Pelleting:
Lessons Learned and Questions Unanswered,
promises ... promises ... promises

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North Dakota State University
Typical pellet press (mill) used in the feed Industry

Common features
- variable speed feeder
- conditioning chamber
- ring-die and roller assembly

Benefits of pelleting
- Physical
  - Densification
  - Packaged nutrients
  - Animal acceptance
- Nutritional
  - Improved nutrient digestion
    - Increased rates of gain
- Value
  - Feed savings
Fundamentals of pellet production

Die – Roller interaction

- Feed on the die face **must** be compressed and extruded through the die holes during successive rotations
  - Moisture > 17.5% in the feed will cause the roll to slip or slide
  - Some materials with high levels of protein and/or low bulk density can be difficult to pellet

- **Resists Compression**
- **Resists Extrusion**

  - Dried Distiller’s Gains with Solubles (DDGS)
  - Corn Gluten Meal (CGM)
  - Soybean Meal (SBM)
  - Beet Pulp
  - Soybean Hulls

Illustration, Leaver, 1970
In order to make pellets all forces must be balanced

- **Roll Force must be greater than Slip Resisting Force** or material will not compress
  - moisture, lipid (fat), fiber and protein have strong influence

- **Roll Force must be greater than Flow Resisting Force** or material will not extrude
  - particle size, fiber and protein have a major influence

Illustration, Leaver, 1970
Die hole dimensions

- Feed material is compressed into the die hole (D, d) and extruded through the effective length (L) of the die.

Factors that determine Pellet Quality

- Performance ratio (L/d)
  - Change the performance ratio to accommodate feed characteristics
- Retention time
  - Change the speed of the die
Performance ratio = \( \frac{L}{d} \)

For corn-sbm diets = 10 - 12
## DDGS (full fat) Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Bulk Density, kg/hl</th>
<th>Particle Size, microns</th>
<th>Protein, %</th>
<th>Fat, %</th>
<th>Fiber, %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knott, Shurson, Goihl</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg.</td>
<td>45.9</td>
<td>Avg. 1282</td>
<td>Avg. 26.6</td>
<td>Avg. 10.0</td>
<td>Avg. 6.9</td>
</tr>
<tr>
<td>Range</td>
<td>39.6 – 50.6</td>
<td>Range 612 – 2125</td>
<td>Range 24.5 – 28.4</td>
<td>Range 9.2 – 11.6</td>
<td>Range 5.8 – 9.1</td>
</tr>
<tr>
<td><strong>Koch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg.</td>
<td>48.4</td>
<td>Avg. 588</td>
<td>Avg. 27.6</td>
<td>Avg. 9.2</td>
<td>Avg. 10.0</td>
</tr>
<tr>
<td>Range</td>
<td>45.4 – 51.3</td>
<td>Range 387 – 810</td>
<td>Range 26.3 – 29.9</td>
<td>Range 8.1 – 10.2</td>
<td>Range 5.5 – 16.0</td>
</tr>
</tbody>
</table>
DDGS and Pellet Production

- Decreased pellet quality?
  - Depends on physical and nutrient characteristics of DDGS
    - Particle size, density
    - Fat, fiber, protein, moisture
  - Depends on ingredients
    - Some are complementary
  - Depends on pellet press operation
    - Die specifications
      - Performance ratio
    - Die speed
    - Conditioning time and temp
DDGS and Pellet Production

- Pellet trials
  - Pellet die specifications
    - .25 inch hole (6.4 mm)
    - 10:1 performance ratio
  - Pellet die peripheral speed
    - 1,200 ft/min. (365.8 m/min.)
  - Conditioning chamber
    - 150 rpm
    - Retention time = 30 sec.
  - Feed rate
    - Constant
      - Same setting all trials
## Pellet Production

Durum wheat midds + DDGS (Koch)

<table>
<thead>
<tr>
<th>Midds - DDGS</th>
<th>100%</th>
<th>80/20</th>
<th>70/30</th>
<th>60/40</th>
<th>50/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>mt/hr</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>23.8</td>
<td>26.0</td>
<td>23.9</td>
<td>27.3</td>
<td>27.5</td>
</tr>
<tr>
<td>PDI %</td>
<td>96.1</td>
<td>96.3</td>
<td>94.4</td>
<td>95.3</td>
<td>93.3</td>
</tr>
<tr>
<td>kg/hl</td>
<td>66.6</td>
<td>63.1</td>
<td>63.3</td>
<td>63.6</td>
<td>60.0</td>
</tr>
</tbody>
</table>
# Pellet Production

**Durum wheat midds + DDGS + Peas** *(Koch)*

<table>
<thead>
<tr>
<th>Midds – DDGS - Peas</th>
<th>100%</th>
<th>60/20/20</th>
<th>60/40</th>
<th>50/30/20</th>
<th>50/50</th>
</tr>
</thead>
<tbody>
<tr>
<td>mt/hr</td>
<td>.7</td>
<td>.9</td>
<td>.8</td>
<td>.9</td>
<td>.8</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>23.8</td>
<td>26.9</td>
<td>23.9</td>
<td>27.3</td>
<td>27.5</td>
</tr>
<tr>
<td>PDI %</td>
<td>96.1</td>
<td>96.6</td>
<td>94.4</td>
<td>95.3</td>
<td>93.3</td>
</tr>
<tr>
<td>kg/hl</td>
<td>66.6</td>
<td>67.6</td>
<td>63.3</td>
<td>63.6</td>
<td>60</td>
</tr>
</tbody>
</table>
## Pellet Production

**Barley malt sprouts and DDGS** (Koch)

### Sprouts - DDGS

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>90/10</th>
<th>80/20</th>
<th>70/30</th>
</tr>
</thead>
<tbody>
<tr>
<td>mt/hr</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>kwh/mt</td>
<td>46.1</td>
<td>41.4</td>
<td>33.4</td>
<td>24.6</td>
</tr>
<tr>
<td>PDI %</td>
<td>95.9</td>
<td>97.1</td>
<td>96.1</td>
<td>92.5</td>
</tr>
<tr>
<td>kg/hl</td>
<td>63.5</td>
<td>60.2</td>
<td>59.3</td>
<td>57.6</td>
</tr>
</tbody>
</table>
# Pellet Production

## DDGS and Beet Pulp (Koch)

<table>
<thead>
<tr>
<th>DDGS – Beet Pulp</th>
</tr>
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<tbody>
<tr>
<td>100%</td>
</tr>
<tr>
<td>mt/hr</td>
</tr>
<tr>
<td>kwh/mt</td>
</tr>
<tr>
<td>PDI %</td>
</tr>
<tr>
<td>kg/hl</td>
</tr>
</tbody>
</table>
## Pellet Production

### Typical swine grower diet (Koch)

$L/d = 10.0$ (6.4cm/6.4mm)

<table>
<thead>
<tr>
<th></th>
<th>Swine grower</th>
<th>substitute 10% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C°</strong></td>
<td>77</td>
<td>76</td>
</tr>
<tr>
<td><strong>mt/hr</strong></td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>kwh/mt</strong></td>
<td>10.2</td>
<td>9.5</td>
</tr>
<tr>
<td><strong>PDI %</strong></td>
<td>84.7</td>
<td>70</td>
</tr>
</tbody>
</table>

Substituting 10% DDGS

- 7.4% decrease in kWh/mt
- save $.02/mt
- 17.4% decrease in PDI

most likely will cause increased re-work (fines) and poorer feed efficiency
Pellet Production

Typical swine grower diet (Koch)

\[ \text{L/d} = 10.7 \ (5.1\text{cm}/4.8\text{mm}) \]

<table>
<thead>
<tr>
<th></th>
<th>Swine grower</th>
<th>substitute 10% DDGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C(^\circ)</strong></td>
<td>84</td>
<td>82</td>
</tr>
<tr>
<td><strong>mt/hr</strong></td>
<td>3.2</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>kwh/mt</strong></td>
<td>8.52</td>
<td>9.5</td>
</tr>
<tr>
<td><strong>PDI %</strong></td>
<td>91.2</td>
<td>90.8</td>
</tr>
</tbody>
</table>

Changing die specification
11.4% increase in kWh/mt
added $.03/mt
essentially the same PDI%
do not expect any differences in re-work, or animal performance
DDGS and Pellet Production

Decreased pellet quality?

- Depends on physical and nutrient characteristics of DDGS
  - Particle size, <400-2100 microns
  - Density, 40-51 kg/hl
  - Fat, <3-11%; fiber, <5.5-16%
  - Protein, 25->30%

- Depends on pellet mill operation
  - Die specifications
    - Performance ratio
  - Die speed
  - Conditioning
1. What is current size reduction

2. What is current density
   a.) fiber removal
   b.) fat removal

3. What is current fat (lipid) content
   a.) low, medium, high

4. What is current protein content

Knowing the answers to these questions will aid operators in their choice of pelleting parameters. Each situation will be unique.
There is no “pre-packaged” expert with answers to the questions – each situation is unique and requires an individual approach.
Thank You

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