How Does Body Composition Affect Productivity

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• What does optimal gilt development look like?
• What are measures of gilt development that have been evaluated?
  • Ages at defined time points
    • puberty (HNS), first mating, conception, first farrowing
  • Intervals (rates in achieving a measurable outcome)
    • puberty (HNS), first mating, conception, first farrowing
  • Fertility rates and percentages
    • Ovulation rate, conception rates, farrowing rates, % served, services per conception
  • Pigs produced at first litter
• Why is age at puberty important
  • It is the first indication that we have of a gilt's reproductive potential.
  • It is positively associated to other indicators of fertility and productivity.
  • Early puberty gilts stay in the herd longer and produce more pigs.
  • It one of the few reproductive traits that is moderately heritable.
Earlier age at puberty associated with greater chance of producing a first and second litter

Trenhaile et al., Midwest ASAS, 2014
Earlier puberty associated with greater longevity

**Graph 1:**
- X-axis: Percent served, %
- Y-axis: Age at removal, d
- Legend:
  - 1 wk
  - 2 wk
  - 3 wk
- Data points:
  - P0 Served
  - P1 Served
  - P2 Served
  - P3 Served

**Graph 2:**
- X-axis: From start of boar exposure to HNS
- Y-axis: Age at removal, d
- Data points:
  - 1 wk
  - 2 wk
  - 3 wk
- Significant difference: \( a, b P < 0.001 \)
- Note: 113 d
• Kirkwood and Aherne, 1984
  • Age and weight threshold for puberty
  • Reproduction (Puberty) depends on body composition (fatness).
  • As an animal ages, the gain of lean tissue is less and gain of adipose tissue is greater as a percentage of body weight gain.
  • Selection for increased lean growth leads to greater mature size associated with a later maturing animals.
  • Hard question to answer because
    • Fatness is linked to growth rate

Figure 2. Body condition scores of sows.
• Genetic selection for high rates of lean growth usually not associated with a negative effect on reproductive performance of gilts.

• High growth rates also accumulate adequate fat

• Some evidence that selecting for high lean growth rate negatively effects gilts ability to have a “good” heat.

Table 2. Correlations between production traits, pubertal age, and estrus symptoms. Genetic correlations (rg), with standard errors, phenotypic (rph) correlations, and number of gilts in each multiple-trait analysis.

<table>
<thead>
<tr>
<th>Traits</th>
<th>rg</th>
<th>SE</th>
<th>rph</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth rateabc</td>
<td>.03</td>
<td>.06</td>
<td>-.00</td>
<td>599</td>
</tr>
<tr>
<td>Length of proestrusb</td>
<td>-.49</td>
<td>.21</td>
<td>-.02</td>
<td>599</td>
</tr>
<tr>
<td>Standing reflexc</td>
<td>-.61</td>
<td>.20</td>
<td>-.06</td>
<td>713</td>
</tr>
<tr>
<td>Reddening and swellingc</td>
<td>.19</td>
<td>.27</td>
<td>-.06</td>
<td>713</td>
</tr>
<tr>
<td>Lean percentagede</td>
<td>.09</td>
<td>.22</td>
<td>-.12</td>
<td>599</td>
</tr>
<tr>
<td>Length of proestrusd</td>
<td>-.02</td>
<td>.16</td>
<td>-.01</td>
<td>599</td>
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<tr>
<td>Standing reflesex</td>
<td>.10</td>
<td>.19</td>
<td>-.02</td>
<td>713</td>
</tr>
<tr>
<td>Reddening and swellingc</td>
<td>-.17</td>
<td>.16</td>
<td>-.08</td>
<td>713</td>
</tr>
<tr>
<td>Age at pubertyef</td>
<td>.15</td>
<td>.22</td>
<td>-.08</td>
<td>610</td>
</tr>
<tr>
<td>Length of proestrusg</td>
<td>-.12</td>
<td>.23</td>
<td>-.04</td>
<td>610</td>
</tr>
<tr>
<td>Standing reflexg</td>
<td>.05</td>
<td>.27</td>
<td>.02</td>
<td>729</td>
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<tr>
<td>Reddening and swellingh</td>
<td>-.01</td>
<td>.24</td>
<td>-.15</td>
<td>729</td>
</tr>
</tbody>
</table>

a Traits with a common superscript were analyzed together.

Kerr and Cameron, 1996; Cameron et al., 1999; Hutchens et al., 1981; Ten Napel and Johnson, 1997; Rydhmer et al., 1994
Generally speaking...

- Puberty occurs over a broad range of lean growth rates and backfat thicknesses.

- Gilts with the highest growth rates accumulate more backfat and cycle earlier.
  - > 600 g/d (1.1 lb/d) from birth to selection.
  - BW at breeding: 135-150 kg (300-330 lb).

Beltranena et al., 1991; Beltranena et al., 1993; Gaughan et al., 1997; Tummaruk et al., 2001; Tummaruk et al., 2007; Bortolozzo et al., 2009; Kummer et al., 2009; Amaral Filha et al., 2009; Patterson et al., 2010.
Limited nutrition and growth in development

Development diet had no effect on:

- Age at puberty
- Age at conception
- Number of piglets

- Restricted gilts
  - Gaining weight
  - Gaining Backfat
  - More efficient

Natural variation in growth, backfat, puberty

**HG > 600 g/d at selection; HF based on the population mean**

For slower growing gilts, more backfat can make a difference.

Modern gilts should have no trouble achieving growth rates and backfat necessary for high reproductive performance.
Are we feeding gilts too much?

n = 1,111 gilts
LWxLR Maternal line

Age at Puberty = 201.68 - 11.54ADG
Reproductive longevity is influenced by age at puberty and energy input during development.

Effects of energy restriction:
- $P_{P1}=0.40$
- $P_{P2}=0.04$
- $P_{P3}=0.03$

**Diet**
- ad libitum
- Energy restricted

Graph showing the probability to generate $P1$ against age at puberty.
Basic Questions

- How are developmental traits and productivity traits related?

- Are there long-term benefits to reducing growth of gilts in development?

- Evaluation has to be applicable:
  - Large numbers of animals
  - Under commercial conditions
  - Practical diets
What is the best way to feed developing gilts

- Aherne and Williams, 1992; Boyd, 1999
  - Feed 16% CP diet ad libitum until mating

- Reese et al., 1995; NRC 1998
  - Feed for maximal growth until ~220 lb (100 kg)
  - Restrict feed until 10-14 days before start of breeding
  - Increase feeding level to induce ovulatory flush

- Baidoo, 2001
  - Moderate lysine (0.6%) high energy (3.5 Mcal/kg)
  - High lysine (1.31%) moderate energy (3.2 Mcal/kg)
  - Limit feed
• Industry survey; what do people feed gilts?
  • ME, 3200-3300 Kcal/kg
  • Lysine, 1 to 1.1%
• Six diets: 3 levels of energy and 2 levels of Lysine

<table>
<thead>
<tr>
<th></th>
<th>Percent different from control diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ME 85 100 115</td>
</tr>
<tr>
<td></td>
<td>Lys 85 100 100</td>
</tr>
</tbody>
</table>

• Fed from 100 to 260 d of age (14-37 wk)
  • 1200 LW x LR maternal line gilts
• Boar stimulation, 160 d of age (23 wk)
• Body weight, body composition
• Slaughter to evaluate reproductive tracts
Body weight

No differences

Body weight, kg

Age

- 85% lys × 85% ME
- 85% lys × 100% ME
- 85% lys × 115% ME
- 100% lys × 85% ME
- 100% lys × 100% ME
- 100% lys × 115% ME
Back Fat

Effect of ME ($P<0.05$)

~10% increase in backfat in High ME gilts
Average daily feed intake

Effect of ME ($P < 0.01$)
No effect of Lys

Average daily ME intake

No effects on development of the uterus or mammary gland.
$y = 7.2546x - 103.37$

$R^2 = 0.5913$
- Standard levels of ME (3000-3300 Kcal/kg)
  - 3 levels of lysine

<table>
<thead>
<tr>
<th>Percent SID Lysine</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>0.68</td>
<td>0.79</td>
<td>0.90</td>
</tr>
<tr>
<td>Phase 2</td>
<td>0.52</td>
<td>0.60</td>
<td>0.68</td>
</tr>
</tbody>
</table>

- Fed from 100 to 200 d of age (14-28 wk)
  - 3,000 LW x LR maternal line gilts (Utah)
  - Boar stimulation, 160 d of age (23 wk)
  - Body weight, body composition
  - Moved to sow farm at 28 wk
    - Gestation diet
Growth and Feed Intake

A. ADG (kg/d) vs. Age (days)
   - Low
   - Medium
   - High

B. Feed intake (kg/d) vs. Age (days)
   - Low
   - Medium
   - High

C. Lysine intake (g/d) vs. Age (days)
   - Low
   - Medium
   - High

D. ME intake (Mcal/d) vs. Age (days)
   - Low
   - Medium
   - High
Measures of body size

Iwasawa et al., 2004 KSU Swine Day pp 17-22

A

Body weight, kg

Caliper, arbitrary units

Age, days

Low
Medium
High

Age, days

Low
Medium
High

B

Age, days

Low
Medium
High

C

Flank to flank, in

Age, days

Low
Medium
High
Body Composition

**A**
- **Backfat, mm**
  - Y-axis: 0 to 20
  - X-axis: Age, days (100, 142, 160, 200)
  - Lines for Low, Medium, High

**B**
- **Loin depth, cm**
  - Y-axis: 0 to 6
  - X-axis: Age, days (100, 142, 160, 200)
  - Lines for Low, Medium, High

**C**
- **Fat free lean, kg**
  - Y-axis: 0 to 60
  - X-axis: Age, days (100, 142, 160, 200)
  - Lines for Low, Medium, High

**D**
- **Fat to lean ratio**
  - Y-axis: 1.0 to 3.5
  - X-axis: Age, days (100, 142, 160, 200)
  - Lines for Low, Medium, High
HNS during first 40 days of boar stimulation

Percent of gilts with HNS

- High lysine: a
- Medium lysine: b
- Low lysine: b

a,b P < 0.0001
High lysine

Medium lysine

Low lysine

Number of gilts

Age at first natural heat

Number of gilts

Age at first natural heat

Number of gilts

Age at first natural heat
Gilts with a natural HNS:
< age < body weight
> LGR > backfat
> Loin depth > fat-to-lean

Gilts needing PG600 for HNS:
1. Slower growing & leaner
2. Delays sexual maturity
Traits at first breeding

**Age**
- Low: 240 days
- Medium: 230 days
- High: 220 days

**Body weight**
- Low: 140 kg
- Medium: 130 kg
- High: 120 kg

**Backfat**
- Low: 12 mm
- Medium: 11 mm
- High: 10 mm

**Fat to lean ratio**
- Low: 2.5
- Medium: 2
- High: 1.5
Changes from HNS to breeding

- Natural HNS
- PG600 HNS
- 1st Breeding

**Flank to flank, in.**

- Low
- Medium
- High

**Backfat, mm**

- Low
- Medium
- High

**Fat free lean, kg**

- Low
- Medium
- High

**Fat to lean ratio**

- Low
- Medium
- High
• If gilts are to fat at entry to farrowing house:
  • Don’t eat enough feed
  • Loose too much body fat

• If gilts lose too much weight during lactation:
  • Failure to return to estrus
  • Prolonged WEI

Gaughan et al., 1995, Anim. Sci. 61;561
Growth rates of gilts more important than composition.
- Todays gilts have no problem reaching adequate levels of body weight and body composition.
- Could lead to breeding gilts a body weights that are too heavy.
- Can slow growth without negatively affecting reproductive performance of gilts.
  - Lifetime productivity?
- Body composition of gilts could affect expression of heat
- More important to manage:
  - Body composition in gestation and lactation
  - Gilts in the breeding barn
    - Boar exposure
    - Opportunities for nutritional management
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