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How has selection for residual feed intake (RFI) affected nursery and finisher pig’s feeding behavior and performance?

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How has selection for residual feed intake (RFI) affected nursery and finisher pig's feeding behavior and performance?

Abstract
Feed is the largest cost in pork production; therefore, improving finisher pig feed efficiency can increase producer profitability. Improving feed efficiency can support industry competitiveness, decrease the demand on global feed resources, and complement environmental sustainability. Selective breeding for residual feed intake (RFI) shows promise in meeting these increased demands. However, it is important to balance the benefits of feed efficiency selection with the pig's feeding behavior and performance. Therefore, this factsheet will discuss feeding behavior and performance research on RFI selection conducted at Iowa State University.

Disciplines
Agricultural Economics | Agriculture | Animal Sciences

Comments

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Introduction

Feed is the largest cost in pork production; therefore, improving finisher pig feed efficiency can increase producer profitability. Improving feed efficiency can support industry competitiveness, decrease the demand on global feed resources, and complement environmental sustainability. Selective breeding for residual feed intake (RFI) shows promise in meeting these increased demands. However, it is important to balance the benefits of feed efficiency selection with the pig’s feeding behavior and performance. Therefore, this factsheet will discuss feeding behavior and performance research on RFI selection conducted at Iowa State University.

Objectives

- To explain residual feed intake and its importance.
- To describe how residual feed intake selection impacts nursery and finisher pig’s feeding behavior and performance in the Iowa State University RFI lines.

What is residual feed intake?

Residual feed intake is one method of measuring feed efficiency. Residual feed intake is defined as the difference between a pig’s observed and expected feed intake. Expected feed intake is determined for each pig based on its growth rate and backfat thickness. Pigs that consume less feed than expected based on their performance have a lower RFI, are more feed efficient, and they are therefore economically better for lean production compared to pigs with high RFI [1, 2; Figure 1]. Factors that contribute to RFI variation are the same as those that affect feed efficiency, energy used during activity, efficiency of digestion, metabolic efficiency, thermoregulation [3] and temperament [4]. Using RFI phenotype as a selection tool, two pig selection lines have been developed at Iowa State University. One is a feed efficient line that has been selected over 10 generations for low RFI (LRFI) during the grow-finish phase. The other is a feed inefficient line that was randomly selected for the first five generations and then selected for high RFI (HRFI) during grow-finish for another 5 generations. Now in their 10th generation, LRFI pigs require 12 to 15% less feed during grow-finish to reach market weight than HRFI pigs.
Performance of pigs selected for RFI
Steckelberg and colleagues (2015) evaluated the effects of RFI selection in the grow-finish phase based on feed efficiency during the nursery phase. Nursery piglets from the LRFI line consumed 20% less feed during the 40-day nursery and, although they gained 8% less weight than piglets from the HRFI line during the nursery phase, they had 12% greater feed efficiency [5].

- **Take home message:** Pigs that are selected for feed efficiency based on RFI during grow-finish, are also more efficient during the nursery phase. Selection for LRFI should also be accompanied with selection for growth rate.

Hsu and colleagues (2015) evaluated finisher pig performance and carcass traits in pigs from the HRFI and LRFI lines. Pigs from the more feed efficient (LRFI) line consumed 0.66 lb./d less than pigs from the less feed efficient (HRFI) line, but had only 0.06 lb./d lower average daily gain and 0.08 inch less backfat, which resulted in, 2.4 percentage points greater feed efficiency [6].

- **Take home message:** Genetic selection for increased feed efficiency based on RFI results in pigs that are more efficient during grow-finish but needs to be combined with selection for increased growth rate for it to be practical.

Figure 1. Schematic of residual feed intake as the difference between observed and expected feed intake. The line represents expected feed intake based on the pig's average daily gain (ADG) and backfat (BF). Pigs that are above the line have high RFI and are less efficient. Pigs that are below the line have low RFI and are more efficient.
Boddicker and colleagues (2009) compared growth performance and feed intake of LRFI and HRFI pigs that were fed either *ad libitum* or at a National Research Council maintenance (weight-stasis ration) level over 6 weeks. In the *ad libitum* treatment, there was no difference in initial or final pig body weights (Figure 2); however, LRFI pigs consumed 9% less feed (Figure 3). In the weight stasis treatment, the average body weight of HRFI pigs remained approximately constant over the 6 week period, but increased slightly for LRFI pigs (Figure 2). By the end of the test period at week 6, LRFI pigs required 20% less feed than that HRFI pigs to maintain constant body weight (Figure 3, [7]).

Figure 2. Body weight of LRFI and HRFI pigs under *ad libitum* and weight stasis feeding.
Arkfeld and colleagues (2015) evaluated the effects of a high energy, low fiber diet and a low energy, high fiber diet on carcass composition of HRFI and LRFI finisher pigs. The LRFI pigs fed the high energy, low fiber diet off-tested with a greater live weight and had greater loin depth than all other line by diet interactions [8].

- **Take home message:** The LRFI pigs that are selected for feed efficiency best utilized the high energy, low fiber diet to maximize ending body weight and muscle accretion.

Harris and colleagues (2013) determined the extent to which whole body tissue accretion rates contribute to feed efficiency differences in gilts divergently selected for RFI in the seventh generation. No differences were observed for starting body weight (132.2 lbs.), end body weight and average daily gain over the six-
week performance period between gilts divergently selected for RFI. More feed efficient (LRFI) gilts tended to have lower average daily feed intake and improved feed efficiency by 8% compared to the HRFI gilts (Table 1, [9]).

- **Take home message:** The LRFI gilts tended to have increased whole body protein accretion.

### Table 1: Performance and body composition of pigs divergently selected for residual feed intake, Harris and colleagues (2013).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>End weight, lb.</th>
<th>ADG\textsuperscript{3}, lb./d</th>
<th>ADFI\textsuperscript{4}, lb./d</th>
<th>G:F\textsuperscript{5}</th>
<th>Whole-body tissue accretion, lb./d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Protein</td>
</tr>
<tr>
<td>HRFI\textsuperscript{1}</td>
<td>208.5</td>
<td>1.65</td>
<td>4.54</td>
<td>0.37</td>
<td>0.28</td>
</tr>
<tr>
<td>LRFI\textsuperscript{2}</td>
<td>207.2</td>
<td>1.60</td>
<td>4.03</td>
<td>0.40</td>
<td>0.31</td>
</tr>
<tr>
<td>P value</td>
<td>0.89</td>
<td>0.67</td>
<td>0.10</td>
<td>0.03</td>
<td>0.08</td>
</tr>
</tbody>
</table>

\textsuperscript{1}HRFI, High residual feed intake; \textsuperscript{2}LRFI, Low residue feed intake; \textsuperscript{3}ADG, Average daily gain; \textsuperscript{4}ADFI, Average daily feed intake; \textsuperscript{5}G:F, gain to feed ratio.

Smith and colleagues (2011) evaluated how selection for LRFI affected pork composition and quality. Carcasses from the LRFI pigs tended to have less backfat, greater loin depth, and greater fat free lean. Loin chops from LRFI pig had less marbling than loin chops from HRFI pigs (Table 2, [10]).

### Table 2. Effect of selection for decreased residual feed intake on carcass composition of pigs.

<table>
<thead>
<tr>
<th>Trait</th>
<th>LRFI</th>
<th>HRFI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loin eye depth, inch</td>
<td>2.26±0.04</td>
<td>2.15±0.03</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Backfat depth, inch</td>
<td>0.06±0.04</td>
<td>0.68±0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>Predicted lean, %</td>
<td>56.48±0.6</td>
<td>54.85±0.45</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

- **Take home message:** Although selection altered carcass parameters, taste panel assessment of eating quality parameters were not different.

Harris and colleagues (2012) determined the extent to which nutrient digestibility and energy use contributed to feed efficiency in LRFI or HRFI pigs. Average daily feed intake was lower for the LRFI pigs (4.4 vs. 5.7 lbs. for LRFI vs. HRFI, respectively), average daily gain did not differ, and feed efficiency was 35%.
higher in LRFI pigs compared to HRFI pigs. The digestibility of dry matter, nitrogen and gross energy were higher in LRFI compared to HRFI pigs (Table 3, [11]).

Table 3. Effects of divergent selection for residual feed intake on nitrogen, dry matter and gross energy digestibility in pigs.

<table>
<thead>
<tr>
<th>Digestibility (%)</th>
<th>LRFI</th>
<th>HRFI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter</td>
<td>87.3 ± 0.25</td>
<td>85.9 ± 0.25</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>88.3 ± 0.47</td>
<td>86.1 ± 0.47</td>
<td>0.003</td>
</tr>
<tr>
<td>Gross Energy</td>
<td>86.9 ± 0.25</td>
<td>85.4 ± 0.25</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

- **Take home message:** The LRFI pigs have higher apparent total tract digestibility coefficient for nutrient and energy digestibility. This may partially explain some of their improved feed efficiency.

**Feeding behavior and performance of pigs selected for RFI**

Young and colleagues (2011) investigated feeding behavior and performance of HRFI and LRFI finisher pigs (Figure 4).
Take home message: Pigs selected for improved feed efficiency altered their feeding behavior. Therefore, we predict that in a production environment, these pigs would adapt quickly to feeding competition. The LRFI pigs had a greater eating rate and spent less time eating per day, visit, and hour than HRFI pigs [2].

Summary
On average over generation 5 to 10, raising LRFI pigs cost $1.37 less than HRFI pigs.

In summary, this work is very encouraging as it relates to the impact of selection for feed efficiency based on residual feed intake on nursery and finisher pig's feeding behavior and performance. Selection for feed efficiency based on RFI reduces the maintenance requirement of pigs but needs to be combined with selection for increased growth rate for it to be practical.

Cited literature


5. Steckelberg JR, Mauch ED, Dannen AM, Serão NVL, Dekkers JCM. Differences in feed efficiency during the nursery phase of pigs divergently selected for residual feed intake during grow-finish phase. The ASAS-ADSA 2015 Midwest Annual Meeting, Des Moines, IA, USA.


Frequently asked questions

Q: What is feeding behavior?
Feeding involves location and ingestion of feed. Feeding behavior typically refers to patterns of feed intake, such as feed intake amount, time spent eating, eating rate, and number of meals per day. Many environmental and physiological factors can impact feeding behavior.

Q: Does selection for feed efficiency based on RFI change the feeding behavior of pig's?
Yes, the feeding behavior of pigs selected LRFI is different from randomly selected pigs. Pigs selected for LRFI ate less, but faster, and spent less time eating per day compared to randomly selected pigs.

Q: Does selection for feed efficiency based on RFI affect growth performance?
Yes, the performance of pigs selected for LRFI is different from pigs not selected for RFI. Pigs selected for LRFI had slightly lower average daily gain, but greater feed efficiency, less backfat, greater loin depth, and greater fat free lean compared to randomly selected pigs.

Q: Where can I find out more about RFI selection in pigs?
For more information, visit the following link: http://www.swinefeedefficiency.com/index.html

Related Resources
How has selection for residual feed intake (RFI) affected the nursery and finisher pig's feeding behavior and performance?

The nutritional program for replacement gilts has a direct effect on sow lifetime productivity. How females are fed in development affects prolificacy.

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