Determining optimal culling parity in commercial swine breeding herds

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Structure of the Swine Industry

Gilt Selection and Gilt Development

- Gilts must be selected to replace sows being removed or culled from the commercial herd.
- Adequate time is necessary for immunization against common diseases - vaccinations
- Not all gilts selected will farrow

(Moeller et al., 2004 – 80%)

Production by Parity

- Sows farrow larger litters and produce heavier pigs at weaning than gilts
- As sows pass ME age, production declines
  * Mature Equivalent Age is P3-P6

Genetic Gain Theory

\[ \frac{\Delta G}{Yr} = \frac{i A \sigma_p}{L} \]

- \( \Delta G/yr \) – Rate of Genetic Change per Year
- \( i \) – Selection Intensity
- \( A \) – Accuracy of Selection
- \( \sigma_p \) – Phenotypic Variance
- \( L \) – Generation Interval

Genetic Lag Time

- Time for improvement at nucleus level to reach commercial level
- Depends on crossbreeding system and generation level
Objective

• To determine the optimal culling parity for commercial sow herds

Assumed Values

• 2.25 litter/sow/year
• Age at first farrowing: 1 year
• Genetic Gain per generation:
  Number Born Alive – 0.3 pigs
  21 Day Litter Weight – 1.36 kg
  Days to Market – 3.0 days
• Economic Values:
  Number Born Alive – $22/pig
  21 Day Litter Weight – $1.54/kg
  Days to Market – $0.17/day

Calculations

• Age of sows by generation
  \[ \frac{\text{Farrowing Interval} \times (\text{Parity} - 1)}{\text{Generation Interval}} + 1 \]

• Genetic Lag
  \[ \text{Age of sows by Generation} \times \text{Genetic Gain per generation} \]

• Value of Genetic Loss
  \[ \text{Genetic Lag} \times \text{Economic Value} \]

<table>
<thead>
<tr>
<th>Parity</th>
<th>Age at Farrowing (years)</th>
<th>Age in Generation Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>0.67</td>
</tr>
<tr>
<td>2</td>
<td>1.44</td>
<td>0.96</td>
</tr>
<tr>
<td>3</td>
<td>1.89</td>
<td>1.26</td>
</tr>
<tr>
<td>4</td>
<td>2.33</td>
<td>1.56</td>
</tr>
<tr>
<td>5</td>
<td>2.78</td>
<td>1.85</td>
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<tr>
<td>6</td>
<td>3.22</td>
<td>2.15</td>
</tr>
<tr>
<td>7</td>
<td>3.67</td>
<td>2.44</td>
</tr>
<tr>
<td>8</td>
<td>4.11</td>
<td>2.74</td>
</tr>
<tr>
<td>9</td>
<td>4.56</td>
<td>3.04</td>
</tr>
<tr>
<td>10</td>
<td>5.00</td>
<td>3.33</td>
</tr>
<tr>
<td>11</td>
<td>5.44</td>
<td>3.63</td>
</tr>
<tr>
<td>12</td>
<td>5.89</td>
<td>3.93</td>
</tr>
<tr>
<td>13</td>
<td>6.33</td>
<td>4.22</td>
</tr>
<tr>
<td>14</td>
<td>6.78</td>
<td>4.52</td>
</tr>
<tr>
<td>15</td>
<td>7.22</td>
<td>4.81</td>
</tr>
</tbody>
</table>

Calculation of Value of the difference in genetic potential between sows in the herd and a potential replacement gilt

\[ V = G_{\text{trait}}E_{\text{trait}}N + G_{\text{trait}}E_{\text{trait}}E_{\text{trait}}N + G_{\text{trait}}E_{\text{trait}}E_{\text{trait}}N + G_{\text{trait}}E_{\text{trait}}N + \]
\[ + \cdots + (G_{\text{trait}}E_{\text{trait}}E_{\text{trait}}E_{\text{trait}}E_{\text{trait}}E_{\text{trait}}E_{\text{trait}})N \]

• \( V \) is the value of the genetic lag
• \( G \) is the genetic lag for each trait at parity \( P \)
• \( E \) is the economic value for each trait
• \( N \) is the total number of pigs that were produced by the sow at parity \( P \)
Developed a spreadsheet to determine the value of the genetic loss associated with keeping sows in the herd for additional parities.
Results and Discussion

- It is not profitable to replace sows in the breeding herds at the rates currently employed by most commercial swine operations.
- Value of genetic improvement must be greater than or equal to gilt development variable costs.
- When sows are retained for additional parities, gilt development costs can be spread out over a greater number of piglets produced.
- If enough time has not passed for the genetic supplier to make genetic progress for the economically important production traits aggregate genetic value is equal or difference is very small.

Cost of replacement Gilt

- Cost estimates reported in the literature for replacing a sow
  - Initial cost - $200
  - Breeding costs - $10 to $15
  - Housing, feed, veterinary costs, for isolation and acclimation - $36
  - Costs of developing gilts that never enter the breeding herd must be covered by gilts that do enter the breeding herd - $10

Cull Sow Value

<table>
<thead>
<tr>
<th>Weight of Cull Sows</th>
<th>Cull Sow Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>136-205kg (300-450lbs)</td>
<td>$99.28 - $149.85</td>
</tr>
<tr>
<td>205-227kg (450-500lbs)</td>
<td>$164.00 - $181.60</td>
</tr>
<tr>
<td>227-250kg (500-550lbs)</td>
<td>$188.41 - $207.50</td>
</tr>
<tr>
<td>250-341kg (550-750lbs)</td>
<td>$217.50 - $296.67</td>
</tr>
</tbody>
</table>

Other considerations

- Cost of replacement gilt
- Cull sow value
- Parity production differences
- Progeny performance differences between young sows and older sows
- Genetic progress modeled in the current study likely represent the upper limits for rate of improvement
Parity Production Differences

<table>
<thead>
<tr>
<th>Parity</th>
<th>NBA (pigs)</th>
<th>W21 (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>6.2</td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>0.2</td>
<td>1.0</td>
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<tr>
<td>4</td>
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<tr>
<td>6</td>
<td>0.2</td>
<td>9.5</td>
</tr>
<tr>
<td>7</td>
<td>0.5</td>
<td>11.6</td>
</tr>
<tr>
<td>8</td>
<td>0.9</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Other considerations

- Cost of replacement gilt
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How does this impact the entire sow herd?

- If culling rate and maximum parity at culling is known
  - Can predict distribution of sows in each parity
  - Can determine the average value of the genetic lag under different parity distributions

Implications

- Producers should focus on sound development of replacement gilts to enhance sow longevity
- Producers should retain sows for as long as they are reproductively and productively sound
- Advantages of herds with sows in older parities suggest the importance of selecting for sow longevity at the seedstock level

Questions???