

# SELECTION LINES FOR RESIDUAL FEED INTAKE IN YORKSHIRE SWINE

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## Introduction

Feed for the growing phase is the largest variable cost in swine production. Large differences in FI exist and a substantial proportion (~30%) of these are related to genetics. Estimates of heritability of FI average 0.3, ranging from 0.12 to 0.74 (Clutter and Brascamp 1998). Although FE (kg product/kg feed) has improved to some degree by selection for growth and reduced backfat, further improvements require direct selection on FI. This is, however, prohibited by the difficulty and expense of recording FI on large numbers of animals, but possible if the genes responsible for differences in FI and FE are known. A thorough understanding of mechanisms that control FI and energy metabolism will be needed to utilize genetic information on FI in a manner that will enhance production efficiency.

Although FI is genetically related to the economically important traits of growth and backfat, these relationships are not perfect; estimates of genetic correlations average 0.65 (0.32-0.89) with growth rate and 0.37 (0.08-0.59) with backfat thickness (Clutter and Brascamp 1998). Thus, although a large proportion (36-64%) (Luiting 1998) of variation in FI is related to production traits, there is considerable variation that is independent of growth and composition. This is referred to as residual FI (RFI), i.e. feed consumed over and above expected requirements for production and maintenance (Luiting, 1990). Variation in RFI is not utilized in genetic selection for growth and composition but is heritable; estimates in the pig range from 0.15 to 0.40 (Foster et al. 1983, Mrode and Kennedy 1993, Von Felde et al. 1996, Johnson et al. 1999). Factors that contribute to genetic variation in RFI include feeding behavior, nutrient digestion, maintenance requirements, and energy homeostasis and partitioning (Luiting 1998). Genetic differences in the ability to digest nutrients are small but differences in maintenance requirements play a major role (Luiting 1998). Although reduced maintenance requirements are desirable for improved FE, this may result in reduced fitness and increased susceptibility to stressors and diseases (Rauw et al. 1998). To enable the study of the genetic and physiological basis of feed efficiency, a selection experiment for RFI was initiated. In this paper, we evaluate response to selection in the first 3 generations.

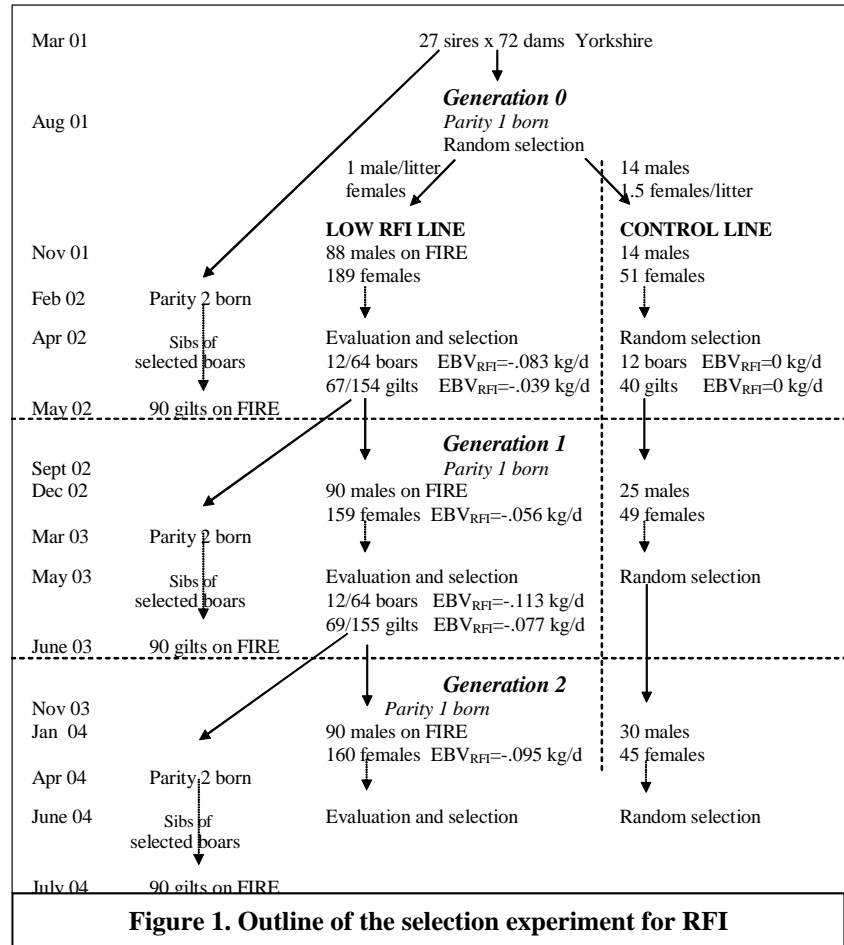
## Materials and Methods

Using purebred Yorkshire pigs, a selection experiment for RFI was started in 2001. An outline of the experiment and its progress is in Fig.1. Starting with random allocation of littermates, in each generation, electronically measured feed intake, body weight, and ultrasound backfat are evaluated from ~40 to ~115 kg on 90 boars from first parity low residual feed intake (LRFI) sows and 90 gilts from second parity LRFI sows. Low RFI line boars are raised on FIRE<sup>®</sup> feeders for electronic recording of FI in pens. Database and edit systems to handle the large amounts of data (~6 meals/d/pig; Casey and Dekkers 2001) were developed (Casey 2003). RFI is estimated by adjusting FI for growth and backfat (Mrode and Kennedy, 1993) and selection is on mixed linear model estimates of breeding values for

RFI. Full- or half-sisters of the selected boars, produced at the 2<sup>nd</sup> parity of their dams, are evaluated for RFI to provide additional data.

Following evaluation of first parity boars, ~12 LRFI boars and 70 gilts are selected to produce ~50 litters for the next generation. About 30 control line litters are produced by random mating. Selection is on EBV for RFI from animal model analysis of average daily feed intake (FI), with group and sex (fixed), pen within group (random), and covariates for on- and off-test weight and age, for average daily gain (ADG) and backfat (BF). The same model was used to estimate heritability of RFI, FI, and ADG and BF based on data on 638 LRFI pigs with FI data across generations.

Since FI is routinely not recorded in the control line, line differences for RFI, FI, ADG and BF were evaluated after 3 generations using phenotypic data on 49 LRFI and 38 control gilts that were simultaneously evaluated for FI from ~40 to ~70 kg. Data were analysed with a mixed model with line as a fixed effect.



**Figure 1. Outline of the selection experiment for RFI**

## Results and Discussion

Estimates of heritabilities and line differences are in Table 1. Estimates of phenotypic and genetic correlations are in Table 2. Residual feed intake contributed nearly 50% of phenotypic variation in feed intake, the rest being explained by variation in growth rate and backfat. Heritability estimate of FI, ADG and BF were within the range observed in literature. RFI had a substantial heritability (0.30). Selection line gilts had significantly lower RFI (93 g/d) and FI (122 g/d) than the control line with no significant change in ADG and BF, although there was a tendency for the LRFI line to have lower growth. Estimates of response based on direct comparison of lines were lower than estimates based on average EBV from analysis of data observed on selection line animals only. This may be because RFI was evaluated over a different time period and on gilts versus boars.

**Table 1. Estimates of phenotypic standard deviations, heritability and differences between the LRFI and control lines based on estimates of breeding values and direct phenotypic comparison.**

Trait	Phenotypic standard deviation	Heritability ± st.error	Line difference (LRFI-control) estimated based on	
			EBV in LRFI line	Phenotypic comparison
RFI (g/d)	130	0.30 ± 0.09	-123	-93***
FI (g/d)	187	0.46 ± 0.10	-153	-123***
ADG (g/d)	79	0.33 ± 0.09	-13	-22 <sup>NS</sup>
BF (mm)	3	0.67 ± 0.11	-0.47	0.063 <sup>NS</sup>

\*\*\* significant at P<.01

<sup>NS</sup> Not significant at P<.10

**Table 2. Estimates of heritability (on diagonal), phenotypic correlations (above diagonal), and genetic correlations (below diagonal) based on bivariate analysis of data from four generations.**

Trait	RFI	FI	ADG	BF	LMA	IMF
RFI	<b>0.33</b>	0.51	-0.01	-0.01	-0.1	0.04
FI	0.71	<b>0.40</b>	0.65	0.44	-0.03	0.10
ADG	0.15	0.74	<b>0.33</b>	0.29	0.11	0.18
BF	-0.01	0.55	0.40	<b>0.61</b>	-0.05	0.04
LMA <sup>a</sup>	-0.265	-0.10	0.19	-0.05	<b>0.62</b>	0.07
IMF <sup>b</sup>	0.15	0.23	0.27	-0.05	0.26	<b>0.53</b>

<sup>a</sup>LMA-Loin muscle area, cm<sup>2</sup>

<sup>b</sup>IMF-Intramuscular fat percentage

### Summary and Implications

A line of Yorkshire pigs was selected for 3 generations for reduced residual feed intake (RFI), a measure of feed efficiency defined as feed consumed over and above average requirements for maintenance and growth. Heritability estimates of RFI, feed intake, growth, and backfat were 0.30, 0.46, 0.33, and 0.67. Comparison of performance of gilts from the selected line (n=49) to those of a randomly selected control line (n=38) from ~40 to ~70 kg showed that selection had significantly decreased feed intake by 123 g/d. There were no significant differences in average daily gain and backfat between the lines, although the selection line tended to have 22 g/d less growth. In conclusion, RFI is a heritable trait and selection for RFI has significantly decreased the amount of feed required for a given rate of growth and backfat.

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