PRODUCTION ENVIRONMENT REALIZED GENETIC MERIT OF LITTER SIZE, BUT THE IMPACT DEPENDS ON HERDS

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QUESTION OF INTEREST

Does **genetic improvement** of purebred pigs translate into **phenotypic improvement** of crossbred production pigs?
THE DANBRED PIG BREEDING SYSTEM

Assumption: Environments are similar

Nucleus herds
- Landrace
- Yorkshire
- Duroc

Multiplier herds
- Landrace
- Yorkshire

Sow herds
- Landrace/Yorkshire F1 or crisscross

Finisher herds
- Duroc x Landrace/Yorkshire F1 or crisscross
THE DANBRED PIG BREEDING SYSTEM

**Genetics**

- **Nucleus herds**
  - Landrace
  - Yorkshire
  - Duroc

- **Multiplier herds**
  - Landrace
  - Yorkshire

- **Sow herds**
  - Landrace
  - Landrace/Yorkshire F1 or crisscross

- **Finisher herds**
  - Duroc x Landrace/Yorkshire F1 or crisscross

**100 % effect?**

**Expressivity (β)**

**Phenotype**
LITTER SIZE

Trait in purebred pigs
• Litter size at day 5 (LS5)
• Implemented in 2004
• Reduces piglet mortality

Trait in production pigs
• Total number born
ANALYSIS OF EXPRESSIVITY

Purpose

• Analyze the association between estimated breeding values (EBVs) for LS5 in purebreds and TNB in sow herds
SOW HERD DATA

Characteristics
• Herds have on-farm production of gilts
• Landrace and/or Yorkshire sows
  • Crisscross crossbred
  • F1 crossbred
  • Purebred
• Primary registrations
  • Ancestry of production sows
  • Farrowing results
    • Sow ID
    • Date
    • Litter size
## SIZE OF DATA

<table>
<thead>
<tr>
<th></th>
<th>Number of levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herds</td>
<td>173</td>
</tr>
<tr>
<td>Sires of sows</td>
<td>2,921</td>
</tr>
<tr>
<td>Sows</td>
<td>98,322</td>
</tr>
</tbody>
</table>
STATISTICAL MODEL

\[ y_n = X b_t + L \beta + S r_h + H d_h + M f_k + Z u_m + e_n \]

\( y \): TNB in a sows first litter

\( X, L, S, H, M, Z \): Design matrices
\( b \): Parameter vector for fixed effects
\( \beta \): Regression coefficient for EBVs of LS5 in sire of sow
\( r \): Regression coefficients for EBVs of LS5 in sire of sow
\( d \): Herd effects
\( f \): Sire of sow effect
\( u \): Herd-year-month effect
\( e \): Residual term

Expressivity depending on herd
Overall expressivity \( \approx 50\% \)

\[
\begin{bmatrix} r \\ d \end{bmatrix} \sim N \left( \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_r^2 & \sigma_{rd} \\ \sigma_{dr} & \sigma_d^2 \end{bmatrix} \otimes I_h \right)
\]

\[ f \sim N(0, [\sigma_f^2] \otimes I_k) \]

\[ u \sim N(0, [\sigma_u^2] \otimes I_m) \]

\[ e \sim N(0, [\sigma_e^2] \otimes I_n) \]

Lengths of vectors:
\( n \): Production sows
\( t \): Fixed parameters
\( h \): Herds
\( m \): Herd-year-month
\( k \): Sires of sows
RESULTS

\[ \beta = 0.39 \]

\[ \sigma_r^2 = 0.0169 \]
## INTERPRETATION

<table>
<thead>
<tr>
<th>Genetic potential for LS5 in sire</th>
<th>Average herd</th>
<th>Herd with low expressivity ($\beta - 1.96\sigma_r$)</th>
<th>Herd with high expressivity ($\beta + 1.96\sigma_r$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-0.78</td>
<td>-0.24</td>
<td>-1.32</td>
</tr>
<tr>
<td>-1</td>
<td>-0.39</td>
<td>-0.12</td>
<td>-0.66</td>
</tr>
<tr>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1</td>
<td>0.39</td>
<td>0.12</td>
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</tbody>
</table>
DISCUSSION

Expected regression coefficient ($\beta_p$) calculated from (co)variance components

\[ \beta_p(C) = \frac{1}{2} \frac{\sigma_{LS5,TNB}}{\sigma_{LS5}^2} \]

<table>
<thead>
<tr>
<th>LS5 breed</th>
<th>TNB breed</th>
<th>$\beta_p(C)$</th>
<th>Sig. Dif. from $\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landrace</td>
<td>Landrace</td>
<td>0.62</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>F1</td>
<td>0.37</td>
<td>No</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>Yorkshire</td>
<td>0.43</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>F1</td>
<td>0.24</td>
<td>Yes</td>
</tr>
</tbody>
</table>

DISCUSSION

Why do we detect more expressivity in some herds?
• Management?
• Confounding effect?

Possible usages
• Detection of factors affecting expressivity
• Find herds in need of counselling
CONCLUSION

Does genetic improvement of purebred pigs translate into phenotypic improvement of production pigs?

1. Yes. Genetic superiority resulted in the expected phenotypic superiority in production herds.
2. However, expressivity varied between herds!
THANK YOU FOR YOUR TIME
PERCENTAGE OF YORKSHIRE X HETEROSIS

Least square means of litter size