010) and U.S. Grains Council (2014)
DDGS IN THE MARKETS

Based on Hoffman and Baker (2010) and U.S. Grains Council (2014)
EVOLVING PROCESSES & NEW OPPORTUNITIES
FRACTIONATION

Biofuel Coproducts → Component Fractionation

Proteins → Oils

Fibers
FRACTIONATION
EVOLVING COPRODUCTS

Source: Dairy One, 2015
EVOLVING PROCESSES

- Oil extraction
  - New enzymes
  - New chemicals
  - New treatments
EVOLVING PROCESSES

• Oil extraction from CDS or stillage
  – 10-12% down to 5-8% fat (or less)
  – BUT: every 1% fat reduction = $3-$6 /ton livestock diet increase (impact on the livestock producer)
  – Jan. 2012: 47% of ethanol plants extracting oil
  – Aug. 2014: ~85%
  – Nov. 2016: ~94%

Now:

1 kg corn =
1/3 kg ethanol
+ 1/3 kg CO₂
+ 1/3 kg DDGS
+ 0.02 kg oil
EVOLVING PROCESSES

• Fiber & protein separation
  – From the DDGS or DDG
**DDGS FRACTIONATION**

a) Original DDGS; b) big DDGS; c) pan DDGS

<table>
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<tr>
<th>Property</th>
<th>Big</th>
<th>Original</th>
<th>Pan</th>
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<td>Protein</td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
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<tr>
<td></td>
<td>31.85 a</td>
<td>33.00 a</td>
<td>37.25 b</td>
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<tr>
<td>Lipid</td>
<td>8.65 a</td>
<td>7.95 b</td>
<td>7.00 c</td>
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<tr>
<td>Ash</td>
<td>4.70 a</td>
<td>4.70 a</td>
<td>5.00 b</td>
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<tr>
<td>Carbohydrate</td>
<td>54.80 a</td>
<td>54.35 a</td>
<td>50.75 b</td>
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<tr>
<td>ADF</td>
<td>11.60 a</td>
<td>12.40 b</td>
<td>11.45 a</td>
</tr>
<tr>
<td>NDF</td>
<td>34.55 a</td>
<td>37.80 b</td>
<td>29.15 c</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Mean</th>
<th>St Dev</th>
<th>Mean</th>
<th>St Dev</th>
<th>Mean</th>
<th>St Dev</th>
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<tbody>
<tr>
<td>Protein</td>
<td>31.85 a</td>
<td>1.06</td>
<td>33.00 a</td>
<td>0.99</td>
<td>37.25 b</td>
<td>0.21</td>
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<td>Lipid</td>
<td>8.65 a</td>
<td>0.07</td>
<td>7.95 b</td>
<td>0.07</td>
<td>7.00 c</td>
<td>0.01</td>
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<tr>
<td>Ash</td>
<td>4.70 a</td>
<td>0.01</td>
<td>4.70 a</td>
<td>0.01</td>
<td>5.00 b</td>
<td>0.01</td>
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<tr>
<td>Carbohydrate</td>
<td>54.80 a</td>
<td>1.13</td>
<td>54.35 a</td>
<td>0.92</td>
<td>50.75 b</td>
<td>0.21</td>
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<tr>
<td>ADF</td>
<td>11.60 a</td>
<td>0.71</td>
<td>12.40 b</td>
<td>0.57</td>
<td>11.45 a</td>
<td>0.07</td>
</tr>
<tr>
<td>NDF</td>
<td>34.55 a</td>
<td>0.49</td>
<td>37.80 b</td>
<td>0.14</td>
<td>29.15 c</td>
<td>0.21</td>
</tr>
</tbody>
</table>

[Image of sifter diagram with fractionation process]
DDGS FRACTIONATION

DDGS fiber

• Protein: 42% db
• Lipid: 1.7% db
• NDF: 52% db
• Ash: 4.0% db
Evolving Processes

- Fiber & protein separation
  - Upstream may be better
EVOLVING COPRODUCTS

• Using coproducts (wet or dry) to grow other organisms
  – Algae
  – Single-cell proteins
  – Fermentation of DDGS & soybean meal
  – Fungal cells for protein
AQUACULTURE

- Tremendous untapped opportunity – 200 MMT/year
- DDGS ~ 1/10 to 1/20 the price of fish meal

Nile Tilapia

Yellow Perch

Rainbow Trout

![Graph showing relative feed cost vs. fish meal replacement percentage for Tilapia, Perch, and Trout. The graph compares FM: 1000 $/tonne and FM: 2000 $/tonne with DDGS: 100 $/tonne.](image-url)
OTHER ISSUES
YEAST CELLS

How much protein addition?
Probiotic/prebiotic effects?

- Bauerfeind et al. (1944)
  - $4 \times 10^9$ cells/g dried syrup (CDS)
  - ~20% of syrup
- Ingeldew (1999)
  - DDGS by mass: 3.9%
  - 5.3% of the DDGS protein
- Belyea et al. (2004)
  - 50% of the DDGS protein
- Han and Liu (2010)
  - Up to 20% of the DDGS protein

- Giving away protein in the DDGS

Saccharomyces cerevisiae
U.S. DDGS Exports to China Halted

July 31, 2014

On Wednesday, July 23, the Chinese import inspection agency, the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), issued a notice requiring all shipments of U.S. distillers dried grains with solubles (DDGS) destined for China be accompanied by a test report with an official stamp certifying the shipment is free from the Syngenta Agrisure Viptera (MIR 162) biotech-enhanced trait. The notice took effect immediately and brings serious concern to the industry because not only does such documentation with an official stamp not exist, either does confidence in the testing results of MIR 162 in DDGS.

In 2013, exports of U.S. DDGS to China alone were estimated at $1.4 billion.

While MIR 162 has been approved in the U.S. since 2010 and has been approved for import into the European Union (and most other importing countries), regulatory approval in China is still pending. In the unofficial translation of the notice, AQSIQ references more than 963 lots of U.S. DDGS imports having tested positive for MIR 162 since December 2013. Evidence of U.S. DDGS imports being rejected by China started last December after China began testing for MIR 162.

Concerns about this new requirement also exist because it may affect the implementation of AQSIQ's Decree 118 for plant-based protein feed products, which includes DDGS. Decree 118 requires U.S. exporters of plant-based feed products to meet the following criteria to pass customs inspection into China:

- Exported product must originate from a registered U.S. facility;
- Registered facilities may be subject to audits by AQSIQ officials; and
- Exported product must be accompanied by a shipment-by-shipment certificate.

Facility audits were to begin in the very near future and the American Feed Industry Association has obtained U.S. government funding through the U.S. Department of Agriculture’s Foreign Agricultural Service's (FAS) Emerging Markets Program to assist with the auditing requirements set forth from AQSIQ. However, with the Chinese market currently shut down for U.S. DDGS, the fate of the pending audit requirement, and therefore the completion of the implementation of Decree 118 for plant-based feed products (including DDGS), is unknown.

Without implementation of Decree 118 for plant-based feed products, exports of U.S. DDGS to China will not be able to continue even if MIR 162 were to get approved in China or if China were to lift the new MIR 162 test report requirement for all shipments. AFIA continues to work with FAS and other industry groups to address these market access constraints for U.S. DDGS.
FDA Food Safety Modernization Act (FSMA)

The FDA Food Safety Modernization Act (FSMA), the most sweeping reform of our food safety laws in more than 70 years, was signed into law by President Obama on January 4, 2011. It aims to ensure the U.S. food supply is safe by shifting the focus from responding to contamination to preventing it.

Stay connected with FSMA E-mail Updates!

Spotlight

- Domestic and Foreign Facility Reinspection, Recall, and Importer Reinspection Fee Rates for Fiscal Year 2015
- FDA to Reopen Comment Period on Reportable Food Registry ANPR
- Operational Strategy for Implementing the FDA Food Safety Modernization Act (FSMA)
- Questions and Answers for Brewers/Distillers on the FSMA Proposed Rule for Preventive Controls for Animal Food
- Clarification on Using Wood Shelving in Artisanal Cheesemaking
- All Released Materials by Date

Progress in Implementing the Act

View information on how FDA is progressing in implementing the FSMA mandates.

- Progress Reports on Implementing the FSMA
- 2013 October - December Progress Report Now Available!
- Produce & Preventive Controls Alliances
- Reports & Studies
- Meetings & Outreach

Contact Us

FSMA@fda.hhs.gov
Food and Drug Administration
5100 Paint Branch Pkwy
Wiley Building, HFS-009
Altn: FSMA Outreach
College Park, MD 20740

For Farmers

- Toolkit for Farmers - resources on the proposed rule for produce safety (PDF - 282KB)
- Statement on Key Provisions of the Proposed Rules Affecting Farmers
INCLUSION RATES
FINAL THOUGHTS

• DDGS is critical to
  – Ethanol plant profitability
  – Livestock producers
  – Key to business sustainability

• Need to produce a feed ingredient that livestock producers desire
  – Producing quality DDGS (with low variability) is what livestock need
FINAL THOUGHTS
Opportunities for Europe

• GM-free
• Antibiotic-free
THANK YOU

Questions?

Comments?

Kurt Rosentrater
Distillers Grains Technology Council
Iowa State University
(515) 294-4019
karosent@iastate.edu