Latest Field Research on Feed Efficiency

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Kansas State University

John Patience

Iowa State University
Outline

• Project 1: Evaluating DDGS with varying oil content.
• Projects 2 & 3: Effects of particle size and diet form on nursery and finishing pig performance.
• Project 4: The influence of stocking density and removal strategy on feed efficiency of pigs to heavy market weights.
• Update on sow gestation weight gain and feed efficiency.
## DDGS Fat % in one Midwest USA Production System

<table>
<thead>
<tr>
<th>Year</th>
<th>Moisture, %</th>
<th>Protein, %</th>
<th>Fat, %</th>
<th>NE, % of Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>9.1</td>
<td>26.9</td>
<td>10.8</td>
<td>103%</td>
</tr>
<tr>
<td>2009</td>
<td>10.1</td>
<td>26.5</td>
<td>10.6</td>
<td>102%</td>
</tr>
<tr>
<td>2010</td>
<td>9.5</td>
<td>26.7</td>
<td>10.7</td>
<td>102%</td>
</tr>
<tr>
<td>2011</td>
<td>9.5</td>
<td>27.0</td>
<td>10.9</td>
<td>103%</td>
</tr>
<tr>
<td>2012</td>
<td>9.9</td>
<td>27.4</td>
<td>10.0</td>
<td>99%</td>
</tr>
<tr>
<td>2013</td>
<td>9.4</td>
<td>29.1</td>
<td>9.0</td>
<td>95%</td>
</tr>
<tr>
<td>2014</td>
<td>9.8</td>
<td>27.5</td>
<td>8.2</td>
<td>91%</td>
</tr>
</tbody>
</table>

Based on data from 1,706 samples obtained from 23 ethanol plants.
Effects of DDGS Source and Level on Average Daily Gain (d 0 to 82)

No significant differences, $P > 0.10$

Graham et al., 2013
Effects of DDGS Source and Level on Feed Efficiency (d 0 to 82)

Source × Level, $P = 0.001$
SEM = 0.004

Graham et al., 2013
NE values, kcal/kg (as-fed)

<table>
<thead>
<tr>
<th>DDGS oil, %</th>
<th>NE values (kcal/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4</td>
<td>2133</td>
</tr>
<tr>
<td>7.6</td>
<td>2320</td>
</tr>
<tr>
<td>9.4</td>
<td>2732</td>
</tr>
<tr>
<td>9.6</td>
<td>2497</td>
</tr>
<tr>
<td>12.1</td>
<td>2887</td>
</tr>
</tbody>
</table>

Corn: 2672 kcal/kg
Predicted Digestible and Net Energy of DDGS

\[ y = 115.01x + 1501 \]
\[ R^2 = 0.86 \]

\[ y = 62.347x + 3058.1 \]
\[ R^2 = 0.41 \]

Net Energy
Digestible Energy

Nitikanchana et al., 2013
Animal Sciences and Industry

Calculators

Feed Efficiency Evaluation Tool (v3 - November, 2015)

Floor Space Impact on Pig Performance (v7 - November, 2015)

Tryptophan:lysine economic model for nursery and finishing pigs (February, 2016)

Iodine Value Prediction Spreadsheet

KSU Fat Analysis calculator

DDGS Calculator (November, 2013)

AA Pricing Spreadsheet

Meat and Bone Meal Calculator

KSU Feed Budget Calculator

KSU Phytase Calculator

DDGS Calculator
Effects of particle size on F/G of finishing pigs

1.2% per 100 microns

- Cabrera, 1994a
- Cabrera, 1994b
- Wondra, 1995

1.0% per 100 microns

- Paulk, 2011
- DeJong, 2012
- Nemecheck, 2013
- De Jong, 2014
- Gebhardt, 2015

Particle size, microns

- 800 600 400
- 750 650 550 450 350 250
Effect of particle size and diet form for nursery pigs

• Two diet types (meal vs pellet)
• Three processing treatments
  – Corn ground to 737 microns (650 micron diet)
  – Corn ground to 324 microns (425 micron diet)
  – Complete diet ground to 541 microns
• 996 pigs
• 6 pens per treatment
Effect of particle size and diet form on nursery pig performance (d 0 to 21; BW 24.5 to 45 lb)

- Diet form × corn μ P < 0.07
- Diet form P < 0.002
- SEM = 0.02

<table>
<thead>
<tr>
<th>Particle size and portion ground</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>737 micron corn</td>
<td>0.95 0.96</td>
</tr>
<tr>
<td>324 micron corn</td>
<td>0.89 1.00</td>
</tr>
<tr>
<td>541 micron diet</td>
<td>0.93 1.00</td>
</tr>
</tbody>
</table>

De Jong et al., 2013
Effect of particle size and diet form on nursery pig performance (d 0 to 21; BW 24.5 to 45 lb)

Particle size and portion ground

Diet form × corn μ P < 0.38
Diet form P < 0.01
SEM = 0.01

De Jong et al., 2013
Corn particle size affects feed intake preference of nursery pigs fed meal diets

De Jong et al., 2014
Effect of particle size and diet form on finishing pig performance (d 0 to 101; BW 76 to 275 lb)

- Grind x form P > 0.58
- Particle size P < 0.01 linear
- Diet form P < 0.001
- SEM = 0.021

ADG, lb

<table>
<thead>
<tr>
<th>Corn particle size</th>
<th>650 microns</th>
<th>50:50 blend</th>
<th>350 microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal</td>
<td>1.97</td>
<td>1.96</td>
<td>1.91</td>
</tr>
<tr>
<td>Pellet</td>
<td>2.07</td>
<td>2.05</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Nemechek et al., 2016
Effect of particle size and diet form on finishing pig performance (d 0 to 101; BW 76 to 275 lb)

Grind x form P < 0.005 linear
Particle size P > 0.34
Diet form P < 0.001
SEM = 0.02

- 650 microns: F/G = 2.69 (Meal), 2.51 (Pellet)
- 50:50 blend: F/G = 2.67 (Meal), 2.55 (Pellet)
- 350 microns: F/G = 2.62 (Meal), 2.56 (Pellet)

Corn particle size

Nemechek et al., 2016
Conclusions-Reducing Particle Size

• Nursery Pigs
  – Benefits in F/G observed as particle size is decreased until 500-600 µm, then little benefit

• Finishing Pigs
  – Meal diets result in 1% improvement in F/G for every 100 µm reduction through 300 µm

• Feed intake and gain are reduced when corn is ground to 300 microns in meal diets for nursery or finisher pigs

• Bottom line – we recommend grinding grain to 550-600 microns for meal diets.
Pulse Pelleting

• A total of 2,100 pigs (PIC 327 × 1050, initially 63 lb were used in an 118-d study.

• Pigs were randomly allotted to pens upon entry into the finisher, and then were allotted randomly to 1 of 6 dietary treatments based on average pen weight.

• There were 25 pigs per pen and 14 pens per treatment (7 gilt and 7 barrow pens).
Effects of pelleting regime on F/G

De Jong et al., 2014
Effects of pelleting regime on pig removals per pen

**Removals/pen**

- **Meal**: 0.50
- **Pellet**: 1.92
- **Meal/Pellet**: 1.06
- **Pellet/Meal**: 0.93
- **Rotated**: 0.85
- **Rotated**: 0.92

*De Jong et al., 2014*

\(ab P < 0.05\)

SEM = 0.265
Gastric ulcers

- Ulcers result when the squamous epithelium of the esophageal region of the stomach is repeatedly exposed to acidic stomach contents.
- Pelleted or finely ground feeds causes increases in the fluidity of the stomach contents.
- When exposed over time to stomach acid, the squamous epithelium begins to first keratinize and subsequently ulcerate.

Friendship et al., (2014)
Gastric ulcers (no keratinization or ulceration)
Gastric ulcers (100% keratinization)

Esophageal opening
Gastric ulcers (100% Ulceration)

Esophageal opening
Effects of pelleting regime on stomach morphology (combined ulceration & keratinization)

De Jong et al., 2014

$P < 0.08$
SEM = 0.613
Effects of pelleting regimen on IOFC

<table>
<thead>
<tr>
<th>Regimen</th>
<th>IOFC ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal</td>
<td>78.48</td>
</tr>
<tr>
<td>Pellet</td>
<td>72.29</td>
</tr>
<tr>
<td>Meal/Pellet</td>
<td>76.50</td>
</tr>
<tr>
<td>Pellet/Meal</td>
<td>77.67</td>
</tr>
<tr>
<td>Rotated</td>
<td>79.25</td>
</tr>
<tr>
<td>Rotated</td>
<td>80.57</td>
</tr>
</tbody>
</table>

$P < 0.08$

SEM = 0.613
Background information

- It's been clearly shown that stocking density influences finishing pig growth.
- Gonyou et al. (2006) developed prediction equations to estimate the reduction in ADG and ADFI with increased stocking density.
- With increases in market weights, stocking density may impact growth performance more than previously realized.
Gonyou et al. (2006)

- \( k = \frac{\text{floor space (m}^2\text{)}/\text{BW}^{0.67}}{} \)

If \( k < 0.0336 \), then
\[
y = 817 \times k + 72.55; \text{ else, } y = 100
\]
Materials and Methods

• After weighing, pens were randomly assigned to one of 4 treatments:

  1. 15 pigs per pen (9.7 ft$^2$), market all pigs at end
  2. 21 pigs per pen (6.9 ft$^2$), remove 2 pigs /pen as pen wt approaches critical k-value (Gonyou et al., 2006)
  3. 21 pigs per pen (6.9 ft$^2$), remove 2 pigs at 240 lb, and 4 pigs at 280 lb.
  4. 21 pigs per pen (6.9 ft$^2$), remove 6 pigs at 280 lb.
## ADG, d 0 to 117

**Initial stocking density,** $P < 0.02$

**SEM** = 0.02

**Means with different superscripts,** $P < 0.05$

<table>
<thead>
<tr>
<th>Floor space, ft²</th>
<th>Marketing strategy</th>
<th>ADG, lb</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.7</td>
<td>---</td>
<td>2.04</td>
<td>a</td>
</tr>
<tr>
<td>6.9</td>
<td>2:2:2</td>
<td>1.99</td>
<td>a,b</td>
</tr>
<tr>
<td>6.9</td>
<td>2:4</td>
<td>1.95</td>
<td>b,c</td>
</tr>
<tr>
<td>6.9</td>
<td>6</td>
<td>1.92</td>
<td>c</td>
</tr>
</tbody>
</table>

**Flohr et al., 2015**
ADFI, d 0 to 117

Initial stocking density, $P < 0.01$
SEM = 0.07
Means with different superscripts, $P < 0.05$

Flohr et al., 2015
Flohr et al., 2015
Analysis of Economics

• Analyzed in a similar statistical model as the growth performance.
• Carcass information was confounded with day of marketing; therefore, a fixed yield (75%) was used to assume the HCW of all pigs marketed.
• Analyzed economics using a premium/discount adjusted carcass price based on HCW.
• Looked at economics on a fixed day (117 days) or a fixed weight (300 lb) basis.
## Economics on a fixed days basis (117 d)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Initial floor space, Ft²</th>
<th>Marketing strategy</th>
<th>Fixed inventory</th>
<th>Feed consumed/pen</th>
<th>Feed cost/pen, $</th>
<th>Facility cost/pen, $</th>
<th>Revenue/pen, $</th>
<th>IOFFC/pen, $</th>
<th>IOFFC/pig, $</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.7</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2:2:2</td>
<td>2:4</td>
<td>6</td>
<td>15</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>198.0</td>
</tr>
<tr>
<td></td>
<td>9,876^[a]</td>
<td>11,505^[b]</td>
<td>11,992^[b]</td>
<td>12,206^[b]</td>
<td>16.75</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>906.73^[a]</td>
<td>1,062.91^[b]</td>
<td>1,103.96^[b]</td>
<td>1,123.05^[b]</td>
<td>1123.05[^b]</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>252.73</td>
<td>252.73</td>
<td>252.73</td>
<td>252.73</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1715.43^[a]</td>
<td>2178.83^[b]</td>
<td>2235.89^[b]</td>
<td>2232.01^[b]</td>
<td>2232.01[^b]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>555.97^[a]</td>
<td>863.19^[b]</td>
<td>879.2^[b]</td>
<td>856.23^[b]</td>
<td>856.23[^b]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>37.06^[a]</td>
<td>41.10^[b]</td>
<td>41.87^[b]</td>
<td>40.77^[b]</td>
<td>1.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Assumptions
- Fixed inventory/pen
- Fixed Yield= 75.0%
- Average diet cost = $185.69/ton
- Facility Cost= $0.11/7.4ft²/day
- Base carcass price of $62.25/Cwt

Flohr et al., 2015
### Economics on a fixed weight basis (310 lb)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Initial floor space, Ft²</th>
<th>Marketing Strategy</th>
<th>Fixed inventory</th>
<th>Feed consumed/pen</th>
<th>Feed cost/pen, $</th>
<th>Facility cost/pen, $</th>
<th>Revenue/pen, $</th>
<th>IOFFC/pen, $</th>
<th>IOFFC/pig, $</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.7</td>
<td>6.9</td>
<td>6.9</td>
<td>6.9</td>
<td>15</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>9,420&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11,918&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12,340&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12,520&lt;sup&gt;b&lt;/sup&gt;</td>
<td>180.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>866.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1,099.47&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,134.75&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1,150.90&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.16</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>242.72</td>
<td>259.95</td>
<td>257.98</td>
<td>256.20</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1680.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2200.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2289.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2291.53&lt;sup&gt;b&lt;/sup&gt;</td>
<td>29.38</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>571.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>840.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td>897.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>884.43&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>38.11&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.04&lt;sup&gt;b&lt;/sup&gt;</td>
<td>42.72&lt;sup&gt;b&lt;/sup&gt;</td>
<td>42.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assumptions**
- Fixed inventory/pen
- Fixed yield = 75.0%
- Average diet cost = $185.69/ton
- Facility cost = $0.11/7.4ft²/day
- Base carcass price of $62.25/Cwt

Flohr et al., 2015
Conclusions

• Floor space allowance as an environmental factor has a large impact on growth performance.

• As finishing weights continue to increase, its more important than ever to realize the impact floor space has on growth.

• Alleviating stocking density pressure by marketing pigs prior to dumping the barn may be a helpful tool to increase revenue (better target optimal packer wt) and regain late finishing performance (Improved FE and ADG).
Conclusions

• In this study it appeared that the use of two marketing points (2 pigs the first time point, and 4 the second time point) offered the most return from an economic standpoint.

• But keep in mind additional labor and transport cost should be considered with the additional marketing points.

• Individual pig performance can be improved with additional floor space but this is negatively correlated with revenue on a unit of space basis.
Objective: Evaluate the feed efficiency of gilts and sows under commercial conditions and their reproductive performance

Graduate Student: Lori Thomas
Procedures

• RFID Tags for Sow ID
• 296 Gilts
• 566 Sows
• ESF feed delivery
  – 2 kg/d
  – 2.26 kg/d
  – 3.0 kg/d
• ESF Daily Sow Body Weight
• 2 known points
Example sow: Raw Data

RFID = 1408612
Example sow: After Data Cleaning

Day of Gestation
Feed efficiency Factsheets

- Swine Feed Efficiency, IPIC 25a: Not Always Linked to Net Income
- Swine Feed Efficiency, IPIC 25b: Genetic Impact
- Swine Feed Efficiency, IPIC 25c: Particle Size Testing Methodology
- Swine Feed Efficiency, IPIC 25d: Influence of Particle Size
- Swine Feed Efficiency, IPIC 25e: Influence of Pelleting
- Swine Feed Efficiency, IPIC 25f: Influence of Temperature
- Swine Feed Efficiency, IPIC 25g: Decision Tree
- Swine Feed Efficiency, IPIC 25h: Influence of Market Weight
- Swine Feed Efficiency, IPIC 25i: Effect of Dietary Energy
- Swine Feed Efficiency, IPIC 25j: Influence of Ractopamine
- Swine Feed Efficiency, IPIC 25k: Feeder Design and Management
- Swine Feed Efficiency, IPIC 25l: Influence of Amino Acids
- Swine Feed Efficiency, IPIC 25m: Sow Feed on Whole Farm Efficiency

www.swinefeedefficiency.com
Thank you!

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