Feeding Swine

Industry
- Feed represents 65 to 75% of total costs
- 60 million hogs and pigs in US
- Smithfield Foods
  - World's largest vertically integrated hog operation (60%)
  - 700,000 sows
  - 12 million market hogs annually
  - Controls about 15% of hogs in the US

US Per Capita Meat Consumption

Energy
- Energy requirement increases as weight increases
  - Greater BW and higher rate of gain
- Lactating sows produce 18 to 24 lbs milk per day
  - Generally in negative energy balance
- Pigs that are full fed generally eat to meet energy requirement

Maintenance ME
- Maintenance energy requirement for all animals is related to surface area
- Body weight raised to the 2/3 or 3/4 power is most common
  - 106 kcal ME/kg BW^{0.75}
  - 100 kg pig = 106 x 31.6 = 3,352 kcal ME

Gain (Tissue accretion)
- Protein
  - 1 g increases energy stores 5.67 kcal and takes 10.5 kcal/g (54%)
  - Deposition of 1 g is accompanied by 4 g water, 2.1 kcal/g lean gain
- Fat
  - 1 g increases energy stores 9.46 kcal and takes 12.8 kcal (74%)
  - Deposition of 1 g is accompanied by 0.2 g water, 10.7 kcal/g fat gain
Gain

<table>
<thead>
<tr>
<th>BW (kg)</th>
<th>ADG (g)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>ME (kcal)</th>
<th>kcal/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>450</td>
<td>69</td>
<td>72</td>
<td>2480</td>
<td>5.5</td>
</tr>
<tr>
<td>35</td>
<td>700</td>
<td>106</td>
<td>106</td>
<td>4518</td>
<td>6.1</td>
</tr>
<tr>
<td>80</td>
<td>820</td>
<td>118</td>
<td>118</td>
<td>7392</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Protein

- Protein makes up 15% of total body mass
- Pig carcasses contain 45 to 55% muscle, approx 22% is protein
- 7 to 9% of the whole body (10 to 12% of the carcass) is in the form of edible protein

Amino Acids

- Lysine is generally the 1st limiting AA
- High concentration of Lys in muscle (7%)
- Lys content of most feedsuffs is low
- Requirements of other amino acids are often expressed in relationship to Lys
  - Ratio of each AA to Lys approximates the ratios in whole body protein

Ideal AA Pattern

<table>
<thead>
<tr>
<th>BW (kg)</th>
<th>Leu</th>
<th>Phe+Tyr</th>
<th>Val</th>
<th>Thr</th>
<th>Met+Cys</th>
<th>Ile</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 45</td>
<td>100</td>
<td>95</td>
<td>68</td>
<td>65</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>45 – 110</td>
<td></td>
<td>95</td>
<td>68</td>
<td>67</td>
<td>65</td>
<td>60</td>
</tr>
<tr>
<td>110 – 120</td>
<td></td>
<td>95</td>
<td>68</td>
<td>70</td>
<td>70</td>
<td>60</td>
</tr>
</tbody>
</table>

AA Likely to be Deficient

<table>
<thead>
<tr>
<th>% of AA</th>
<th>Require</th>
<th>Corn+SBM</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lys</td>
<td>0.75</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>Leu</td>
<td>0.60</td>
<td>1.45</td>
<td>0.99</td>
</tr>
<tr>
<td>Phe-Tyr</td>
<td>0.66</td>
<td>1.29</td>
<td>0.72</td>
</tr>
<tr>
<td>Val</td>
<td>0.48</td>
<td>0.71</td>
<td>0.39</td>
</tr>
<tr>
<td>Thr</td>
<td>0.48</td>
<td>0.57</td>
<td>0.29</td>
</tr>
<tr>
<td>Met+Cys</td>
<td>0.41</td>
<td>0.57</td>
<td>0.37</td>
</tr>
<tr>
<td>Ile</td>
<td>0.46</td>
<td>0.61</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Amino Acids

- Traditionally, diets have been formulated based on CP
  - CP levels are established for various weights of pigs so that Lys is present in adequate amounts
- System works well for corn and SBM diets
- Formulate on Lys basis when other ingredients are used
Protein

- When expressed on a daily basis, CP and AA requirements increase with BW
- When expressed as a percent of diet, requirements decrease with increasing pig weight
- Feed consumption increases with increasing weight

Minerals

- Minerals most likely to be deficient in grain-SBM diets
  - Ca, P, Na, Cl, Fe, Zn, I, and Se
  - Ca and P required in greatest amounts
  - Ca:P ratio = 1:1 to 1.25:1
- Phytate P
  - 60 to 80% of P in grains and oilseeds
  - P requirement takes into account Phytate P

P Availability of Feeds

<table>
<thead>
<tr>
<th>Feed</th>
<th>% P Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>12 to 14</td>
</tr>
<tr>
<td>Oats &amp; Barley</td>
<td>20 to 30</td>
</tr>
<tr>
<td>Wheat</td>
<td>46 to 53</td>
</tr>
<tr>
<td>Peanut &amp; CS Meal</td>
<td>1 to 12</td>
</tr>
<tr>
<td>SBM</td>
<td>23 to 31</td>
</tr>
<tr>
<td>Animal Protein</td>
<td>66 to 96</td>
</tr>
</tbody>
</table>

Minerals

- Salt - 0.25 to 0.50% of diet
- K, Mg, S usually OK
- Zn - parakeratosis
- Fe - anemia (baby pigs)
- I - usually get from iodized salt
- Se - FDA supplementation 0.3 PPM max
- Cr - improves lean muscle gain

Vitamins

- Most likely to be deficient in grain-SBM diets
  - A, D, Riboflavin, Niacin, Pantothentic Acid, and B<sub>12</sub>

Energy Sources

- Corn - accounts for over 85% of the grain fed to swine
  - Corn is the standard
  - Highly digestible starch, palatable, low in fiber, fed in variety of ways
  - Negatives - low in CP, deficient in Lys and Trp
Energy Feeds for Swine

<table>
<thead>
<tr>
<th>Energy Sources</th>
<th>Rel Value</th>
<th>Max Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>230</td>
<td>5 – 10</td>
</tr>
<tr>
<td>Wheat</td>
<td>98</td>
<td>100</td>
</tr>
<tr>
<td>Sorghum</td>
<td>97</td>
<td>100</td>
</tr>
<tr>
<td>Barley</td>
<td>89</td>
<td>100</td>
</tr>
<tr>
<td>Rye</td>
<td>88</td>
<td>25</td>
</tr>
<tr>
<td>Wheat Midds</td>
<td>87</td>
<td>30</td>
</tr>
<tr>
<td>Oats</td>
<td>80</td>
<td>25</td>
</tr>
</tbody>
</table>

Energy Sources

- Wheat - Higher protein & Lys, Cost $$
- Sorghum - 2nd most common, lower protein and Lys
- Barley - lower ME, beta-glucans
- Rye - lower ME, pectins, palatability
- Wheat Midds - fiber, pelleting
- Oats - fiber, good for starter diets
- Fat - max 6%, aids pelleting, dustiness

Protein Sources

- SBM - accounts for 85% of protein
  - especially high in Lys, Trp, & Thr
- Other plant sources - Lys content and/or palatability limit inclusion
- Animal sources
  - excellent AA profile
  - drying process important (ring or flash dried)
  - spray dried porcine plasma
- Canola
- Brewers
- Distillers
- Gluten Meal
- Plasma
- Blood Meal

Relative Value of Protein

<table>
<thead>
<tr>
<th>Protein Source</th>
<th>RV</th>
<th>Max % Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBM</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>Canola</td>
<td>94</td>
<td>10</td>
</tr>
<tr>
<td>Brewers</td>
<td>51</td>
<td>15</td>
</tr>
<tr>
<td>Distillers</td>
<td>41</td>
<td>20</td>
</tr>
<tr>
<td>Gluten Meal</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td>Plasma</td>
<td>138</td>
<td>6</td>
</tr>
<tr>
<td>Blood Meal</td>
<td>136</td>
<td>3</td>
</tr>
</tbody>
</table>

Minerals Sources

- Ca & P
  - mono- and dicalcium phosphate
  - defluorinated rock phosphate
  - steamed bone meal
- Ca
  - limestone (Ca carbonate)
- Iodized Salt
- Trace mineral and vitamin premixes

Additives

- Antibiotics and Chemotherapeutics
  - stimulate growth, improve feed efficiency, decrease mortality and morbidity
  - tetracyclines, tylosin, etc.
- Anthelmintics (dewormers)
  - remove internal and external parasites
- Therapeutic levels of Cu and Zn
Feed Processing
- Grains must be ground - 3/16” to 1/4”
- Gain and utilization greater on pelleted diets

Prebreeding
- Flushing
  - most beneficial for thin sows/gilts
  - increases # of eggs ovulated
  - full-feed 1 to 2 weeks before breeding
- Antibiotics
  - improve conception rate and reduce embryo mortality
  - chlortetracycline

Gestation
- Most of fetal growth last 1/3 of gestation
- Body weight increases 75 lb
- Feed about 4 to 4.5 lb/d of corn soybean meal diet containing 1,450 kcal ME/lb
- ME = 5,800 to 6,500 kcal/d
- CP = 14% or 250 g/d
- Ca = 0.8% (14.5 g) P = 0.65% (11.5 g)

Effect of Intake on Nutrient %

<table>
<thead>
<tr>
<th>Fed (lb)</th>
<th>CP</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>17</td>
<td>1.10</td>
<td>0.85</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>0.80</td>
<td>0.65</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>0.65</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Lactation
- Requirements increase 3 to 4 x
- Produce about 2 lb milk/pig/d
- Full-feed gestation diet - 12 to 16 lb/d
  - ME = 17,000 kcal/d
  - CP = 16 to 18%
  - Ca = 0.8%, P = 0.65%

Antibiotics in Breeding Feed

<table>
<thead>
<tr>
<th>Farrowing Rate, %</th>
<th>Control</th>
<th>Antibiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live pigs/litter</td>
<td>75.4</td>
<td>82.1</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Antibiotics in Farrowing and Lactating Feed

<table>
<thead>
<tr>
<th>Survival,%</th>
<th>Control</th>
<th>Antibiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg Weaning Wt,lb</td>
<td>10.23</td>
<td>10.34</td>
</tr>
</tbody>
</table>
### Milk Composition Comparison

<table>
<thead>
<tr>
<th></th>
<th>Sow (%)</th>
<th>Cow (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>8.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Protein</td>
<td>5.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Lactose</td>
<td>5.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Ash</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Total Solids</td>
<td>20</td>
<td>13</td>
</tr>
</tbody>
</table>

### Segregated Early Weaning

- Wean about 2 weeks
- Pigs are separated before their immune system becomes activated
- SEW pigs having low antigen challenge backgrounds gain weight extremely rapid
- Facilities must be extremely clean

### Weanling Pigs

- Prestarter for about 1 wk, 1.6% Lys, 10 lb
  - dried whey (25-35%), dried plasma protein
- Phase 1 starter for 1 wk, 1.4% Lys, 15 lb
  - dried whey (25-35%), dried plasma protein
- Phase 2 starter for 2 wk, 1.2% Lys, 25 lb
  - dried whey (10-20%), dried blood meal/cells
- Phase 3 starter for 2 wk, 1.0% Lys, 45 lb
  - dried whey (10-20%), dried blood meal/cells

### Growing-Finishing Pigs

- Growing Phase - to 100-125 lbs
  - 1480 kcal ME/lb, 18% CP, 0.95% Lys
- Finishing phase - to 240 lb
  - 1485 kcal ME/lb, 16% CP, 0.80% Lys
- Split sexes
  - barrows eat and gain more (18/15% CP)
  - gilts more efficient (feed:gain) and leaner (18/17%)

### Improvement in Feed:Gain

<table>
<thead>
<tr>
<th></th>
<th>Antibiotic</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter</td>
<td>6.9%</td>
<td>9.7%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Grower</td>
<td>4.5</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Finisher</td>
<td>2.2</td>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

- P Additive effect of antibiotics and Cu
- 14% improvement in feed:gain ratio
- 250 PPM Cu, 3000 PPM Zn

### Feed Requirements

- 325 to 350 lb feed/100 lb pork, 780-840 lb per pig
- 15-20% of feed consumed by breeding herd, 80-85% consumed by the pig