Are more feed efficient pigs really less robust and more susceptible to disease?

Jack Dekkers
Selection for Productivity has been very effective

1972:
380 kg feed → 100 kg market pig

2007:
325 kg feed → 125 kg market pig

Courtesy: Graham Plastow, Univ. Alberta

Has selection for growth, leaness and efficiency made pigs less robust?

Does selection for feed efficiency result in pigs that have greater behavioral, physiological, and immunological problems, and that are more susceptibility to stress and disease?
Measures of Feed Efficiency

**FCR** = Feed/gain

**FE** = Gain/Feed

**Residual Feed Intake** = (Observed FI) – (Expected FI based on energy requirements for growth and maintenance) 

(Koch et al., 1963)

Pigs with low (negative) RFI are more efficient

$$RFI = FI - \beta_1 ADG - \beta_2 BF$$
RFI - % of variation

- RFI
  - 40 Residual
  - 29 Genetic
  - 30 Pen

- ADFI
  - 66% related to ADG, BF
  - 34% RFI

- ADG,BF
  - 52 Residual
  - 44 Genetic
  - 4 Pen

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Department of Animal Science

Animal Breeding & Genetics
Factors that contribute to RFI

**Residual Feed Intake** = (Observed FI) – (Expected FI based on energy requirements for growth and maintenance)

(Koch et al., 1963)

RFI = FI – $\beta_1$ ADG – $\beta_2$ BF

**Potential factors contributing to RFI**

- Body composition
- Physical activity
- Maintenance requirements
- Digestibility
- Energetic efficiency
- Tissue turnover rates
- Immune response
- Food wastage
- Measurement error

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Residual Feed Intake
Selection Lines

Est. 1999

Yorkshire
Large White

Low RFI line

Hi RFI line

Experimental Objectives

Develop lines that differ in Residual Feed Intake
As a resource population to study the biological & physiological basis of feed intake & efficiency

Develop tools to improve feed efficiency

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Individual feed intake under group housing
Response in G9

HRFI – LRFI

In Genetic SD

In Trait Units
Estimates of the contribution of different mechanisms to variation in RFI

Amanda Harris and Nick Gabler

- Body Composition (Energy Ret.): 27%
- Feeding Patterns: 16%
- Protein Deposition/Turnover: 14%
- Urine: 13%
- Digestibility: 3%
- Active Behavior: 2%
- Other: 1%
- Maintenance Requirement: 1%
Are efficient pigs less able to handle different types of stress?

- Behavioral stress
- Cortisol response to ACTH challenge
- Response to immune and inflammatory challenges
- Stress of gestation and lactation
Behavioral stress

Jessica Colpoys
Anna Johnson et al.

Low-RFI pigs:
- Took longer to approach the human and cone
- Were calmer and less reactive to both tests

Implications
- Improving feed efficiency (Low-RFI):
  - Did not compromise pig welfare
  - Less reactive to novel stimuli
  - May have effects on animal-human interactions and handling facilities
Stress response – ACTH challenge

Jessica Colpoys
Nick Gabler et al.

Low-RFI gilts had lower pre- and post-challenge cortisol levels

<table>
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<tr>
<th>Factor</th>
<th>P-value</th>
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<tr>
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<tr>
<td>Time</td>
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<tr>
<td>Line*Time</td>
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Low RFI pigs had:

- Higher Red Blood Cell counts ➔ Greater oxygen carrying capacity
- Lower White Blood Cell counts ➔ Lower energy requirements for basal immune response
Response to PRRS challenge

KSU Rowland nursery pig model

Dunkelberger et al.
Livestock Sci. 2015

~100 piglets / line infected with PRRS virus isolate NVSL97-7985

Day post infection: -7 to 40

Birth
Serum
Antibiotics
Inoculation
Weight
Serum
Weight
Serum
Weight
Serum
Weight
Serum
Weight
Serum
Weight
Serum
Low RFI pigs also had a greater increase in PRRS antibody levels from 7 to 11 dpi.
Drop in ADG from infection was lower for Low RFI pigs than for High RFI pigs.

Conclusion: Low RFI pigs were at least as robust to PRRSV infection as high RFI pigs – perhaps even more robust.
EFFECT OF SELECTION FOR RFI ON SOW PERFORMANCE

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Low RFI sows have
higher number born alive
higher number weaned
Low RFI sows have similar litter and piglet weight at weaning.
Feed intake and body resources during lactation

Low RFI sows have greater weight loss during lactation

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Department of Animal Science
Feed intake and body resources during lactation

Low RFI sows have
- higher weight loss during lactation
- higher backfat loss during lactation
Feed intake and body resources during lactation

Low RFI sows have:
- higher weight loss during lactation
- higher backfat loss during lactation
- lower feed intake during lactation

Sow feed intake

LRFI

HRFI

***
Feed efficiency during lactation

LRFI sows have
- higher weight loss during lactation
- higher backfat loss during lactation
- lower feed intake during lactation
- higher number of born alive
- higher number of weaned
- similar weaning litter weight and piglet weight

⇒ What about feed efficiency during lactation?
LRFI sows have higher (ns) lactation efficiency and higher energy inputs (P=0.09) lower lactation RFI (also at INRA) higher negative energy balance
Conclusions

• ~35% of differences in feed efficiency are independent of growth and backfat = RFI

• RFI is a heritable trait and responds to selection

• Pigs that are selected for increased efficiency based on RFI do NOT have greater behavioral, physiological, and immunological problems, or are more susceptibility to stress and disease?

• In contrast pigs selected for efficiency based on RFI:
  – Are calmer and less fearful
  – Are less responsive to physiological stress
  – Are less affected by PRRS infection
  – Appear to have a more effective efficient immune response
  – Are not more affected by heat stress
  – Are better able to withstand the stresses of gestation and lactation
  – Are better able to direct resources where needed – greater “metabolic flexibility”
  – Are less affected by environmental differences
Feed efficiency during lactation

LRFI sows have
- higher weight loss during lactation
- higher backfat loss during lactation
- lower feed intake during lactation

- greater number of born alive
- greater number of weaned
- similar weaning litter weight and piglet weight

⇒ No impairment of the lactation efficiency

⇒ What about rebreeding?

- Low numbers of rebreeding failures
- No difference observed between lines
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- Nutrition: Mani, Harris
- Physiology / Behavior: Lhakgvadorj, Saddler, Colpoy
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