KSU Swine Day 2011
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Morning – Finisher pigs

Afternoon – Nursery and sows
  • Vitamin D research
  • New KSU premix recommendations
  • Nursery diet ingredients
  • Feed processing
Grow-finish pigs

- Alternative ingredients
  - Wheat
  - Bakery meal
  - DDGS
  - Withdrawal from high fiber diets
- Feeder design
- Paylean
- Correct market weight
- Improvest
Feeding Wheat to Swine

• **Nutrient differences wheat vs. corn:**
  – Lysine: 35% more SID lysine; (CP: 13.5. vs 8.5%)
  – ME: 6% less energy; (1,456 vs. 1,551 kcal/lb)
  – Available Phosphorus: ~4 x higher (0.19 vs. 0.04%)

• **Ingredient changes:**
  – Less soybean meal and supplemental phosphorus
  – Higher synthetic lysine use is possible
  – Can add fat to balance dietary energy

• **Grinding:**
  – Still target 600-700 microns
  – More “flouring” occurs as wheat is more finely ground
Feeding Wheat to Swine

• **Anticipated performance and breakeven changes:**
  - No added fat to balance energy:
    • Higher F/G (~+0.12 F/G from 50 - 250 lb)
    • Slightly lower ADG
    • Current breakeven is 102% of corn price (bu/bu)
  - Added fat to balance energy ($0.48/lb CWG):
    • Similar ADG and F/G
    • Current breakeven is 95% of corn price (bu/bu)
# Bakery meal (importance of source)

<table>
<thead>
<tr>
<th></th>
<th>Source 1</th>
<th>Source 2</th>
<th>Source 3</th>
<th>Source 4</th>
<th>Source 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture, %</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>11.0</td>
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<tr>
<td>Protein, %</td>
<td>12.0</td>
<td>10.0</td>
<td>12.0</td>
<td>9.7</td>
<td>9.3</td>
</tr>
<tr>
<td>Fat, %</td>
<td>8.5</td>
<td>9.0</td>
<td>9.1</td>
<td>3.4</td>
<td>9.2</td>
</tr>
<tr>
<td>Fat, % of NRC</td>
<td>75%</td>
<td>80%</td>
<td>81%</td>
<td>30%</td>
<td>81%</td>
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<tr>
<td>Crude fiber, %</td>
<td>5.0</td>
<td>5.0</td>
<td>3.1</td>
<td>2.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Ash, %</td>
<td>5.5</td>
<td>5.5</td>
<td>4.0</td>
<td>2.8</td>
<td>2.3</td>
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<tr>
<td>Salt, %</td>
<td>1.3</td>
<td>1.3</td>
<td>2.0</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Sugar, %</td>
<td>12</td>
<td>16</td>
<td>13.4</td>
<td>19.2</td>
<td>22.8</td>
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<tr>
<td>Starch, %</td>
<td>20</td>
<td>22</td>
<td>37.2</td>
<td>28.0</td>
<td>19.2</td>
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<tr>
<td>ME, Mcal/lb</td>
<td>1.53</td>
<td>1.55</td>
<td>1.59</td>
<td>1.49</td>
<td>1.63</td>
</tr>
<tr>
<td>ME, % of NRC</td>
<td>91%</td>
<td>92%</td>
<td>95%</td>
<td>89%</td>
<td>97%</td>
</tr>
</tbody>
</table>
Feeding high DDGS levels

• Economics in 2011 greatly increased DDGS inclusion rates
  – Savings were as high as $7 to 8/pig with 40% inclusion
  – Still $1.50 to 5/pig potential savings depending on corn, DDGS, and soybean meal prices
  – Iodine value and carcass yield are the limiting factors
  – Economics will change as more fat is removed from DDGS
    • Potentially less iodine value issues, but more impact on growth and yield
Effect of TID Try:Lys in 30% DDGS diets on finishing ADG (Exp. 2; d 0 to 73; BW 150 to 275 lb)

Linear, P < 0.001
SEM = 0.023

Barnes et al., 2010
DDGS x SID Trp:Lys ratio for finishing pigs
(Exp. 4; d 0 to 71; BW 150 to 300 lb)

Trp x DDGS P = 0.80
Trp P=0.23; DDGS P = 0.14
SEM = 0.021

Nitikanchana et al., 2011
DDGS x SID Trp:Lys ratio for finishing pigs
(Exp. 4; d 0 to 71; BW 150 to 300 lb)

Trp x DDGS P = 0.21
Trp P = 0.93; DDGS P = 0.02
SEM = 0.035

<table>
<thead>
<tr>
<th>Feed/gain</th>
<th>0%</th>
<th>20%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.97</td>
<td>3.00</td>
<td>3.10</td>
<td>3.10</td>
</tr>
<tr>
<td>3.00</td>
<td>3.03</td>
<td>3.04</td>
<td>3.04</td>
</tr>
<tr>
<td>3.10</td>
<td>3.04</td>
<td>3.04</td>
<td>3.04</td>
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</table>

Trp:Lys, %

DDGS, %

Nitikanchana et al., 2011
DDGS x SID Trp:Lys ratio for finishing pigs
(Exp. 4; d 0 to 71; BW 150 to 300 lb)

Trp x DDGS P = 0.07
Trp P=0.02; DDGS P = 0.85
SEM = 0.408

DDGS x SID Trp:Lys ratio for finishing pigs
(Exp. 4; d 0 to 71; BW 150 to 300 lb)

Trp:Lys, %
- 16.5
- 20

Yield, %
- 74.0
- 76.0
- 78.0
- 80.0

DDGS, %
- 0%
- 20%
- 40%

Nitikanchana et al., 2011
DDGS x SID Trp:Lys ratio for finishing pigs (Exp. 4; d 0 to 71; BW 150 to 300 lb)

- Trp x DDGS P = 0.07
- Trp P=0.02; DDGS P = 0.85
- SEM = 0.408

Carcass wt, lb

<table>
<thead>
<tr>
<th>DDGS, %</th>
<th>0%</th>
<th>20%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trp:Lys</td>
<td>229.3</td>
<td>229.8</td>
<td>225.1</td>
</tr>
<tr>
<td></td>
<td>231.0</td>
<td>230.7</td>
<td>229.5</td>
</tr>
</tbody>
</table>

Nitikanchana et al., 2011
SID Trp:Lys ratio for finishing pigs
(Exp. 5; d 0 to 71; BW 157 to 280 lb)

<table>
<thead>
<tr>
<th>SID Trp:Lys</th>
<th>15%</th>
<th>17%</th>
<th>19%</th>
<th>21%</th>
<th>17%</th>
<th>21%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trp in DDGS diets</td>
<td>P&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Trp in corn-soy diets</td>
<td>P=0.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDGS</td>
<td>P = 0.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>= 0.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nitikanchana et al., 2011 at Hanor
Corn DDGS quality control

- Variability in DDGS quality
  - Main issue is fat level
    - Low = < 9% fat
      - Fat, %: 8.4
      - ME, %: 95.0%
    - Medium = 9 to 10.5% fat
      - Fat, %: 10.2
      - ME, %: 97.5%
    - High = > 10.5% fat
      - Fat, %: 11.9
      - ME, %: 100%
  - Need to monitor DDGS quality or work with company that monitors DDGS quality
Effects of Sorghum or Corn DDGS on ADG

DDGS linear $P < 0.01$
Sorghum vs. corn $P = 0.88$
DDGS source $P = 0.04$

Sotak, et al., 2011
Effects of Sorghum or Corn DDGS on F/G

Linear DDGS $P > 0.05$
Sorghum vs. corn $P = 0.89$
DDGS source $P = 0.15$

- Sorghum: 3.04, 3.07, 3.07, 3.11
- Corn: 2.99, 2.98

Grain source: Sorghum
DDGS level: 0%, 15%, 30%, 45%

Sotak, et al., 2011
Effects of Sorghum or Corn DDGS on Jowl IV

- DDGS linear $P < 0.01$
- Sorghum vs. corn $P = 0.10$
- DDGS source $P = 0.01$

Sotak, et al., 2011
Effect of DDGS and wheat midds on carcass weight (100 to 295 lb)

Wheat midds linear $P < 0.01$
DDGS $P = 0.22$

Wheat Midds (%) in 30% DDGS diets

- Corn-soy: 220.7 lb
- 0%: 216.3 lb
- 10%: 210.0 lb
- 20%: 206.4 lb

Barnes et al., 2010
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011

Inter P = 0.28
Midds P<0.001
DDGS P=0.68
SEM 0.04
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

<table>
<thead>
<tr>
<th>Yield, %</th>
<th>NDF, %</th>
<th>Midds, %</th>
<th>DDGS, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>73.8</td>
<td>9.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>72.2</td>
<td>14.0</td>
<td>9.5</td>
<td>30</td>
</tr>
<tr>
<td>71.9</td>
<td>14.0</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>72.2</td>
<td>16.4</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>71.5</td>
<td>16.4</td>
<td>9.5</td>
<td>30</td>
</tr>
<tr>
<td>72.4</td>
<td>18.8</td>
<td>19</td>
<td>30</td>
</tr>
</tbody>
</table>

Inter P = 0.09
Midds P < 0.37
DDGS P = 0.17
SEM 0.69

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Inter P = 0.95
Midds P<0.001
DDGS P<0.001
SEM 0.42

Jowl iodine value

<table>
<thead>
<tr>
<th></th>
<th>68.2</th>
<th>70.3</th>
<th>74.6</th>
<th>73.4</th>
<th>77.0</th>
<th>76.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDF, %</td>
<td>9.2</td>
<td>14.0</td>
<td>14.0</td>
<td>16.4</td>
<td>16.4</td>
<td>18.8</td>
</tr>
<tr>
<td>Midds, %</td>
<td>- - -</td>
<td>9.5</td>
<td>- -</td>
<td>19</td>
<td>9.5</td>
<td>19</td>
</tr>
<tr>
<td>DDGS, %</td>
<td>- - -</td>
<td>- -</td>
<td>30</td>
<td>15</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

<table>
<thead>
<tr>
<th>Duration</th>
<th>Feed/gain</th>
<th>Level P</th>
<th>SEM 0.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>d 0 to 43:</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>d 43 to 67:</td>
<td>Low</td>
<td>Low</td>
<td>Med</td>
</tr>
<tr>
<td>d 67 to 90:</td>
<td>Low</td>
<td>Low</td>
<td>Med</td>
</tr>
</tbody>
</table>

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011

Yield, %

- Duration P=.002
- Level P= 0.001
- SEM 0.26
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

<table>
<thead>
<tr>
<th>Duration</th>
<th>Carcass weight, lb</th>
<th>SEM</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 43</td>
<td>Low</td>
<td>194.3</td>
<td>2.54</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>195.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>193.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>195.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>193.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>191.4</td>
<td></td>
</tr>
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Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Duration P<0.01
Level P< 0.05
SEM 0.46

Asmus et al., 2011
Effect of DDGS (0, 15, 30%) and Midds (0, 9.5, 19%) on pig performance (90 to 270 lb)

Asmus et al., 2011
Effect of fiber level and fat addition during withdrawal on pig performance (100 to 275 lb)

- Fat x fiber P = 0.03
- Level P < 0.001
- Fat P = 0.24
- SEM = 0.50

<table>
<thead>
<tr>
<th>Jowl iodine value</th>
<th>Fat x fiber</th>
<th>Level</th>
<th>Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>d 0 to 73:</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>d 73 to 92:</td>
<td>Low</td>
<td>Low</td>
<td>Med</td>
</tr>
</tbody>
</table>

Fat, %:
- d 0 to 73: ---
- d 73 to 92: ---
- Fiber = DDGS (0, 15, 30%) and Midds (0, 9.5, 19%)

Asmus et al., 2012
Influence of days of withdrawal of high IV diet on jowl fat iodine value

\[ y = 0.0111x + 0.0127 \]

\[ R^2 = 0.6851 \]

Assumed pigs switched to corn-soy diet for withdrawal
Influence of days of withdrawal of high IV diet on jowl fat iodine value

<table>
<thead>
<tr>
<th>Days</th>
<th>21</th>
<th>42</th>
<th>21</th>
<th>42</th>
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</thead>
<tbody>
<tr>
<td>IV increased from normal</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>IV reduced, %</td>
<td>25%</td>
<td>48%</td>
<td>25%</td>
<td>48%</td>
</tr>
<tr>
<td>IV reduced, mg/g</td>
<td>1.5</td>
<td>2.9</td>
<td>2.9</td>
<td>5.7</td>
</tr>
</tbody>
</table>

IV reduction % = 0.0111x + 0.0127

Assumed pigs switched to corn-soy diet for withdrawal
Feeder type – Dry vs. Wet/Dry

Dry feeder

Single-sided, 62.7 in long, 5-hole feeder (Staco, Inc., Schaefferstown, PA) and a stainless steel cup waterer

Wet/Dry feeder

Double-sided with 15 in wide opening on both sides of the trough and single nipple waterer (Crystal Springs, GroMaster, Inc., Omaha, NE)

Bergstrom et al. 2011
## Wet Dry vs Dry Feeders

<table>
<thead>
<tr>
<th>Trial</th>
<th>ADG</th>
<th>FG</th>
<th>Lean</th>
<th>IOFC*</th>
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</thead>
<tbody>
<tr>
<td>1 Meal</td>
<td>Pos</td>
<td>No Diff</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2 Meal</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>3 Meal</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>4 Meal</td>
<td>Pos</td>
<td>Pos</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>5 Meal</td>
<td>Pos</td>
<td>No Diff</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>6 Meal</td>
<td>Pos</td>
<td>No Diff</td>
<td>Neg</td>
<td>Pos</td>
</tr>
<tr>
<td>7 Meal</td>
<td>Pos</td>
<td>No Diff</td>
<td>No Diff</td>
<td>No Diff</td>
</tr>
<tr>
<td>8 Meal</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>9 Pellets</td>
<td>Pos</td>
<td>Pos</td>
<td>Neg</td>
<td>Pos</td>
</tr>
<tr>
<td>9 Meal</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>No Diff</td>
</tr>
<tr>
<td>10 Pellets</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>10 Meal</td>
<td>Pos</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
<tr>
<td>11 Meal</td>
<td>Pos</td>
<td>Pos</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
1. Width of a single feeding space – minimum 14 inches
   - Shoulder width (cm) + 10% = 6.1 x BW^{0.33} kg + 10%
2. Depth of feeding space – Approximately 10 inches
3. Divider to provide some degree of pig protection
   - Forces pig to stand perpendicular to feeder to eat
   - Decreased rooting and pig/pig interaction
## Summary of feeder adjustment trials

<table>
<thead>
<tr>
<th>Authors</th>
<th>Stage</th>
<th>Feeder type</th>
<th>Coverage, %</th>
<th>Significant response</th>
<th>Change in F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>Nursery</td>
<td>Dry</td>
<td>6</td>
<td>93</td>
<td>ADG, ADFI</td>
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<tr>
<td>Duttlinger1</td>
<td>Finisher</td>
<td>Dry</td>
<td>26</td>
<td>79</td>
<td>---</td>
</tr>
<tr>
<td>Duttlinger2</td>
<td>Finisher</td>
<td>Dry</td>
<td>24</td>
<td>78</td>
<td>ADG</td>
</tr>
<tr>
<td>Bergstrom1</td>
<td>Grower</td>
<td>Dry</td>
<td>9</td>
<td>79</td>
<td>ADFI</td>
</tr>
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<td>Bergstrom1</td>
<td>Grower</td>
<td>Wet/dry</td>
<td>35</td>
<td>65</td>
<td>ADG, ADFI</td>
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<tr>
<td>Bergstrom2</td>
<td>Finisher</td>
<td>Dry</td>
<td>25</td>
<td>83</td>
<td>---</td>
</tr>
<tr>
<td>Bergstrom2</td>
<td>Finisher</td>
<td>Wet/dry</td>
<td>53</td>
<td>82</td>
<td>ADG, ADFI</td>
</tr>
<tr>
<td>Bergstrom3</td>
<td>Finisher</td>
<td>Wet/dry</td>
<td>63</td>
<td>83</td>
<td>ADG, ADFI</td>
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<tr>
<td>Myers</td>
<td>Finisher</td>
<td>Dry</td>
<td>28</td>
<td>75</td>
<td>ADFI, F/G</td>
</tr>
<tr>
<td>Myers2</td>
<td>Finisher</td>
<td>Dry</td>
<td>43</td>
<td>87</td>
<td>ADFI, F/G</td>
</tr>
</tbody>
</table>

**Finisher F/G improvement by decreasing pan coverage**  2.9%
Paylean economic return

• During high feed and market prices
  – Greater economic return per pig
  – Greater return for higher doses
    • $9 > 6.75 > 4.5 \text{ g/ton}$
  – Optimal duration increases slightly
    • Feed for 21 to 28 days before market
Determining optimal marketing strategy for barns

• To accurately market barns, we need information:
  – Average weight of pigs in barn
  – Variation in pig weight

• Then, we must be able to find the heaviest pigs and get them on the truck?
Normal distribution of pig weights in a barn
Mean = 213.5 lb, Standard Deviation = 21.5 lb

When does the top 13% need to be marketed to maximize my economic return?
Histogram of Pig Weights

**Groesbeck**

- Mean = 253.0 lb
- Median = 254 lb
- Standard Deviation = 38.2 lb
- CV = 13.0%

**Portland**

- Mean = 213.5 lb
- Median = 214 lb
- Standard Deviation = 21.5 lb
- CV = 10.1%

Paulk et al., 2011
Methods of sampling a barn to determine average pig weight (30 pig sample)

<table>
<thead>
<tr>
<th>Pigs/pen</th>
<th>Pens</th>
<th>Upper, lb</th>
<th>Lower, lb</th>
<th>Range, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2</td>
<td>223.9</td>
<td>197.6</td>
<td>26.3</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>223.3</td>
<td>201.3</td>
<td>22.0</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>222.5</td>
<td>203.9</td>
<td>18.6</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>222.0</td>
<td>204.6</td>
<td>17.4</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>221.3</td>
<td>205.6</td>
<td>15.7</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>220.9</td>
<td>206.1</td>
<td>14.8</td>
</tr>
</tbody>
</table>

Mean of 10,000 random samples of pigs from 1260 head barn with 19 pens with 56 to 81 pigs/pen (weight 213.5)

Paulk et al., 2011
Methods of sampling a barn to determine standard deviation (30 pig sample)

<table>
<thead>
<tr>
<th>Pigs/pen</th>
<th>Pens</th>
<th>Upper, lb</th>
<th>Lower, lb</th>
<th>Range, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2</td>
<td>27.5</td>
<td>14.6</td>
<td>12.9</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>27.9</td>
<td>15.0</td>
<td>12.9</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>27.6</td>
<td>15.3</td>
<td>12.3</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>27.6</td>
<td>15.3</td>
<td>12.3</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>27.5</td>
<td>15.8</td>
<td>11.6</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>27.3</td>
<td>15.9</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Mean of 10,000 random samples of pigs from 1260 head barn with 19 pens with 56 to 81 pigs/pen (SD = 21.5)

Paulk et al., 2011
Normal distribution of pig weights in a barn
Mean = 213.5 lb, Standard Deviation = 21.5 lb

95% of pigs are within 2 SD of mean

Paulk et al., 2012
Normal distribution of pig weights in a barn
Mean = 213.5 lb, Standard Deviation = 21.5 lb

Can the weight of a sample of the lightest and heaviest pigs in subsample of pens predict the average pig weight and variation?

Paulk et al., 2012
What is immunological castration?

– Temporary immunological suppression of testicular function (late in life) as an alternative to surgical castration (early in life) to control ‘boar taint’

– Mode of action is induction of antibodies to endogenous GnRF which temporarily blocks pituitary-gonadal endocrine axis

– Or stated another way “blocks communication between the brain and the testicles”
What is the advantage of immunological castration late in life?

- Boars are more feed efficient and have a higher lean meat yield compared to barrows
- Immunological castrated male pigs spend a large proportion of their life as boars
- Immunological castration temporarily blocks production of sexual hormones that are the cause of “boar taint”
What products are available for immunological castration in the US?

- Improvest – Pfizer Animal Health
- FDA Approved/Not widely available commercially
- First product available in its class in the US
  - 5 year exclusivity
How is immunological castration late in life performed?

- Requires two injections
- First injection primes the immune system but full testicular and reproductive function is retained
- Second injection induces a strong immune response that causes temporary suppression of testicular function
Biology of Immunological castration

IMPROVEST stimulates an immune response temporarily reducing off-odor compounds

Suppressive Antibody Level

- Priming Dose: After 9 weeks of age
- 2nd Dose: At least 4 weeks after primary dose
- QA Inspection
- Market window: 4-8 weeks after 2nd dose

* QA certificate delivered with animals

Off-odor compounds
Immunity
Aniti-GnRF antibodies in immunocastrates (Improvest) compared to barrows and boars

Source: FDA NADA 141-322
How effective is immunological castration?

- Reduces circulating testosterone
- Reduces chemical responsible for “boar taint”
Serum testosterone in immunocastrates (Improvest) compared to barrows and boars

Source: FDA NADA 141-322
Olfactory scores from cooked meat from immunocastrates (Improvvest) compared to barrows and boars

Source: FDA NADA 141-322
Influence of Improvest and lysine level on F/G
d 55 to 160

F/G (d 55-160)

- Barrows, Low
- Improvest, Low
- Improvest, Med Low
- Improvest, Med High
- Improvest, High
- Boars, High

2.66
2.42
2.40
2.41
2.41
2.24

2.0
2.2
2.4
2.6
2.8
Influence of Improvest and lysine level on carcass weight, lb

- **Barrows, Low**: 205.0
- **Improvest, Low**: 199.7
- **Improvest, Med Low**: 209.2
- **Improvest, Med High**: 211.2
- **Improvest, High**: 208.8
- **Boars, High**: 205.2

**Graph Explanation**:
- **Carras weight, lb**
- **Carras Wt**
- **Barrows,Low**
- **Improvest, Low**
- **Improvest, Med Low**
- **Improvest, Med High**
- **Improvest, High**
- **Boars, High**

**Legend**:
- b, c
- a, b, c
- a
- b, c
Influence of Ractopamine and Improvest on average daily gain

Moore et al., 2008
General information about Improvest?

• How applied:
  – Injection, subcutaneous – under the skin
  – Two doses at least 4 weeks apart
  – First dose can be more than 4 weeks prior to the second injection

• Slaughter window is a minimum of 4 weeks and up to 8 weeks after the 2\textsuperscript{nd} injection

Source: FDA NADA 141-322
General information about Improvest

- **Availability** – Only by veterinary prescription due to precautions for human user safety
  - Use a safety injector
  - Accidental self injection can interfere with reproductive function of men and women
  - Proper training for administration critical
- **Withdrawal** – none when used according to label, no evidence of tissue residues

Source: FDA NADA 141-322
Key Take Home Points

- Requires effective injection administration
- Requires dietary adjustments
  - Feed like boars up to second injection
  - Feed like barrows after second injection
- ADG and feed efficiency for immunocastrates after second injection is better than barrows
- Carcass yield is decreased
- Packer contracts are containing clauses to require notification of use

Source: FDA NADA 141-322
Thank You!
KSU Swine Day 2011

Morning – Finisher pigs

Afternoon – Nursery and sows

- Vitamin D research
- New KSU premix recommendations
- Nursery diet ingredients
- Feed processing
Vitamin D – The Nutritionist Perspective
History

• University Research Herd
• Omission of all supplemental Vitamin D from premix
• Kyphosis “Humpback” out break
• Signs first observed in growing pigs fed research diets marginal with Ca/P

Rortvedt et al., 2010
Nursery growth rate from weaning at 4 weeks of age until 9 weeks

Vit D $P < 0.05$  Ca/aP $P < 0.05$

<table>
<thead>
<tr>
<th>Vit D, IU/kg</th>
<th>Ca/aP, %</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.56/0.16</td>
<td>0.94</td>
</tr>
<tr>
<td>280</td>
<td>0.56/0.16</td>
<td>1.43</td>
</tr>
</tbody>
</table>

Rortvedt et al., 2010
Kyphosis – 9 wk of age

Vit D, IU/kg
0
280
Ca/aP,%
0.56 /0.16
0.84/0.40

Percentage

K-State
Research and Extension

Rortvedt et al., 2010
Kyphosis – 13 wk of age

All pigs fed 0.40 aP diets from wk 9 to 13

Vit D, IU/kg

Ca/aP,%

0.56 /0.16
0.84 /0.40

Percentage

0 5 10 15 20 25 30 35

25

33

Rortvedt et al., 2010
Exp. 2. Vitamin D at 0 or 280 IU/kg with four calcium/phosphorus regimens

<table>
<thead>
<tr>
<th>Diet</th>
<th>Calcium: Phosphorus:</th>
<th>Low</th>
<th>High</th>
<th>Low</th>
<th>High</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td></td>
<td>Low</td>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Ca, %</td>
<td></td>
<td>0.53</td>
<td>1.05</td>
<td>0.53</td>
<td>1.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P, %</td>
<td></td>
<td>0.57</td>
<td>0.57</td>
<td>0.72</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available P, %</td>
<td></td>
<td>0.25</td>
<td>0.25</td>
<td>0.40</td>
<td>0.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca:P</td>
<td></td>
<td>0.93</td>
<td>1.86</td>
<td>0.74</td>
<td>1.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca:aP</td>
<td></td>
<td>2.2</td>
<td>4.3</td>
<td>1.3</td>
<td>2.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Low Ca = 75% NRC  High Ca = 150% NRC
Low P = 95% NRC  High P = 120% NRC

Rortvedt et al., 2011
Vitamin D/Ca/aP on nursery pig growth

Rortvedt et al., 2011

Vit D P < 0.01
Vitamin D/Ca/aP on bone mineral density

Vit D x Ca, Vit D x P, Vit D, Ca, aP P < 0.01

Rortvedt et al., 2011
What does this mean?

• Dietary vitamin D supplementation is clearly necessary
• Increases growth rate and bone mineralization
• As expected, marginal dietary Ca and P affect growth rate and bone mineralization
• Supplementing additional Ca and P is not as effective without vitamin D supplementation
  – Confirms vitamin D is necessary for Ca and P absorption
Comparison of vitamin D recommendations

<table>
<thead>
<tr>
<th>Source, IU/kg</th>
<th>NRC, 1998</th>
<th>NSNG, 2010</th>
<th>KSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation</td>
<td>200</td>
<td>660</td>
<td>1378</td>
</tr>
<tr>
<td>Lactation</td>
<td>200</td>
<td>660</td>
<td>1378</td>
</tr>
<tr>
<td>Early nursery</td>
<td>220</td>
<td>660</td>
<td>1378</td>
</tr>
<tr>
<td>Late nursery</td>
<td>200</td>
<td>660</td>
<td>1378</td>
</tr>
<tr>
<td>Grower</td>
<td>150</td>
<td>550</td>
<td>827</td>
</tr>
<tr>
<td>Finisher</td>
<td>150</td>
<td>440</td>
<td>551</td>
</tr>
<tr>
<td>Paylean phase</td>
<td>150</td>
<td>550</td>
<td>413</td>
</tr>
</tbody>
</table>
Effects of Oral Vitamin D3 Supplementation

Flohr et al., 2011
Effect of oral vitamin D$_3$ on lactation phase piglet growth rate (d 2 to 20)

P = .42 Linear SEM = 0.02

Flohr et al., 2011
Effect of oral vitamin D$_3$ on pig weaning weight (d 20)

P = .44 Linear SEM = 0.39

Control 13.0
40,000 IU 13.3
80,000 IU 13.3

Flohr et al., 2011
Effect of oral vitamin D$_3$ on nursery phase piglet growth rate (d 20 to 52)

P = .50 Linear
SEM = 0.02

0.79

0.82

0.81

Control

40,000 IU

80,000 IU

Vitamin D$_3$

Flohr et al., 2011
Effect of oral vitamin D$_3$ on pig weight (d 52)

- Control: 39.2 lb
- 40,000 IU: 39.7 lb
- 80,000 IU: 39.7 lb

P = .65 Linear
SEM = 0.75

Flohr et al., 2011
Effect of oral vitamin D$_3$ on bone ash (d 19)

P > .09 Linear
SEM = 0.02

Dark = Femur
Lighter = Rib

Flohr et al., 2011
Effect of oral vitamin D<sub>3</sub> on serum 25(OH)D<sub>3</sub>

*P < .01 Quadratic within Day
# P < .01 Linear within Day

Flohr et al., 2011
Steps to ensure vitamin D is supplemented correctly (and other vitamins and trace minerals):

- Develop clear premix specifications
- Use reputable premix suppliers
- Verify premix production batch sheets
- Ensure product rotation
- Separate vitamin and trace mineral premix
- Verify premix additions
  - Inventory control
  - Eliminate hand adds
- Evaluate mixer efficiency
- Consider premix testing
Changes made to diets for pigs <15 lb

- Lower lysine levels
- Eliminate fishmeal / Add DDGS
- Single “Phase 1” Diet
- Available at www.KSUswine.org
Field validation of diets for < 15 lb pigs
D 0 to 34 ADG

No Significant Effects
SEM = .01

ADG, lb

Phases:
Two
Two
Single
Two
Single

Lysine:
Higher
Lower
Lower
Lower
Lower

DDGS:
No
No
Yes
Yes
Yes

Commercial Research Nursery
**Field validation of diets for < 15 lb pigs**

**D 0 to 34 F/G**

<table>
<thead>
<tr>
<th>Phases</th>
<th>Lysine</th>
<th>DDGS</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>Higher</td>
<td>No</td>
<td>1.39</td>
</tr>
<tr>
<td>Two</td>
<td>Lower</td>
<td>No</td>
<td>1.43</td>
</tr>
<tr>
<td>Single</td>
<td>Lower</td>
<td>No</td>
<td>1.42</td>
</tr>
<tr>
<td>Two</td>
<td>Lower</td>
<td>Yes</td>
<td>1.38</td>
</tr>
<tr>
<td>Single</td>
<td>Lower</td>
<td>Yes</td>
<td>1.37</td>
</tr>
</tbody>
</table>

DDGS $P = .05$

SEM = .02
Field validation of diets for < 15 lb pigs
D 0 to 34 feed cost per lb of gain

DDGS $/lb

Commercial Research Nursery
Field validation of diets for < 15 lb pigs D 0 to 34 income over feed cost

| Phases: | Two, Two, Single, Two, Two, Single |
| Lysine: | Higher, Lower, Lower, Lower, Lower, Lower |
| DDGS:   | No, No, No, Yes, Yes, Yes |

<table>
<thead>
<tr>
<th>$/pig</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.67</td>
</tr>
<tr>
<td>6.51</td>
</tr>
<tr>
<td>6.57</td>
</tr>
<tr>
<td>6.67</td>
</tr>
<tr>
<td>6.74</td>
</tr>
</tbody>
</table>

No significant difference
SEM = .14

Commercial Research Nursery
2012 KSU premix and base mix recommendations

• Changes:
  – Phytase specified in coated forms
  – At least 50% of vitamin D as A/D cross-linked beadlet
  – Natural vitamin E offered at 2:1 bioequivalency
  – Decreased iron levels
  – Decreased zinc levels
  – Decreased manganese levels

• Official change date of January 1, 2012
Influence of natural vitamin E on sow plasma α-tocopherol at weaning

\[ y = 0.0401x + 0.76 \]

Natural Linear, \( P < 0.001 \)
Natural Quadratic, \( P > 0.74 \)
SEM=0.139

Plasma α-tocopherol, µg/mL

Added dietary Vitamin E. mg/kg

Natural E
Synthetic E

Shelton et al., 2012
Influence of natural vitamin E on piglet plasma α-tocopherol at weaning

- Natural Linear, $P < 0.004$
- Natural Quadratic, $P > 0.40$
- SEM=0.376

$y = 0.0499x + 1.735$

Shelton et al., 2012
Estimated relative bioavailability of natural vs synthetic vitamin E

<table>
<thead>
<tr>
<th>Based on synthetic level:</th>
<th>44 mg/kg</th>
<th>66 mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow Plasma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D 100</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Farrowing</td>
<td>4.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Weaning</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Wean piglet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma</td>
<td>3.0</td>
<td>5.1</td>
</tr>
<tr>
<td>Heart</td>
<td>1.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Liver</td>
<td>2.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Sow Colostrum</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Sow milk</td>
<td>1.6</td>
<td>7.3</td>
</tr>
</tbody>
</table>

Varies depending on the response criteria but is greater than the standard value of 1.36 in sows.

Shelton et al., 2012
Amino acid requirement of nursery pigs

• Recent years:
  – Lysine levels
  – Ratios of other amino acids to lysine
    • Thr, Met&Cys, Iso, Val, CP:Lys

• 2011
  – Lysine source
  – Trp:Lys ratios (5 studies)
Effect of Trp:Lys ratio on ADG from 13 to 22 lb

- Probability, $P <$
- Linear = $< 0.02$
- Quadratic = 0.33
- SEM = 0.026

Nitikanchana et al., 2011
Effect of Trp:Lys ratio on F/G from 13 to 22 lb

Tryptophan:lysine ratio, %

Feed/gain

Probability, $P <$
Linear = < 0.06
Quadratic = 0.08
SEM = 0.039

14.7 16.5 18.4 20.3 22.1 24

1.46 1.41 1.41 1.32 1.33 1.4

Nitikanchana et al., 2011
Effect of Trp:Lys ratio on F/G from 13 to 24 lb

Trp x Iso = > 0.35
Trp = > 0.30
Iso = 0.90
SEM = 0.024

Nitikanchana et al., 2011
Influence of SID Trp:Lys ratio on margin over feed

Percent of maximum margin over feed

SID Trp:lys ratio

Ma
Quant
Jansman
Influence of amino acid source on lysine requirement

Lys $P < 0.0001$; Linear $P < 0.0001$

ADG, lb

L-Lys·HCl

1.20  1.30  1.40  1.50  1.60

0.69  0.75  0.81  0.84  0.81

SBM

1.20  1.30  1.40  1.50  1.60

0.70  0.74  0.76  0.80  0.84

Jones et al., 2011
Influence of amino acid source on margin over feed

<table>
<thead>
<tr>
<th>MOF, $/pig</th>
<th>L-Lys·HCl</th>
<th>SBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.37</td>
<td>4.09</td>
<td>3.67</td>
</tr>
<tr>
<td>3.77</td>
<td>4.27</td>
<td>3.89</td>
</tr>
<tr>
<td>4.04</td>
<td></td>
<td>4.23</td>
</tr>
</tbody>
</table>

Jones et al., 2011
Wheat Middlings

• During the wheat milling process, about 70 to 75% of the grain becomes flour, leaving 25 to 30% as wheat byproducts, one of these byproducts is wheat middlings.

• Wheat midds can be valuable to swine diets because of their protein, phosphorus and moderate energy content.
  – 16% CP; 89% the ME value of corn;

• Typically, 100 lb of wheat midds will replace 86.5 lb of corn, 12 lb of high protein soybean meal, and 1.5 lb of monocalcium phosphate.

• This will decrease the energy content of the diet marginally by approximately 15 Kcal ME/ton (equivalent to 0.50% added fat).
Effect of wheat midds on nursery ADG
(Exp. 2; 26 to 54 lb)

Midds x DDGS, P > 0.17
Midds, linear P < 0.02
DDGS, P > 0.79
SEM 0.03

De Jong et al., 2011
Effect Wheat Midds on nursery F/G
(Exp. 2; 26 to 54 lb)

Midds x DDGS, P > 0.78
Midds, linear P < 0.01
DDGS, P > 0.70
SEM 0.03

De Jong et al., 2011
Effect of wheat midds on nursery ADG (Exp. 3; 15 to 48 lb)

Midds, linear $P < 0.11$
SEM 0.03

De Jong et al., 2011
Effect of wheat midds on nursery F/G (Exp. 3; 15 to 48 lb)

Midds, linear $P < 0.003$
SEM 0.02

Wheat Middling Inclusion

De Jong et al., 2011
Wheat Midds and Nursery Diet Summary

- Feeding increasing midds to 12-50 lb pigs consistently lowered ADG which was driven by either reduced ADFI and higher F/G
- Effects were minimal until over 10% midds were added to the diet.
- Evaluating wheat middlings economics on an IOFC basis is important when valuing in rations for nursery and finishing pigs
Effect of XFE Liquid Energy and Choice White Grease on Nursery ADG (Exp. 1; 27 to 57 lb)

CWG, linear $P < 0.05$
Liquid energy, linear $P < 0.08$
CWG vs. Liquid Energy, $P > 0.75$

SEM 0.03

Control: 1.38
2% CWG: 1.45
4% CWG: 1.47
2% Liquid Energy: 1.48
4% Liquid Energy: 1.46

Ying et al., 2011
Effect of XFE Liquid Energy and Choice White Grease on Nursery F/G (Exp. 1; 27 to 57 lb)

- CWG, linear $P < 0.01$
- Liquid energy, $P > 0.40$
- CWG vs. Liquid Energy, $P < 0.02$

SEM 0.02

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>2%</th>
<th>4%</th>
<th>2%</th>
<th>4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/G</td>
<td>1.54</td>
<td>1.52</td>
<td>1.43</td>
<td>1.51</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Ying et al., 2011
Effect of AV-E Digest and XFE Liquid Energy on Nursery ADG
(Exp. 3; Day 0 to 9)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>0.24</td>
</tr>
<tr>
<td>7.1% PEP2+</td>
<td>None</td>
<td>0.23</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>None</td>
<td>0.24</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>3% liquid energy</td>
<td>0.27</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>3% CWG</td>
<td>0.27</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>None</td>
<td>0.27</td>
</tr>
<tr>
<td>12.5% AV-E + 2.5% SDBC</td>
<td>3% liquid energy</td>
<td>0.27</td>
</tr>
<tr>
<td>12.5% AV-E + 2.5% SDBC</td>
<td>3% CWG</td>
<td>0.30</td>
</tr>
</tbody>
</table>

SEM = 0.04

- Liquid energy vs. CWG, P > 0.55
- Liquid energy, P < 0.08
- CWG, P > 0.23
- Protein source, P > 0.93

a, b, c P < 0.05
### Effect of AV-E Digest and XFE Liquid Energy on Nursery F/G
(Exp. 3; Day 0 to 9)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>1.16&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>None</td>
<td>1.09&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>3% liquid energy</td>
<td>1.00&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.1% PEP2+ + 3.75% SDAP</td>
<td>3% CWG</td>
<td>0.87&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>12.5% AV-E + 2.5% SDBC</td>
<td>None</td>
<td>1.01&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>12.5% AV-E + 2.5% SDBC</td>
<td>3% liquid energy</td>
<td>0.98&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>12.5% AV-E + 2.5% SDBC</td>
<td>3% CWG</td>
<td>1.01&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

- Liquid energy vs. CWG, P > 0.70
- Liquid energy, P > 0.41
- CWG, P > 0.66
- Protein source, P > 0.82
- SEM = 0.06

*a, b P < 0.05*
## Effect of AV-E Digest and XFE Liquid Energy on Nursery ADG
(Exp. 3; Day 9 to 23)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>0.73&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>None</td>
<td>0.68&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>None</td>
<td>0.64&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>3% liquid energy</td>
<td>0.72&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>3% CWG</td>
<td>0.69&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.5% AV-E</td>
<td>None</td>
<td>0.75&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.5% AV-E</td>
<td>3% liquid energy</td>
<td>0.71&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>7.5% AV-E</td>
<td>3% CWG</td>
<td>0.79&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

- Liquid energy vs. CWG, $P > 0.48$
- Liquid energy, no effect, $P > 0.59$
- CWG, $P > 0.21$
- Protein source, $P < 0.04$
- SEM = 0.05
- $a,b \ P < 0.05$

Ying et al., 2012
Effect of AV-E Digest and XFE Liquid Energy on Nursery G/F (Exp. 3; Day 9 to 23)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>1.46</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>3% liquid energy</td>
<td></td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>3% CWG</td>
<td></td>
</tr>
<tr>
<td>3.8% PEP2+</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>7.5% AV-E</td>
<td>7.5% liquid energy</td>
<td></td>
</tr>
<tr>
<td>7.5% AV-E</td>
<td>7.5% CWG</td>
<td></td>
</tr>
</tbody>
</table>

Liquid energy vs. CWG, $P < 0.01$
Liquid energy, $P > 0.26$
CWG, $P > 0.17$
Protein source, $P < 0.10$
SEM = 0.06

$^{a,b} P < 0.05$
Effect of AV-E Digest and XFE Liquid Energy on Nursery Pig Performance (Exp. 3; Day 23 to 44)

| Protein Source | Energy Source | F/G  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>1.66 &lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>1.59 &lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>None</td>
<td>1.58 &lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>3% liquid energy</td>
<td>1.56 &lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>3% CWG</td>
<td>1.49 &lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>2.5% AV-E</td>
<td>None</td>
<td>1.59 &lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>2.5% AV-E</td>
<td>3% liquid energy</td>
<td>1.61 &lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>2.5% AV-E</td>
<td>3% CWG</td>
<td>1.51 &lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

SEM = 0.02

- Liquid energy vs. CWG, P < 0.001
- Liquid energy, P > 0.95
- CWG, P < 0.001
- Protein source, P > 0.19

<sup>a,b,c,d</sup> P < 0.05

Ying et al., 2012
**Effect of AV-E Digest and XFE Liquid Energy on Nursery Pig Performance**

(Exp. 3; Day 0 to 44)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBM</td>
<td>None</td>
<td>0.83</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>None</td>
<td>0.82</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>3% liquid energy</td>
<td>0.78</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>3% CWG</td>
<td>0.84</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>None</td>
<td>0.84</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>3% liquid energy</td>
<td>0.83</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>3% CWG</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Liquid energy vs. CWG, $P > 0.19$

Liquid energy, $P > 0.27$

CWG, $P < 0.02$

Protein source, $P > 0.26$

SEM = 0.03

a,b $P < 0.05$
Effect of AV-E Digest and XFE Liquid Energy on Nursery Pig Performance (Exp. 3; Day 0 to 44)

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>Energy Source</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBM SBM SBM</td>
<td>None</td>
<td>1.57a</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>3% liquid energy</td>
<td>1.54ab</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>3% CWG</td>
<td>1.53ac</td>
</tr>
<tr>
<td>PEP2+ SDAP</td>
<td>None</td>
<td>1.50bcd</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>None</td>
<td>1.45de</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>3% liquid energy</td>
<td>1.51bc</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>3% CWG</td>
<td>1.54ab</td>
</tr>
<tr>
<td>AV-E + SDBC</td>
<td>None</td>
<td>1.44e</td>
</tr>
</tbody>
</table>

Liquid energy vs. CWG, P < 0.001
Liquid energy, P > 0.98
CWG, P < 0.001
Protein source, P > 0.91
SEM = 0.03

Ying et al., 2012
Liquid Energy and AV-E Digest Summary

• Liquid Energy:
  – No F/G response
  – Mixed ADG response
  – While the actual energy value is unknown, it cannot directly substitute added fat and maintain similar performance.

• AV-E Digest:
  – Can be used as a replacement for other animal specialty proteins sources in Phase 2 (15-25 lb) nursery diets.
  – More research is needed validating AV-E as a SDAP replacement in Phase 1 diets due to the lack of growth response for pigs fed diets with plasma over the negative control.
Update on Feed Processing Research
Effects of sorghum particle size in finishing pig diets

No differences

ADG, lb

Corn

Sorghum

Paulk et al., 2011
Effects of sorghum particle size in finishing pig diets

Paulk et al., 2011
Particle size of sorghum to have same F/G as corn

\[ y = 0.00025728x + 2.5601 \]

Paulk et al., 2011
Effects of particle size on feed efficiency

1.2% per 100 microns

0.9% per 100 microns

F/G

Particle size, microns

Cabrera, 1994a
Cabrera, 1994b
Wondra, 1995

Paulk, 2011

Particle size, microns

800 600 400

800 600 400
Whether it's from 1990's data or 2011, for every 100 microns decrease in particle size, F/G improves 1.2%
Effect of regrinding dried distillers grains with solubles on growth performance in finishing pigs

De Jong et al, 2011

95 micron difference in DDGS particle size
## Effects of pelleting on growth performance of grow-finish pigs
1969 to 1999

<table>
<thead>
<tr>
<th>Reference</th>
<th>Meal</th>
<th>Pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADG</td>
<td>F/G</td>
</tr>
<tr>
<td>NCR-42 (1969)</td>
<td>1.70</td>
<td>3.23</td>
</tr>
<tr>
<td>Hanke et al. (1972)</td>
<td>1.65</td>
<td>3.45</td>
</tr>
<tr>
<td>Baird (1973)</td>
<td>1.52</td>
<td>3.70</td>
</tr>
<tr>
<td>Tribble et al. (1975)</td>
<td>1.46</td>
<td>3.77</td>
</tr>
<tr>
<td>Harris et al. (1979)</td>
<td>1.34</td>
<td>3.83</td>
</tr>
<tr>
<td>Tribble et al. (1979)</td>
<td>1.37</td>
<td>4.10</td>
</tr>
<tr>
<td>Erickson et al. (1980)</td>
<td>1.54</td>
<td>3.03</td>
</tr>
<tr>
<td>Skoch et al. (1983)</td>
<td>1.70</td>
<td>3.10</td>
</tr>
<tr>
<td>Wondra et al. (1993a)</td>
<td>1.83</td>
<td>3.64</td>
</tr>
<tr>
<td>Van Heugten (1997)</td>
<td>1.59</td>
<td>2.14</td>
</tr>
<tr>
<td>Van Heugten (1997)</td>
<td>2.17</td>
<td>2.89</td>
</tr>
<tr>
<td>Brumm (1998)</td>
<td>1.76</td>
<td>3.13</td>
</tr>
<tr>
<td>Johnston et al. (1999)</td>
<td>2.01</td>
<td>3.03</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>1.66</strong></td>
<td><strong>3.31</strong></td>
</tr>
</tbody>
</table>

Average response = 5.6% for ADG and 7.0% for F/G
## Effects of pelleting on growth performance of grow-finish pigs
### 2005 to 2011

<table>
<thead>
<tr>
<th>Reference</th>
<th>Meal ADG</th>
<th>Meal F/G</th>
<th>Pellet ADG</th>
<th>Pellet F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groesbeck et al. (2005)</td>
<td>0.83</td>
<td>1.25</td>
<td>0.90</td>
<td>1.22</td>
</tr>
<tr>
<td>Groesbeck et al. (2005)</td>
<td>0.62</td>
<td>1.43</td>
<td>0.65</td>
<td>1.37</td>
</tr>
<tr>
<td>Groesbeck et al. (2006)</td>
<td>0.80</td>
<td>1.25</td>
<td>0.78</td>
<td>1.17</td>
</tr>
<tr>
<td>Potter et al. (2009)</td>
<td>1.95</td>
<td>2.12</td>
<td>2.05</td>
<td>2.07</td>
</tr>
<tr>
<td>Potter et al. (2009)</td>
<td>1.92</td>
<td>2.83</td>
<td>2.04</td>
<td>2.68</td>
</tr>
<tr>
<td>Myers et al. (2010)</td>
<td>1.81</td>
<td>2.76</td>
<td>1.94</td>
<td>2.82</td>
</tr>
<tr>
<td>Potter et al. (2010)</td>
<td>1.92</td>
<td>2.86</td>
<td>2.03</td>
<td>2.70</td>
</tr>
<tr>
<td>Frobose et al. (2011)</td>
<td>1.46</td>
<td>1.72</td>
<td>1.43</td>
<td>1.63</td>
</tr>
<tr>
<td>Frobose et al. (2011)</td>
<td>1.29</td>
<td>1.51</td>
<td>1.38</td>
<td>1.40</td>
</tr>
<tr>
<td>Myers et al. (2011)</td>
<td>1.96</td>
<td>2.73</td>
<td>1.97</td>
<td>2.67</td>
</tr>
<tr>
<td>Paulk et al. (2011)</td>
<td>2.50</td>
<td>2.75</td>
<td>2.63</td>
<td>2.55</td>
</tr>
<tr>
<td>Paulk et al. (2011)</td>
<td>2.31</td>
<td>2.50</td>
<td>2.44</td>
<td>2.40</td>
</tr>
</tbody>
</table>

| Average          | 1.61     | 2.14     | 1.69       | 2.06       |

Average response = 5.0% for ADG and 4.0% for F/G
Effect of diet form on overall ADG and F/G
40% fines

**ADG, lb**

<table>
<thead>
<tr>
<th></th>
<th>Meal</th>
<th>Pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>1.46</td>
<td>1.33</td>
</tr>
</tbody>
</table>

**F/G**

<table>
<thead>
<tr>
<th></th>
<th>Meal</th>
<th>Pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>2.23</td>
<td>2.59</td>
</tr>
</tbody>
</table>

*Myers et al., 2011*
Effect of diet form on overall ADG and F/G

4% fines

**ADG, lb**

<table>
<thead>
<tr>
<th>Diet Form</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal</td>
<td>2.21</td>
</tr>
<tr>
<td>Pellet</td>
<td>2.31</td>
</tr>
</tbody>
</table>

**F/G**

<table>
<thead>
<tr>
<th>Diet Form</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal</td>
<td>2.93</td>
</tr>
<tr>
<td>Pellet</td>
<td>2.74</td>
</tr>
</tbody>
</table>

*P < 0.01* 

Myers et al., 2011
Effects of feeder adjustment and pellet quality on ADG

Nemecheck et al. 2012
Effects of feeder adjustment and pellet quality on F/G

Diet form P < 0.05

Meal Pellets Pellets with 30% fines

Feeder opening, in.

0.75 1.25

Nemecheck et al. 2012
Pellet quality

Pellets with fines

Good quality pellets

Nemecheck et al. 2012
Future feed processing needs

• Particle size
  – Effects of fine particle sizes (< 500 microns)
  – Grinding of ingredients or complete diet

• Pelleting
  – Pellet quality standards
  – Expanding

• Feeder by pellet quality interaction
Thank You!