KSU Swine Day 2012
KSU Swine Day 2012

Morning – Sows (Vitamin E, carnitine, chromium)
  Vitamin D
  Feed additives

Afternoon – Nursery (soy hulls, wheat middlings)
  Grow-finish
  • Wheat
  • DDGS (low vs high oil)
  • Feed processing
  • Improvest
  • Marketing
Agricultural Output 2010 = 100

- Productivity growth needed to double output
- Current productivity growth

Technology Gap

K-STATE
Research and Extension
Effects of dietary vitamin E level and source on sow, milk, and piglet levels of α-tocopherol
Introduction

- Vitamin E is a generic term for 4 tocopherols and 4 tocotrienols that serve as antioxidants in the lipid components of animal and plant tissues.
- The α-tocopherol form is the most bioactive form for animals and has eight stereoisomers.
- The biological activities of these 8 stereoisomers range from 25 to 100% (Blatt et al., 2004), with the RRR-α-tocopherol form being the most bioactive.

http://lpi.oregonstate.edu/ss01/attp.html
Introduction

- Common to utilize the esterified forms of α-tocopherol to prolong stability
- Two common sources of vitamin E:
  - Natural vitamin E (RRR-α-tocopherol acetate or d-α-tocopherol acetate) is compromised only of the RRR stereoisomer.
  - Synthetic vitamin E (all rac-α-tocopherol acetate or dl-α-tocopherol acetate) is a combination of the 8 stereoisomers

http://lpi.oregonstate.edu/ss01/attp.html
Objective

- The objectives of this study are to:
  1) determine the level of α-tocopherol in plasma, milk, and piglet body tissues when supplied from synthetic or natural vitamin E.
  2) estimate the bioavailability of natural vitamin E relative to synthetic vitamin E when included in diets containing a large proportion of DDGS.
Effects of dietary vitamin E level and source on sow colostrum α-tocopherol levels

Colostrum α-tocopherol, µg/mL

- dl-α-tocopherol acetate
- d-α-tocopherol acetate

Dietary α-tocopherol level, mg/kg

Trt effect, *P* < 0.02; SEM=2.165
Syn. 44 vs. 66, *P* > 0.45
Natural Linear, *P* < 0.004
Natural Quadratic, *P* > 0.26
Effects of dietary vitamin E level and source on sow colostrum α-tocopherol levels

Dietary α-tocopherol level, mg/kg

Trt effect, $P < 0.02$; SEM=2.165
Syn. 44 vs. 66, $P > 0.45$
Natural Linear, $P < 0.004$
Natural Quadratic, $P > 0.26$

Colostrum α-tocopherol, µg/mL

Calculated BA=2.9
Calculated BA=3.0

K-State Research and Extension
Knowledge for Life
Effects of dietary vitamin E level and source on piglet plasma α-tocopherol levels at weaning

Plasma α-tocopherol, µg/mL

Dietary α-tocopherol level, mg/kg

Trt effect, $P < 0.03$; SEM=0.376
Syn. 44 vs. 66, $P > 0.68$
Natural Linear, $P < 0.004$
Natural Quadratic, $P > 0.40$

Effects of dietary vitamin E level and source on piglet plasma α-tocopherol levels at weaning
Effects of dietary vitamin E level and source on piglet plasma α-tocopherol levels at weaning.

<table>
<thead>
<tr>
<th>Dietary α-tocopherol level, mg/kg</th>
<th>Plasma α-tocopherol, µg/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>2.47</td>
</tr>
<tr>
<td>66</td>
<td>2.38</td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td></td>
</tr>
</tbody>
</table>

Trt effect, $P < 0.03$; SEM=0.376
Syn. 44 vs. 66, $P > 0.68$
Natural Linear, $P < 0.004$
Natural Quadratic, $P > 0.40$

Calculated BA=3.0
Calculated BA=5.1

K-State Research and Extension
Effects of dietary vitamin E level and source on piglet heart α-tocopherol levels at weaning

Trt effect, $P < 0.02$; SEM=0.619
Syn. 44 vs. 66, $P > 0.22$
Natural Linear, $P < 0.002$
Natural Quadratic, $P > 0.31$

Heart α-tocopherol, µg/mL

Dietary α-tocopherol level, mg/kg
Effects of dietary vitamin E level and source on piglet heart α-tocopherol levels at weaning

- Trt effect, \( P < 0.02; \) SEM=0.619
- Syn. 44 vs. 66, \( P > 0.22 \)
- Natural Linear, \( P < 0.002 \)
- Natural Quadratic, \( P > 0.31 \)

Calculated BA=1.8
Calculated BA=5.3

Heart α-tocopherol, µg/mL

Dietary α-tocopherol level, mg/kg

- dl-α-tocopherol acetate
- d-α-tocopherol acetate
Conclusions

• Treatment effects were not observed ($P > 0.10$) for lactation feed intake, piglet BW or BW gain, or sow BW measures.

• As Natural E increased in the diet, sow plasma, colostrum, milk, piglet plasma, and piglet heart concentrations of α-tocopherol increased (linear; $P < 0.03$).

• This study shows that the relative bioavailability for Natural E:Syn E varies depending on the response criteria but is greater than the potency of 1.36.
Effects of dietary L-carnitine and chromium picolinate on sow reproductive performance
Introduction

• Adding L-carnitine to sow diets at 50 ppm been shown to:
  – Increase birth weight (Musser et al., 1999)
  – Increase litter size (Ramanau et al., 2004)
  – Increase conception rates (Real et al., 2008)
  – Improve nutrient utilization (Musser et al., 1999; Ramanau et al., 2004)
  – Increase plasma leptin concentrations (Woodworth et al., 2004)
  – Increase maternal IGF-I concentrations (Musser et al., 1999; Doberenz et al., 2006) and decrease mRNA for IGF-II in porcine embryonic muscle cells (Waylon et al., 2005)

• Adding chromium picolinate to sow diets has been shown to:
  – Increase litter size (Lindemann et al., 1995, 2004)
  – Improve efficiency of insulin (Lindemann et al., 1995)
Introduction

• The modes of actions for L-carnitine and chromium appear to be different; therefore, combining both may result in additive responses.

• Objective-To evaluate the effects of L-carnitine and chromium on sow feed utilization, as well as litter size, birth weight, and variation in birth weight on a commercial sow farm.
Effect of dietary Carnichrome on individual birth weights

SEM = 0.050
Parity × Diet, $P = 0.49$
Parity, $P = 0.67$
Diet, $P = 0.58$
Conclusion

Feeding 25 ppm of carnitine and 200 ppb of chromium picolinate did not improve piglet birth weight or litter size.
2012 Vitamin D Update

- Oral dose in farrowing
- Vitamin D$_3$ in nursery diet
- Vitamin D$_3$ in sow diet
Effect of oral vitamin D₃ dose on weaning weight

Dose effect, $P = 0.17$

SEM = 0.15

Oral vitamin D₃ dosage

Flohr et al., 2012

None

40,000 IU

11.4

11.6

BW, lb
Effects of supplemental vitamin D₃ by oral dose or in early nursery diets on nursery ADG (d 21 to 45)

Dose × diet interaction, $P = 0.59$
SEM = 0.018

Dose effect, $P = 0.83$

Diet effect, $P = 0.92$

Flohr et al., 2012
Effects of supplemental vitamin D₃ by oral dose or in early nursery diets on pig serum 25(OH)D₃ concentrations

Dose × Diet interaction, $P > 0.25$

*d 21, Oral dose, $P < 0.01$

**d 31, Oral dose, $P = 0.08$; Diet, $P < 0.01$

<table>
<thead>
<tr>
<th>Oral D₃</th>
<th>Dietary D₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1,378 IU/kg</td>
</tr>
<tr>
<td>40,000 IU</td>
<td>1,378 IU/kg</td>
</tr>
<tr>
<td>40,000 IU</td>
<td>13,780 IU/kg</td>
</tr>
</tbody>
</table>

* Flohr et al., 2012
Analyzed dietary vitamin D₃ concentrations

<table>
<thead>
<tr>
<th></th>
<th>Diet A</th>
<th>Diet B</th>
<th>Vitamin Premix</th>
<th>Vitamin D₃ premix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulated level, IU/kg</td>
<td>1,378</td>
<td>13,780</td>
<td>550,000</td>
<td>12,375,000</td>
</tr>
<tr>
<td>Analyzed level, IU/kg</td>
<td>1,267</td>
<td>10,346</td>
<td>597,886</td>
<td>8,948,486</td>
</tr>
<tr>
<td>Analytical error**</td>
<td>± 25%</td>
<td>± 20%</td>
<td>± 10%</td>
<td>± 5%</td>
</tr>
</tbody>
</table>

* Vitamin D₃ feed assays were conducted by DSM Nutritional Products Inc. (Parsippany, NJ).
** Laboratory assay variability associated with vitamin D₃ content.

73% of Expected
## Effect of Oral Vitamin D Supplementation above basal Dietary Supplementation

<table>
<thead>
<tr>
<th>Trial</th>
<th>Wean Weight, lb</th>
<th>Wean 25(OH)D$_3$, ng/ml</th>
<th>Nursery End Weight, lb</th>
<th>Nursery 25(OH)D$_3$, ng/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neonatal Oral Dosing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flohr (SD 2011) $^1$</td>
<td>+.3</td>
<td>+20.1</td>
<td>+.5</td>
<td>+1.1</td>
</tr>
<tr>
<td>Rortvedt (MW 2012) $^{1,2}$</td>
<td>NS</td>
<td>+20.3</td>
<td>-2.3</td>
<td>--</td>
</tr>
<tr>
<td>Flohr (SD 2012) $^3$</td>
<td>+0.2</td>
<td>+16.4</td>
<td>0.0</td>
<td>+2.4</td>
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<tr>
<td>Tousignant (UMN)</td>
<td>+0.2</td>
<td>NS</td>
<td>NS</td>
<td>+17.0</td>
</tr>
<tr>
<td>Field Trial $^{2,4}$</td>
<td>0.0</td>
<td>--</td>
<td>-0.4</td>
<td>--</td>
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<tr>
<td><strong>Nursery H2O</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flohr (SD 2012)</td>
<td>--</td>
<td>--</td>
<td>-0.9</td>
<td>+90 (d10) +18 (d31)</td>
</tr>
<tr>
<td>Field Trial (2 wk)</td>
<td>--</td>
<td>--</td>
<td>+0.2</td>
<td>+6 (d 49)</td>
</tr>
</tbody>
</table>

$^1$ NS Effect on bone ash, $^2$ NS effect on mortality $^3$ NS effect on PCV2 Antibody $^4$ SIV/PRRS positive NS Effect on WF ADG or Mortality NS=Not significant
Dietary Vitamin D Preference Trials
d 7 to 21 after weaning

Flohr et al., 2012
Effects of supplemental vitamin D₃ in sow diets on pig serum 25(OH)D₃ concentrations

#Quadratic $P < 0.01$
*Quadratic $P = 0.03$;

Flohr et al., 2013
Effects of supplemental vitamin D$_3$ in sow or nursery diets on pig serum 25(OH)D$_3$ concentrations

Sow × Nurs interaction, $P < 0.01$
#d 10, 20 Sow Diet Linear $P < 0.01$
*d 10, 21, Nur Diet $P < 0.01$
**d 35 Nur Diet $P = 0.04$;

Flohr et al., 2013
Field Case

• May 2011 – Rachitic Rosary noted as an incidental finding in a necropsy survey of PWM, Confirmed histologically
• August 2011 – Reports of broken legs when loading out pigs (20 to 30 per 1,200 head barn)
• September 2011 – Survey of multiple feed samples Ca/Phos meet targets
• October 2011 – Submit Premix for analysis
## Premix Vitamin D₃, IU/lb

<table>
<thead>
<tr>
<th>Premix</th>
<th>Result</th>
<th>Expected</th>
<th>% of Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>GF VTM Lot 1</td>
<td>No measurable amount</td>
<td>250,000</td>
<td>NA</td>
</tr>
<tr>
<td>GF VTM Lot 2</td>
<td>No measurable amount</td>
<td>250,000</td>
<td>NA</td>
</tr>
<tr>
<td>Sow VTM Lot 1</td>
<td>169,875</td>
<td>500,000</td>
<td>34%</td>
</tr>
<tr>
<td>Sow VTM Lot 2</td>
<td>227,408</td>
<td>500,000</td>
<td>45%</td>
</tr>
<tr>
<td>Nur VTM Lot 1</td>
<td>373,688</td>
<td>400,000</td>
<td>93%</td>
</tr>
<tr>
<td>Nur VTM Lot 2</td>
<td>159,890</td>
<td>400,000</td>
<td>40%</td>
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</table>
# Slaughter Plant Defect Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>ARTH</th>
<th>BACK</th>
<th>CULL</th>
<th>RIBS</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>0.02%</td>
<td>1.90%</td>
<td>0.11%</td>
<td>0.04%</td>
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<tr>
<td>2011</td>
<td>1</td>
<td>0.03%</td>
<td>2.05%</td>
<td>0.07%</td>
<td>0.02%</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.03%</td>
<td>2.23%</td>
<td>0.06%</td>
<td>0.03%</td>
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<tr>
<td></td>
<td>3</td>
<td>0.02%</td>
<td>2.48%</td>
<td>0.06%</td>
<td>0.04%</td>
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<td>4</td>
<td>0.02%</td>
<td>2.42%</td>
<td>0.07%</td>
<td>0.02%</td>
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<td>5</td>
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<td>0.04%</td>
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<tr>
<td></td>
<td>6</td>
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<td>3.31%</td>
<td>0.05%</td>
<td>0.04%</td>
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<td>7</td>
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<tr>
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<td>8</td>
<td>0.03%</td>
<td>2.51%</td>
<td>0.02%</td>
<td>0.01%</td>
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<tr>
<td></td>
<td>9</td>
<td>0.02%</td>
<td>1.36%</td>
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<td>0.01%</td>
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<td></td>
<td>10</td>
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<tr>
<td></td>
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<td>0.01%</td>
<td>0.78%</td>
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<td>0.01%</td>
<td>0.59%</td>
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<tr>
<td>2012</td>
<td>1</td>
<td>0.02%</td>
<td>0.74%</td>
<td>0.01%</td>
<td>0.00%</td>
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<td>0.75%</td>
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<td>3</td>
<td>0.01%</td>
<td>0.56%</td>
<td>0.01%</td>
<td>0.00%</td>
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<td>4</td>
<td>0.02%</td>
<td>0.73%</td>
<td>0.02%</td>
<td>0.00%</td>
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</table>
Slaughter Plant Defect Data

<table>
<thead>
<tr>
<th>Periods</th>
<th>ARTH</th>
<th>BACK</th>
<th>CULL</th>
<th>RIBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan to Sept 11</td>
<td>0.03%</td>
<td>2.36%</td>
<td>0.07%</td>
<td>0.04%</td>
</tr>
<tr>
<td>Sept to Dec 11</td>
<td>0.02%</td>
<td>1.42%</td>
<td>0.02%</td>
<td>0.01%</td>
</tr>
<tr>
<td>Jan to May 12</td>
<td>0.01%</td>
<td>0.68%</td>
<td>0.01%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

| Relative Risk      | 1.9   | 3.5  | 8.4  | 56.9  |
| Affected per 100,000 Pigs |      |      |      |       |
| Jan to Sept 11     | 25    | 2360 | 67   | 35    |
| Sept to Dec 11     | 21    | 1425 | 16   | 10    |
| Jan to May 12      | 13    | 675  | 8    | 1     |

Little evidence of effects could be found when evaluating sow or growing pig performance
Comparison of vitamin D recommendations

<table>
<thead>
<tr>
<th>Source, IU/kg</th>
<th>NRC, 1998</th>
<th>NRC, 2012</th>
<th>KSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation</td>
<td>200</td>
<td>800</td>
<td>1378</td>
</tr>
<tr>
<td>Lactation</td>
<td>200</td>
<td>800</td>
<td>1378</td>
</tr>
<tr>
<td>Early nursery</td>
<td>220</td>
<td>220</td>
<td>1378</td>
</tr>
<tr>
<td>Late nursery</td>
<td>200</td>
<td>200</td>
<td>1378</td>
</tr>
<tr>
<td>Grower</td>
<td>150</td>
<td>150</td>
<td>827</td>
</tr>
<tr>
<td>Finisher</td>
<td>150</td>
<td>150</td>
<td>551</td>
</tr>
<tr>
<td>Paylean phase</td>
<td>150</td>
<td>150</td>
<td>413</td>
</tr>
</tbody>
</table>
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
Influence of enzyme blend and Diet Complexity on nursery ADG (d 0 – 18; initially 13 lb)

- Complexity linear, $P < 0.01$
- Enzyme, $P = 0.44$
- SEM = 0.023

<table>
<thead>
<tr>
<th>Diet Complexity</th>
<th>No Enzyme</th>
<th>Added Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.49</td>
<td>0.47</td>
</tr>
<tr>
<td>Medium</td>
<td>0.53</td>
<td>0.52</td>
</tr>
<tr>
<td>High</td>
<td>0.54</td>
<td>0.54</td>
</tr>
</tbody>
</table>

DeRouchev et al., 2012
Influence of enzyme blend and diet complexity on nursery F/G (d 0 – 18; initially 13 lb)

- Complexity linear, $P < 0.01$
- Enzyme, $P = 0.39$
- SEM = 0.030

**Legend:**
- No Enzyme
- Added Enzyme

<table>
<thead>
<tr>
<th>Diet Complexity</th>
<th>F/G No Enzyme</th>
<th>F/G Added Enzyme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1.44</td>
<td>1.46</td>
</tr>
<tr>
<td>Medium</td>
<td>1.36</td>
<td>1.39</td>
</tr>
<tr>
<td>High</td>
<td>1.37</td>
<td>1.37</td>
</tr>
</tbody>
</table>

DeRouchey et al., 2012
Influence of Easyzyme and Wheat Middlings on nursery ADG (Exp. 1; d 0 – 21; initially 22 lb)

- Easyzyme x diet, $P = 0.34$
- Easyzyme, $P = 1.00$
- Diet, $P = 0.0003$
- SEM = 0.02

Graham et al., 2012
Influence of Easyzyme and Wheat Middlings on nursery F/G (Exp. 1; d 0 – 21; initially 22 lb)

- Easyzyme x diet, \( P = 0.01 \)
- Easyzyme, \( P = 0.15 \)
- Diet, \( P = 0.001 \)
- SEM = 0.04

Graham et al., 2012
Influence of Easyzyme and Phytase in high by-product diets on nursery ADG (Exp. 2; d 0 – 21; initially 25 lb)

Easyzyme, $P = 0.37$
SEM = 0.02

Phytase, $P > 0.61$
SEM = 0.02

Graham et al., 2012
Influence of Easyzyme and Phytase in high by-product diets on nursery F/G (Exp. 2; d 0 – 21; initially 25 lb)

Easyzyme, $P = 0.001$
SEM = 0.02

Phytase, $P > 0.41$
SEM = 0.03

Graham et al., 2012
Effect of diet type and Microsource S on finishing pig performance (ADG, d 0 to 90)

Nitikanchana et al., 2012
Effect of diet type and Microsource S on finishing pig performance (FG, d 0 to 90)

Microsource NS
Diet Type P < 0.01  SEM = 0.032

- Control: 2.76
- MicroSource: 2.96
- 1.3x MicroSource: 2.94

Nitikanchana et al., 2012
Effect of diet type and Microsource S on Pen Wash Time (min/pen)

- Control: 6.3
- MicroSource: 8.7
- 1.3x MicroSource: 9.7

- Microsource NS
- Diet Type P < 0.01  SEM = 0.66

~2 hr more wash time for a 1,200 head barn when feeding DDGS/Bakery

Nitikanchana et al., 2012
KSU Swine Day 2012

Morning – Sows (Vitamin E, carnitine, chromium)

Vitamin D
Feed additives

Afternoon – Nursery (soy hulls, wheat middlings)
Grow-finish

• Wheat
• DDGS (low vs high oil)
• Feed processing
• Improvest
• Marketing
Wheat Middlings

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

• Wheat middlings
  – 16% CP; 89% the ME value of corn.
  – Wheat midds contain between 7.0 and 9.5% fiber.
  – Low bulk density (anywhere from 18 to 24 lb/cubic ft.) increases the volume of the feed unless they are pelleted at the flour mill.

• Wheat midds are commonly added to pelleted feeds because of its beneficial effects on pellet quality.
Effect of Wheat Middlings on nursery pig performance (d 0 to 35; 15 to 25 lb)

Linear $P > 0.11$
SEM = 0.03

Wheat Middlings

<table>
<thead>
<tr>
<th>Wheat Middlings</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.95</td>
</tr>
<tr>
<td>5%</td>
<td>0.96</td>
</tr>
<tr>
<td>10%</td>
<td>0.95</td>
</tr>
<tr>
<td>15%</td>
<td>0.93</td>
</tr>
<tr>
<td>20%</td>
<td>0.90</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Effect of Wheat Middlings on nursery pig performance (d 0 to 35; 15 to 25 lb)

Linear $P < 0.004$
SEM = 0.02

<table>
<thead>
<tr>
<th>Wheat Middlings</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.52</td>
</tr>
<tr>
<td>5%</td>
<td>1.48</td>
</tr>
<tr>
<td>10%</td>
<td>1.52</td>
</tr>
<tr>
<td>15%</td>
<td>1.53</td>
</tr>
<tr>
<td>20%</td>
<td>1.58</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Economics of Increasing Wheat Middlings in nursery pig diets (d 0 to 35; 15 to 25 lb)

- Feed cost/pig, $
- Linear $P > 0.25$
- $SEM = 0.205$

<table>
<thead>
<tr>
<th>Wheat Middlings</th>
<th>Feed cost/pig, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>7.62</td>
</tr>
<tr>
<td>5%</td>
<td>7.35</td>
</tr>
<tr>
<td>10%</td>
<td>7.40</td>
</tr>
<tr>
<td>15%</td>
<td>7.24</td>
</tr>
<tr>
<td>20%</td>
<td>7.29</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Economics of Increasing Wheat Middlings in nursery pig diets (d 0 to 35; 15 to 25 lb)

Linear $P < 0.14$
SEM = 0.409

<table>
<thead>
<tr>
<th>Wheat Middlings</th>
<th>IOFC, $/pig</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>14.09</td>
</tr>
<tr>
<td>5%</td>
<td>14.47</td>
</tr>
<tr>
<td>10%</td>
<td>14.26</td>
</tr>
<tr>
<td>15%</td>
<td>13.92</td>
</tr>
<tr>
<td>20%</td>
<td>13.38</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Effect of Wheat Middlings and DDGS in nursery pig diets (d 0 to 21; BW 27 to 54 lb)

- No Interactive or DDGS effects
- Midds linear, $P < 0.02$
- SEM = 0.029

De Jong et al., 2012
Effect of Wheat Middlings and DDGS in nursery pig diets (d 0 to 21; BW 27 to 54 lb)

No Interactive or DDGS effects
Midds linear, $P < 0.01$
SEM = 0.032

- No DDGS
- 20% DDGS

<table>
<thead>
<tr>
<th>Diet Type</th>
<th>F/G 1.60</th>
<th>F/G 1.64</th>
<th>F/G 1.65</th>
<th>F/G 1.66</th>
<th>F/G 1.71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-Soy</td>
<td>1.59</td>
<td>1.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10% Midds</td>
<td></td>
<td>1.64</td>
<td>1.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20% Midds</td>
<td></td>
<td></td>
<td></td>
<td>1.66</td>
<td>1.71</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Economics of Wheat Middlings and DDGS in nursery pig diets (d 0 to 21; BW 27 to 54 lb)

- **No DDGS**
  - Corn-Soy: 53.4 lb/bu
  - 10% Midds: 48.7 lb/bu
  - 20% Midds: 46.4 lb/bu

- **20% DDGS**
  - Corn-Soy: 48.8 lb/bu
  - 10% Midds: 44.9 lb/bu
  - 20% Midds: 42.4 lb/bu

*De Jong et al., 2012*
Effect of Wheat Middlings and NE Formulation on nursery pig performance (d 0 to 29; BW 15 to 43 lb)

Midds × balanced NE interaction, $P > 0.95$
Midds, level, $P = 0.12$
NE formulation, $P = 0.13$
SEM = 0.021

<table>
<thead>
<tr>
<th>Added fat:</th>
<th>Midds:</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>None</td>
<td>0.97</td>
</tr>
<tr>
<td>0%</td>
<td>10%</td>
<td>0.97</td>
</tr>
<tr>
<td>0%</td>
<td>20%</td>
<td>0.94</td>
</tr>
<tr>
<td>1.4%</td>
<td>10%</td>
<td>1.00</td>
</tr>
<tr>
<td>2.8%</td>
<td>20%</td>
<td>0.97</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Effect of Wheat Middlings and NE Formulation on nursery pig performance (d 0 to 29; BW 15 to 43 lb)

- Midds × balanced NE interaction, $P > 0.34$
- Midds linear, $P < 0.06$
- Midds level, $P < 0.01$
- NE formulation, $P = 0.35$
- SEM = 0.025

De Jong et al., 2012
Economics of increasing Wheat Middlings and NE Formulation in nursery pigs (d 0 to 29; BW 15 to 43 lb)

<table>
<thead>
<tr>
<th>Added fat:</th>
<th>0%</th>
<th>0%</th>
<th>0%</th>
<th>1.4%</th>
<th>2.8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midds:</td>
<td>None</td>
<td>10%</td>
<td>20%</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>Cost/pig, $</td>
<td>9.18</td>
<td>8.94</td>
<td>9.03</td>
<td>9.57</td>
<td>9.60</td>
</tr>
</tbody>
</table>

Midds × balanced NE interaction, $P > 0.88$
Midds, level, $P > 0.79$
NE formulation, $P = 0.01$
SEM = 0.200

De Jong et al., 2012
Economics of increasing Wheat Middlings and NE Formulation in nursery pigs (d 0 to 29; BW 15 to 43 lb)

- Midds × balanced NE interaction, $P > 0.81$
- Midds quadratic, $P > 0.12$
- Midds, level, $P > 0.02$
- NE formulation, $P = 0.96$
- SEM = 0.270

<table>
<thead>
<tr>
<th>Midds:</th>
<th>None</th>
<th>10%</th>
<th>20%</th>
<th>10%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Added fat:</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>1.4%</td>
<td>2.8%</td>
</tr>
<tr>
<td>IOFC, $$/pig</td>
<td>9.19</td>
<td>9.35</td>
<td>8.62</td>
<td>9.30</td>
<td>8.70</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
KSU Swine Day 2012

Morning  – Sows (Vitamin E, carnitine, chromium)
          Vitamin D
          Feed additives
Afternoon – Nursery (soy hulls, wheat middlings)
          Grow-finish
          • Wheat
          • DDGS (low vs high oil)
          • Feed processing
          • Improvest
          • Marketing
Soybean Hulls

• During the soybean crush process, the hulls is separated which represents ~8% of the seed.

• Soybean hulls
  – 10.3% CP; 1.3% fat; 50% the ME of corn (NRC, 2012).

• High fiber, bulky ingredient typically used in ruminant rations.

• Very little information is available on nursery and finishing diets.
  – Research supported by National Pork Board
Effect of Soybean Hulls and DDGS in nursery pig diets (Exp. 1, d 0 to 42; BW 15 to 65 lb)

- No Interactive effect
- Soybean hulls w/out DDGS, $P > 0.28$
- Soybean hulls with DDGS, quadratic $P < 0.05$
- SEM = 0.036

Soybean Hulls:

- 0%: 1.25
- 3%: 1.20
- 6%: 1.21
- 9%: 1.22
- 12%: 1.24

DDGS added:

- 0%: 1.19
- 3%: 1.20
- 6%: 1.22
- 9%: 1.18
- 12%: 1.09

Goehring et al., 2012
Effect of Soybean Hulls and DDGS in nursery pig diets (Exp. 1, d 0 to 42; BW 15 to 65 lb)

<table>
<thead>
<tr>
<th>Soybean Hulls Level (%)</th>
<th>No DDGS</th>
<th>DDGS added</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.51</td>
<td>1.48</td>
</tr>
<tr>
<td>3%</td>
<td>1.54</td>
<td>1.47</td>
</tr>
<tr>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9%</td>
<td>1.57</td>
<td>1.55</td>
</tr>
<tr>
<td>12%</td>
<td>1.51</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Hulls level x DDGS, quadratic $P < 0.05$
Soybean hulls w/out DDGS, $P < 0.03$
Soybean hulls with DDGS, quadratic $P < 0.01$
SEM = 0.024

Goehring et al., 2012
Main Effects of Soybean Hulls on nursery pig performance (Exp. 1, d 0 to 42; BW 15 to 65 lb)

No effects, $P > 0.23$
SEM = 0.026

<table>
<thead>
<tr>
<th>Soybean Hulls</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.22</td>
</tr>
<tr>
<td>3%</td>
<td>1.20</td>
</tr>
<tr>
<td>6%</td>
<td>1.22</td>
</tr>
<tr>
<td>9%</td>
<td>1.20</td>
</tr>
<tr>
<td>12%</td>
<td>1.17</td>
</tr>
</tbody>
</table>

Goehring et al., 2012
Main Effects of Soybean Hulls on nursery pig performance (Exp. 1, d 0 to 42; BW 15 to 65 lb)

Soybean hulls linear, $P < 0.03$

SEM = 0.018

Goehring et al., 2012
Effects of Soybean Hulls on nursery pig performance (Exp. 3, d 0 to 34; BW 15 to 47 lb)

Soybean hulls, linear $P < 0.01$
SEM = 0.024

Goehring et al., 2012
Effects of Soybean Hulls on nursery pig performance (Exp. 3, d 0 to 34; BW 15 to 47 lb)

Soybean hulls, linear $P < 0.0001$
SEM = 0.024

Soybean Hulls

0% 1.54
5% 1.53
10% 1.62
15% 1.65
20% 1.67

Goehring et al., 2012
Effects of Soybean Hulls on nursery pig performance (Exp. 3, d 0 to 34; BW 15 to 47 lb)

Soybean hulls, linear $P < 0.02$
SEM = 23.5

NE, kcal/lb gain

<table>
<thead>
<tr>
<th>Soybean Hulls</th>
<th>0%</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,658</td>
<td>1,592</td>
<td>1,633</td>
<td>1,600</td>
<td>1,561</td>
</tr>
</tbody>
</table>

Goehring et al., 2012
Effects of soybean hulls level and particle size on finishing pigs (0 to 118; BW 68 to 280 lb)

- Soybean hull particle size, $P > 0.34$
- Soybean hulls level, $P > 0.45$
- SEM = 0.022

**Graph:**
- 0% Ground hulls (370 µ)
- 7.5% Unground hulls (787 µ)
- 15% Unground hulls (787 µ)

**Values:**
- 0%: 1.84
- 7.5%: 1.85
- 7.5%: 1.85
- 15%: 1.81
- 15%: 1.86

Goehring et al., 2012
Effects of soybean hulls level and particle size on finishing pigs (0 to 118; BW 68 to 280 lb)

Soybean hull particle size, $P < 0.04$
Soybean hulls level, $P > 0.26$
Soybean hulls linear, $P < 0.02$
SEM = 0.026

- Ground hulls (370 µ)
- Unground hulls (787 µ)

Goehring et al., 2012
Effects of soybean hulls level and particle size on finishing pigs (0 to 118; BW 68 to 280 lb)

Soybean hull particle size, $P < 0.03$
Soybean hulls level, $P < 0.0002$
Soybean hulls linear, $P < 0.0001$
SEM = 28.6

Goehring et al., 2012
Effects of soybean hulls level and particle size on finishing pigs (0 to 118; BW 68 to 280 lb)

Soybean hull particle size, $P > 0.55$
Soybean hulls level, $P > 0.12$
Soybean hulls linear, $P < 0.001$
SEM = 0.361

Ground hulls (370 µ)
Unground hulls (787 µ)

Carcass Yield, %

<table>
<thead>
<tr>
<th>Soybean Hulls</th>
<th>0</th>
<th>7.5%</th>
<th>15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Hulls</td>
<td>76.26</td>
<td>75.23</td>
<td>75.16</td>
</tr>
<tr>
<td>Unground Hulls</td>
<td></td>
<td>75.42</td>
<td>74.96</td>
</tr>
</tbody>
</table>

Goehring et al., 2012
Soybean Hulls Summary

- 5-10% in nursery diets had minimal effects on growth performance.
- 7.5% in finishing did not affect ADG or F/G.
- Grinding soybean hulls did not improve performance in nursery and finishing pigs.
- Feeding soybean hulls through marketing reduces carcass yield, similar to other high fiber containing ingredients.
Bakery Meal

• **Things to recognize:**
  • Bakery products can vary in fat content which directly affects the assigned energy value.
    – NRC, 2012
      • Bakery = 8.1% fat, 1,749 kcal/lb ME (+13.6% ↑ME vs. corn)
      • Corn = 3.5% fat, 1,540 kcal/lb ME
  • Many bakery products contain lower levels of fat than book values. Recent analysis from a Midwest commercial mill using bakery:
    • Bakery = 6.4% Fat, Calculated ME value was 92% of corn
Effects of bakery meal on finishing pig performance (Exp. 1, d 0 to 102; BW 78 to 280 lb)

Bakery, quadratic $P < 0.07$
SEM = 0.01

ADG, lb

<table>
<thead>
<tr>
<th>Bakery meal</th>
<th>0.0%</th>
<th>7.5%</th>
<th>15.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.06</td>
<td>2.02</td>
<td>2.05</td>
</tr>
</tbody>
</table>

Paulk et al., 2012
Effects of bakery meal on finishing pig performance (Exp. 1, d 0 to 102; BW 78 to 280 lb)

Bakery, quadratic $P > 0.50$
SEM = 0.02

<table>
<thead>
<tr>
<th>Bakery meal</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0%</td>
<td>2.63</td>
</tr>
<tr>
<td>7.5%</td>
<td>2.68</td>
</tr>
<tr>
<td>15.0%</td>
<td>2.70</td>
</tr>
</tbody>
</table>

Paulk et al., 2012
Effects of bakery meal on finishing pig performance (Exp. 1, d 0 to 102; BW 78 to 280 lb)

Bakery, linear $P > 0.0001$
SEM = 34

Bakery meal

- 0.0%: 4,052 kcal/lb gain
- 7.5%: 4,160 kcal/lb gain
- 15.0%: 4,218 kcal/lb gain

Paulk et al., 2012
Effects of bakery meal on finishing pig performance (Exp. 1, d 0 to 102; BW 78 to 280 lb)

Bakery, linear $P < 0.09$
SEM = 0.6

Bakery meal

- 0.0%
- 7.5%
- 15.0%

Paulk et al., 2012
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
Effects of wheat and synthetic amino acid level on nursery pig performance (d 0 to 21; BW 27 to 52 lb)

Wheat, linear $P < 0.08$
0 vs 50% wheat, $P > 0.75$
Synthetic AA level in wheat diets, $P > 0.23$
SEM = 0.021

<table>
<thead>
<tr>
<th></th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>1.21</td>
</tr>
<tr>
<td>50% Corn:Wheat</td>
<td>1.22</td>
</tr>
<tr>
<td>Wheat, Maximum</td>
<td>1.15</td>
</tr>
<tr>
<td>Wheat, Moderate</td>
<td>1.19</td>
</tr>
</tbody>
</table>

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on nursery pig performance (d 0 to 21; BW 27 to 52 lb)

Wheat, linear $P > 0.44$
0 vs 50% wheat, $P > 0.99$
Synthetic AA level in wheat diets, $P < 0.07$
SEM = 0.018

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on finishing pig performance (d 0 to 61; BW 160 to 270 lb)

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on finishing pig performance (d 0 61)

<table>
<thead>
<tr>
<th>Diet</th>
<th>BW, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>270.9</td>
</tr>
<tr>
<td>50% Corn:Wheat</td>
<td>270.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>265.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>266.1</td>
</tr>
</tbody>
</table>

- Wheat, $P > 0.18$
- 0 vs 50% wheat, $P > 0.86$
- Synthetic AA level in wheat diets, $P > 0.68$
- SEM = 3.14

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on finishing pig performance (d 0 to 61; BW 160 to 270 lb)

Wheat, linear $P < 0.003$
0 vs 50% wheat, $P > 0.32$
Synthetic AA level in wheat diets, $P > 0.73$
SEM = 0.029

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on finishing pig performance (d 0 61)

- Wheat, $P > 0.37$
- 0 vs 50% wheat, $P > 0.51$
- Synthetic AA level in wheat diets, $P > 0.21$
- SEM = 0.19

<table>
<thead>
<tr>
<th></th>
<th>Carcass Yield, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>73.4</td>
</tr>
<tr>
<td>50% Corn:Wheat</td>
<td>73.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>73.4</td>
</tr>
<tr>
<td>Wheat</td>
<td>73.1</td>
</tr>
</tbody>
</table>

Goehring et al., 2012
Effects of wheat and synthetic amino acid level on finishing pig performance (d 0 61)

<table>
<thead>
<tr>
<th></th>
<th>Jowl fat iodine value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>68.9</td>
</tr>
<tr>
<td>50% Corn:Wheat</td>
<td>67.7</td>
</tr>
<tr>
<td>Wheat</td>
<td>67.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>67.4</td>
</tr>
</tbody>
</table>

Wheat, linear $P < 0.001$
0 vs 50% wheat, $P < 0.002$
Synthetic AA level in wheat diets, $P > 0.27$
SEM = 0.24
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:
    - 113% of corn price on bu:bu
    - 105% of corn price on wt:wt
Dried Distillers Grains with Solubles Research

1. Tryptophan requirements with DDGS
2. Fiber (from DDGS and wheat midds) withdrawal × Paylean
3. Medium-oil DDGS study
4. Evaluating energy in DDGS
5. Preliminary data - High- vs. low-oil DDGS
SID Trp:Lys ratio and Trp source for finishing pigs (Exp. 6; d 0 to 56; BW 156 to 285 lb)

- Trp x source P = 0.20
- Source P = 0.07
- Trp quad P < 0.01
- SEM = 0.026

ADG, lb

<table>
<thead>
<tr>
<th>SID Trp:Lys</th>
<th>16%</th>
<th>18%</th>
<th>20%</th>
<th>22%</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Trp</td>
<td>1.98</td>
<td>2.02</td>
<td>2.13</td>
<td>2.04</td>
</tr>
<tr>
<td>SBM</td>
<td></td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nitikanchana et al., 2012
SID Trp:Lys ratio and Trp source for finishing pigs (Exp. 6; d 0 to 56; BW 156 to 285 lb)

- Trp x source P = 0.20
- Trp quad P < 0.01
- SEM = 0.026

Nitikanchana et al., 2012
SID Trp:Lys ratio and Trp source for finishing pigs (Exp. 6; d 0 to 56; BW 156 to 285 lb)

<table>
<thead>
<tr>
<th>SID Trp:Lys</th>
<th>Feed/gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>16%</td>
<td>3.16</td>
</tr>
<tr>
<td>18%</td>
<td>3.02</td>
</tr>
<tr>
<td>20%</td>
<td>3.02</td>
</tr>
<tr>
<td>22%</td>
<td>3.09</td>
</tr>
</tbody>
</table>

Trp x source P = 0.03
Trp quad P < 0.01
SEM = 0.014

<table>
<thead>
<tr>
<th>Trp source</th>
<th>Feed/gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Trp</td>
<td>3.05</td>
</tr>
<tr>
<td>SBM</td>
<td>3.04</td>
</tr>
</tbody>
</table>

Source P = 0.70
SEM = 0.014

Nitikanchana et al., 2012
SID Trp:Lys ratio and Trp source for finishing pigs (Exp. 6; d 0 to 56; BW 156 to 285 lb)

- Trp x source P > 0.01
- Source P = 0.23
- Trp quad P > 0.15
- SEM = 0.61

Yield, %

- 16%: L-Trp 74.3, SBM 75.8
- 18%: L-Trp 75.4, SBM 75.8
- 20%: L-Trp 74.7, SBM 74.6
- 22%: L-Trp 74.6, SBM 74.6

Nitikanchana et al., 2012
SID Trp:Lys ratio and Trp source for finishing pigs (Exp. 6; d 0 to 56; BW 156 to 285 lb)

- Trp x source $P > 0.31$
- Source $P = 0.30$
- Trp quad $P < 0.01$
- $SEM = 8.4$

<table>
<thead>
<tr>
<th>SID Trp:Lys</th>
<th>L-Trp</th>
<th>SBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>16%</td>
<td>205.2</td>
<td>205.2</td>
</tr>
<tr>
<td>18%</td>
<td>207.5</td>
<td>207.5</td>
</tr>
<tr>
<td>20%</td>
<td>210.3</td>
<td>211.8</td>
</tr>
<tr>
<td>22%</td>
<td>209.5</td>
<td>209.5</td>
</tr>
</tbody>
</table>

Nitikanchana et al., 2012
Fiber withdrawal before marketing in combination with Paylean

• Day 0 to 49
  – Pigs fed either a corn-soybean meal diet (1/3) or one with 30% DDGS and 19% midds (2/3).
  – Pigs fed the corn-soybean meal diets had 6% better ADG and 4% better F/G.

• Day 49 to 73
  – Pigs remained on the corn-soybean meal diet.
  – Pigs switched from high fiber diet to corn-soybean meal diet.
  – Pigs remained on high fiber.
  – All treatments with or without 9 g/ton Paylean.

<table>
<thead>
<tr>
<th></th>
<th>Corn-soy</th>
<th>High fiber</th>
<th>High fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-soy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High fiber</td>
<td>Corn-soy</td>
<td>High fiber</td>
<td></td>
</tr>
</tbody>
</table>
Effect of fiber level and Paylean on finishing pig performance (d 49 to 73; BW 230 to 285 lb)

- **Control**:
  - d 0 to 49: Corn-soy
  - d 49 to 73: Corn-soy
  - ADG: 2.00

- **Paylean**:
  - d 0 to 49: High fiber
  - d 49 to 73: Corn-soy
  - ADG: 2.46

Paylean P < 0.001
Withdrawal P = 0.002
Corn-soy vs fiber P < 0.02
SEM = 0.20

Graham et al., 2012
Effect of fiber level and Paylean on finishing pig performance (d 49 to 73; BW 230 to 285 lb)

Paylean P < 0.001
Withdrawal P = 0.01
Corn-soy vs fiber P < 0.001
SEM = 0.18

Graham et al., 2012
Effect of fiber level and Paylean on finishing pig performance (d 0 to 73; BW 123 to 285 lb)

- Interaction $P = .92$
- Paylean $P < 0.001$
- Withdrawal $P = 0.01$
- Corn-soy vs fiber $P < 0.03$
- SEM = 0.12

**Graham et al., 2012**
Effect of fiber level and Paylean on finishing pig performance (d 0 to 73; BW 123 to 285 lb)

Paylean P < 0.001
Withdrawal P = 0.64
Corn-soy vs fiber P < 0.001
SEM = 0.10

Graham et al., 2012
Effect of fiber level and Paylean on finishing pig performance (d 73)

Paylean P < 0.001
Withdrawal P < 0.01
Corn-soy vs fiber P < 0.001
SEM = 0.19

<table>
<thead>
<tr>
<th>Yield, %</th>
<th>Control</th>
<th>Paylean</th>
</tr>
</thead>
<tbody>
<tr>
<td>74.2</td>
<td>75.1</td>
<td></td>
</tr>
<tr>
<td>73.7</td>
<td></td>
<td>74.6</td>
</tr>
<tr>
<td>72.8</td>
<td></td>
<td>73.6</td>
</tr>
</tbody>
</table>

d 0 to 49:
- Corn-soy
- High fiber
- High fiber

d 49 to 73:
- Corn-soy
- Corn-soy
- High fiber

Graham et al., 2012
Effect of fiber level and Paylean on finishing pig performance (d 73)

Paylean P < 0.001
Withdrawal P = 0.01
Corn-soy vs fiber P < 0.001
SEM = 2.76

Carcass weight, lb

<table>
<thead>
<tr>
<th></th>
<th>d 0 to 49:</th>
<th>d 49 to 73:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>203.2</td>
<td>195.0</td>
</tr>
<tr>
<td>Paylean</td>
<td>215.3</td>
<td>201.4</td>
</tr>
<tr>
<td>Corn-soy High</td>
<td>210.5</td>
<td>Corn-soy</td>
</tr>
<tr>
<td>High fiber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High fiber</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graham et al., 2012
Effect of fiber level and Paylean on full large intestine weight (d 73)

Paylean P < 0.70
Withdrawal P = 0.003
Corn-soy vs fiber P < 0.001
SEM = 0.65

Graham et al., 2012
Effect of fiber level and Paylean on finishing pig performance (d 73)

- Control
- Paylean

Paylean P = 0.74
Withdrawal P < 0.01
Corn-soy vs fiber P < 0.01
SEM = 0.86

Graham et al., 2012

<table>
<thead>
<tr>
<th></th>
<th>d 0 to 49</th>
<th>d 49 to 73</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn-soy</strong></td>
<td>High fiber</td>
<td>High fiber</td>
</tr>
<tr>
<td><strong>High fiber</strong></td>
<td>Corn-soy</td>
<td>High fiber</td>
</tr>
</tbody>
</table>

65.1 64.3
72.4 73.2
69.3 70.0
Summary – Fiber × Paylean

• Feeding high fiber diets containing DDGS and midds decreased growth performance and carcass yield and increased IV compared with those fed a corn-soybean meal diet.

• Withdrawing the high fiber diet and switching to a corn-soybean meal diet for the last 24 d before harvest partially mitigated these negative effects.

• Feeding RAC for the last 24 d before market, regardless of dietary regimen, improved growth performance and carcass yield.
Effect of medium-oil DDGS on pig performance (d 0 to 67; BW 152 to 280 lb)

Linear $P > 0.01$
SEM = 0.02

Medium-oil DDGS

<table>
<thead>
<tr>
<th>Percentage</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>1.93</td>
</tr>
<tr>
<td>15%</td>
<td>1.87</td>
</tr>
<tr>
<td>30%</td>
<td>1.85</td>
</tr>
<tr>
<td>45%</td>
<td>1.80</td>
</tr>
</tbody>
</table>

7.4% fat,
28.1% CP,
10.8% ADF,
25.6% NDF

Graham et al., 2012
Effect of medium oil DDGS on pig performance (d 0 to 67; BW 152 to 280 lb)

Medium-oil DDGS (7.4% oil)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>F/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>3.13</td>
</tr>
<tr>
<td>15%</td>
<td>3.19</td>
</tr>
<tr>
<td>30%</td>
<td>3.20</td>
</tr>
<tr>
<td>45%</td>
<td>3.26</td>
</tr>
</tbody>
</table>

Linear $P > 0.02$
SEM = 0.04

Graham et al., 2012
Effect of medium oil DDGS on pig performance (d 0 to 67; BW 152 to 280 lb)

Linear $P > 0.02$

SEM = 0.04

Medium-oil DDGS (7.4% oil)

Graham et al., 2012
Effect of medium oil DDGS on pig performance (d 0 to 67; BW 152 to 280 lb)

Linear $P > 0.02$
SEM = 0.04

Medium-oil DDGS (7.4% oil)

<table>
<thead>
<tr>
<th>Medium-oil DDGS (%)</th>
<th>Jowl fat iodine value, mg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>70.2</td>
</tr>
<tr>
<td>15%</td>
<td>71.1</td>
</tr>
<tr>
<td>30%</td>
<td>73.7</td>
</tr>
<tr>
<td>45%</td>
<td>76.3</td>
</tr>
</tbody>
</table>

Graham et al., 2012
Energy Systems for Swine

- Gross Energy
  - Digestible Energy
    - Metabolizable Energy
      - Net Energy
        - Feces
        - Urine & gas
        - Heat of digestion
Evaluating Energy in Ingredients

If caloric efficiency improves (F/G gets better)
Then we underestimated the energy content of the ingredient – its energy is greater than what we initially thought

Poor

Good

Increasing amount of test ingredient
Evaluating Energy in Ingredients

If caloric efficiency worsens (F/G gets poorer)
Then we overestimated the energy content of the ingredient – its energy is less than what we initially thought

Poor

Caloric Efficiency

Good

Increasing amount of test ingredient
Evaluating Energy in Ingredients

If caloric efficiency doesn’t change at all
Then we correctly estimated the energy content of the ingredient – we pegged it!
Effect of medium-oil DDGS on pig performance on caloric efficiency

![Graph showing the effect of medium-oil DDGS on pig performance on caloric efficiency. The graph indicates that ME, linear, $P < 0.02$ and NE, no difference. The graph includes data from Graham et al., 2012.](image_url)
Preliminary Data: Effect of high- vs low-oil DDGS on finishing pig performance (d 0 to 60; BW 100 to 230 lb)

ADG

Control 20% Low 40% High

2.18 2.15 2.14 2.15

Graham et al., 2013
Preliminary Data: Effect of high- vs low-oil DDGS on finishing pig performance (d 0 to 60; BW 100 to 230 lb)

Control 20% 40% Low 20% 40% High

2.49 2.57 2.68 2.48 2.50

Graham et al., 2013
Preliminary Estimates of Net Energy values for DDGS Sources with Different Oil Concentrations

\[ y = 187.5x + 1945.7 \]

\[ R^2 = 0.9895 \]
Corn DDGS quality control

• Variability in DDGS quality
  – Main issue is fat level
    • Low = < 5% fat 4.0 80.0%
    • Medium = 6 to 9% fat 7.5 87.5%
    • High = > 9% fat 11.0 95.0%
  – Need to monitor DDGS quality or work with company that monitors DDGS quality
  – Ethanol plants guarantee often underestimate the true oil content – guarantee 6% but really 9%
Update on Feed Processing Research
Effect of particle size and diet form on finishing pig performance (d 0 to 111; BW 57 to 288 lb)

<table>
<thead>
<tr>
<th>Particle Size and PortionGround</th>
<th>ADG, lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 micron corn</td>
<td>2.02</td>
</tr>
<tr>
<td>300 micron corn</td>
<td>2.06</td>
</tr>
<tr>
<td>300 micron diet</td>
<td>1.99</td>
</tr>
</tbody>
</table>

- 300 vs 600 microns $P < 0.15$
- Grind x form $P < 0.001$
- Grind $P = 0.89$; Form $P < 0.001$
- SEM = 0.018

De Jong et al., 2012
Effect of particle size and diet form on finishing pig performance (d 0 to 111; BW 57 to 288 lb)

300 vs 600 microns $P < 0.001$
Grind x form $P = 0.37$
Grind $P = 0.52$; Form $P < 0.001$
SEM = 0.03

Particle size and portion ground

F/G

<table>
<thead>
<tr>
<th>600 micron corn</th>
<th>300 micron corn</th>
<th>300 micron diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal 2.82</td>
<td>Pellet 2.71</td>
<td>Meal 2.74</td>
</tr>
<tr>
<td></td>
<td>300 micron corn</td>
<td></td>
</tr>
<tr>
<td>Pellet 2.60</td>
<td></td>
<td>300 micron diet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pellet 2.60</td>
</tr>
</tbody>
</table>

De Jong et al., 2012
Effect of particle size and diet form on finishing pig performance (d 0 to 111; BW 57 to 288 lb)

- 300 vs 600 microns $P < 0.01$
- Grind x form $P = 0.15$
- Grind $P = 0.03$; Form $P < 0.001$
- SEM = 1.143

Income over feed cost, $/pig

- 600 micron corn: $53.27
- 300 micron corn: $57.94
- 300 micron diet: $53.96
- Meal: $62.20
- Pellet: $61.35

Particle size and portion ground

De Jong et al., 2012
Effects of particle size on feed efficiency

1.2% per 100 microns

1.0% per 100 microns

F/G

Particle size, microns

Cabrera, 1994a
Cabrera, 1994b
Wondra, 1995
Paulk, 2011
DeJong, 2012

Particle size, microns
<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>Groesbeck et al. (2005)</td>
<td>0.83</td>
<td>1.25</td>
</tr>
<tr>
<td>Groesbeck et al. (2005)</td>
<td>0.62</td>
<td>1.43</td>
</tr>
<tr>
<td>Groesbeck et al. (2006)</td>
<td>0.80</td>
<td>1.25</td>
</tr>
<tr>
<td>Potter et al. (2009)</td>
<td>1.95</td>
<td>2.12</td>
</tr>
<tr>
<td>Potter et al. (2009)</td>
<td>1.92</td>
<td>2.83</td>
</tr>
<tr>
<td>Myers et al. (2010)</td>
<td>1.81</td>
<td>2.76</td>
</tr>
<tr>
<td>Potter et al. (2010)</td>
<td>1.92</td>
<td>2.86</td>
</tr>
<tr>
<td>Frobose et al. (2011)</td>
<td>1.46</td>
<td>1.72</td>
</tr>
<tr>
<td>Frobose et al. (2011)</td>
<td>1.29</td>
<td>1.51</td>
</tr>
<tr>
<td>Myers et al. (2011)</td>
<td>1.96</td>
<td>2.73</td>
</tr>
<tr>
<td>Paulk et al. (2011)</td>
<td>2.50</td>
<td>2.75</td>
</tr>
<tr>
<td>Paulk et al. (2011)</td>
<td>2.31</td>
<td>2.50</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>1.61</strong></td>
<td><strong>2.14</strong></td>
</tr>
</tbody>
</table>

Average response = 5.0% for ADG and 4.0% for F/G
Effects of feeder adjustment and pellet quality on ADG

Feeder opening and diet form P < 0.05

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

<table>
<thead>
<tr>
<th>Feeder opening, in.</th>
<th>0.75</th>
<th>1.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meal</td>
<td>1.59</td>
<td>1.59</td>
</tr>
<tr>
<td>Pellets</td>
<td>1.57</td>
<td>1.57</td>
</tr>
<tr>
<td>Pellets with 30% fines</td>
<td>1.56</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Diet form P < 0.05

Nemecheck et al. 2012
Effects of feeder adjustment and pellet quality on finisher ADG

Diet form $P = 0.08$

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

Diet form $P < 0.001$; Feeder adjust. $P < 0.03$

Nemecheck et al. 2012
• Wide feeder adjustment with 50% fines

• Wide feeder adjustment with 10% fines
Effect of fiber level and diet form on finishing pig performance (d 0 to 81; BW 109 to 287 lb)

Interaction $P = .83$
Pellet $P = 0.03$
Diet $P = 0.35$
SEM = 0.038

Nemechek et al., 2012
Effect of fiber level and diet form on finishing pig performance (d 0 to 81; BW 109 to 287 lb)

Interaction $P = 0.19$
Pellet $P = 0.001$
Diet $P = 0.001$
SEM = 0.037

- **d 0 to 64**: Corn-soy | High fiber | High fiber
- **d 64 to 81**: Corn-soy | Corn-soy | High fiber

Nemechek et al., 2012
Effect of fiber level and diet form on finishing pig performance (d 81; BW 287 lb)

Interaction $P = 0.88$

Pellet $P = 0.28$

Diet $P = 0.001$

SEM = 0.24

<table>
<thead>
<tr>
<th>Yield, %</th>
<th>Meal</th>
<th>Pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.1</td>
<td>75.0</td>
<td></td>
</tr>
<tr>
<td>74.7</td>
<td>74.8</td>
<td></td>
</tr>
<tr>
<td>74.1</td>
<td>73.4</td>
<td></td>
</tr>
</tbody>
</table>

- d 0 to 64:
  - Corn-soy
  - High fiber
  - High fiber

- d 64 to 81:
  - Corn-soy
  - Corn-soy
  - High fiber

Nemechek et al., 2012
Effect of fiber level and diet form on finishing pig belly fat iodine value (d 81; BW 287 lb)

Interaction $P = 0.003$
Pellet $P < 0.001$
Diet $P < 0.001$
SEM = 0.38

$d_0$ to $d_{64}$:
- Corn-soy
- High fiber
- High fiber

$d_{64}$ to $d_{81}$:
- Corn-soy
- Corn-soy
- High fiber

Nemechek et al., 2012
Effect of DDGS withdrawal on IC pigs

• 2 x 3 factorial
  – Physical castrated barrows vs immunocastrates
    • 2 ml primer dose on d 39 (110 d of age)
    • 2 ml second dose on d 74 (145 d of age)
    • Quality assurance check on d 88 (21 of 680 pigs)
  – DDGS duration
    • 0% throughout
    • 30% throughout
    • 30% from d 0 to 74 (200 lb), then 0% from d 74 to 125

<table>
<thead>
<tr>
<th>Wt, lb:</th>
<th>53</th>
<th>200</th>
<th>260</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day:</td>
<td>0</td>
<td>39</td>
<td>74</td>
<td>107</td>
</tr>
</tbody>
</table>
Effect of DDGS removal on performance of barrows and IC pigs

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs (d 0 to 125; BW 53 to 300 lb)

- Interaction $P = 0.89$
- Gender $P < 0.003$
- Diet $P = 0.37$
- SEM = 0.02

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs (d 0 to 125; BW 53 to 300 lb)

- Interaction $P = 0.33$
- Gender $P < 0.001$
- Diet $P = 0.01$
- SEM = 0.02

**F/G**

<table>
<thead>
<tr>
<th></th>
<th>Barrow</th>
<th>IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>d 0 to 74:</td>
<td>2.54</td>
<td>2.38</td>
</tr>
<tr>
<td>d 74 to 125:</td>
<td>2.62</td>
<td>2.45</td>
</tr>
<tr>
<td></td>
<td>2.59</td>
<td>2.48</td>
</tr>
</tbody>
</table>

- d 0 to 74: Corn-soy 30% DDGS 30% DDGS
- d 74 to 125: Corn-soy Corn-soy 30% DDGS

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs (d 125; BW 300 lb)

Interaction $P = .89$
Gender $P < 0.002$
Diet $P = 0.70$
SEM = 3.21

Asmus et al., 2012
Effect of DDGS removal on performance of barrows and IC pigs (d 125)

Interaction $P = 0.41$
Gender $P < 0.001$
Diet $P = 0.001$
SEM = 0.16

Yield, %

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Yield</th>
<th>Gender</th>
<th>Diet</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>d 0 to 74: Corn-soy</td>
<td>76.3</td>
<td>Barrow</td>
<td>30% DDGS</td>
<td>0.16</td>
</tr>
<tr>
<td>d 0 to 74: 30% DDGS</td>
<td>76.2</td>
<td>IC</td>
<td>30% DDGS</td>
<td></td>
</tr>
<tr>
<td>d 74 to 125: Corn-soy</td>
<td>75.8</td>
<td>Barrow</td>
<td>Corn-soy</td>
<td></td>
</tr>
<tr>
<td>d 74 to 125: 30% DDGS</td>
<td>74.0</td>
<td>IC</td>
<td>30% DDGS</td>
<td></td>
</tr>
</tbody>
</table>

Asmus et al., 2012

K-State Research and Extension
New Horizon Farms LLP
Knowledge for Life
Effect of DDGS removal on performance of barrows and IC pigs (d 125)

Interaction $P = 0.94$
Gender $P < 0.30$
Diet $P = 0.23$
SEM = 2.28

Asmus et al., 2012
Effect of DDGS withdrawal on IC barrows

• Response to DDGS withdrawal was similar to our other research.

• Immunocastrates had reduced carcass yield, regardless of diet type; however, they also had lower ADFI and improved ADG, which resulted in improved F/G.

• Although Improvest barrows can increase IV of fat depots when pigs are harvested at 5 wk post 2nd injection, extending the length of feeding duration prior to harvest after the second injection returns IV to values similar to physically-castrated barrows.
Abstract # SO0296
Meta-analysis comparing growth performance, carcass characteristics, and water usage of pigs fed using conventional dry or wet-dry feeder

Sureemas Nitikanchana, Kansas State University

Best Production Medicine Abstract
2012 International Pig Veterinary Society
Introduction

Recent research at K-State (2010 – 2011) in commercial facility

- Bergstrom (6 studies)
  - ↑ ADG, ↑↓ ADFI, G:F ??
  - ↑ BF, ↓ FFLI, ↓ Loin, ↑ % tough coverage

- Myers (2 studies)
  - ↑ ADG, ↑↓ ADFI, G:F ??
  - ↑ BF, ↓ FFLI, ↓ Yield
  - Feeder design x diet type

- Nitikanchana (3 studies)
  - ↑ ADG, ↑ ADFI, G:F ??
## Meta-analysis results (15 experiments)

<table>
<thead>
<tr>
<th>Items</th>
<th>Dry</th>
<th>Wet-dry</th>
<th>SEM</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial wt, lb</td>
<td>74.3</td>
<td>74.3</td>
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Nitikanchana et al., 2012
Wet-dry feeder economic analysis (IOFC, Income over feed cost)

Feed cost = 306 $/ton, Carcass price = 0.88 $/lb, 1.5$/ %lean reduction

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<td>+0.74</td>
<td>- 0.09</td>
<td>-0.95</td>
</tr>
</tbody>
</table>

Nitikanchana et al., 2012
Swine Research and Extension

The Kansas State University Swine Extension program takes practical swine nutrition research and works with producers to facilitate rapid adoption of technology by the industry. The program also works with producers in the area of environmental management of swine facilities.

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Swine Day Publications

- Swine Day 2012
- Swine Day 2011
- Swine Day 2010
- Swine Day 2009 and Swine Day Presentations

Quick Links

- Pork Information Gateway
- Kansas Pork Association
- National Pork Board (NPB)
- NPB Trucker Quality Assurance
- NPB Pork Quality Assurance
- NPB Pork Science
- KSU Livestock Budgets
- KSU AgManager
- Swine Feed Efficiency

Upcoming Events

- 2012 KSU Swine Day
  - KSU Alumni Center
  - November 15, 2012

- 2012 SWINE DAY
  - Sowbridge Breeding Herd Education Series 2012-2013
  - Multiple Locations
  - Multiple Dates
  - Sowbridge Brochure

- Porkbridge
  - Multiple Locations
  - Multiple Dates
  - Porkbridge Brochure

Swine Research Faculty

- Dr. Duane L. Davis
  - Swine Reproductive Physiology

- Dr. Joel DeRouchey
  - Environmental management
Marketing tools
# Feed efficiency and marginal cost near market weight

Values specific for your situation can be entered in any of the yellow cells.

## Finishing closeout data
- **Initial wt, lb**: 50
- **Final wt, lb**: 275
- **Feed/gain**: 2.80

## Marginal costs

<table>
<thead>
<tr>
<th>Carcass weight, lb</th>
<th>Live wt, lb</th>
<th>Cumulative feed, lb</th>
<th>Incremental F/G</th>
<th>Feed cost, $/cwt gain</th>
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<th>Feed and mortality, $/cwt gain</th>
<th>Feed, mortality, &amp; facilities, $/cwt gain</th>
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For demonstration purposes only

Any cells with red font indicates that marginal cost exceeds market price at that weight.

If this spreadsheet suggests that pigs be marketed below the packers optimal weight window, please refer to the "KSU Market Weight Predictor" under marketing tool at www.KSUswine.org.
Excel optimal weight

<table>
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<tr>
<th>Carcass base, $/cwt</th>
<th>Feed cost $/ton</th>
<th>Est. live base price, $/cwt</th>
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www.KSUswine.org
Carcass Feed cost Est. live base
base, $/cwt $/ton price, $/cwt
$ 80.00 $ 300.00 $ 60.80

Triumph non-owner

www.KSUswine.org
<table>
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<th>Carcass base, $/cwt</th>
<th>Feed cost $/ton</th>
<th>Est. live base price, $/cwt</th>
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<td>$ 300.00</td>
<td>$ 60.80</td>
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</table>

Triumph owner

www.KSUswine.org
Carcass Feed cost Est. live base base, $/cwt $/ton price, $/cwt
$ 80.00 $ 300.00 $ 60.80

Triumph barn dump

![Graph showing the cost of feed and facility over weight for pig production.](www.KSUswine.org)
Triumph barn dump

Carcass Feed cost Est. live base base, $/cwt $/ton price, $/cwt
$ 100.00 $ 300.00 $ 76.00

June/July Futures

www.KSUswine.org
### Feed efficiency and marginal cost near market weight

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#### Finishing closeout data

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#### Marginal costs

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Swine Day 2009 and Swine Day Presentations
There is an immediate and urgent interest in improving feed efficiency. The average feed cost has increased by more than $100 per ton in the last year alone. Concurrently, the value of one point in feed conversion has increased from about 30c to about 45c.

Our long term goal is to increase nutrient utilization and feed efficiency in the pig, to strengthen the competitiveness of the pork industry and to reduce its demand on grants and proteins. We will use a truly multi-disciplinary approach in this project, including nutrition, physiology, microbiology, behavior, immunology, quantitative genetics, swine genomics, proteomics, transcriptomics, bioinformatics and statistics. Through this grant, we will develop new knowledge and new tools to benefit our pork industries and agriculture in general.

www.swinefeedefficiency.com
Thank You!