

Analysis of Ten Generations of Selection for Residual Feed Intake in Yorkshire Pigs

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Summary and Implications

Ten generations (G) of divergent selection for residual feed intake (RFI) was practiced in Yorkshire pigs. This study shows that feed efficiency based on RFI was moderately heritable and responded to selection. Pigs selected for increased feed efficiency from the low RFI line ate less, grew slightly slower, and were leaner than pigs from the high RFI line. Thus, the results of this study show that selection for decreased RFI can improve feed efficiency and can be included in an economic selection index in addition to growth for reducing feed cost.

Introduction

Feed is the largest cost in swine industry. Thus, improving feed efficiency is one of the most important economic goals, especially for the grow-finish phase of pork production. Improving feed efficiency can be accomplished by selection for RFI, which is the difference between observed feed intake and expected feed intake. To determine the genetic basis of RFI, evaluate direct and correlated responses to selection, and develop a genetic resource to study the physiological basis of differences in RFI, a selection experiment based on RFI was initiated in a population of purebred Yorkshire pigs in 2001. The ISU RFI population consists of a line that has been selected for increased feed efficiency based on low RFI for 10 generations and a line that was maintained as a randomly selected control line for the first 5 generations and then selected for reduced feed efficiency based on high RFI for the last 5 generations. The objectives of the analyses were to estimate genetic parameters and direct and correlated responses to selection for feed efficiency and growth performance traits.

Materials and Methods

The low RFI (LRFI) line was selected for decreased estimated breeding value (EBV) for RFI during the grow to finish period. The high RFI (HRFI) line was randomly mated until G4 and then selected for increased EBV for RFI from G5 to G10. Both lines were maintained with ~50 litters by ~12 boars, avoiding full- and half-sib matings, with ~70 gilts per generation, except ~10 boars and ~40 gilts that

produced ~30 litters in the first 4 generations of the HRFI line. Records analyzed were for pigs with off-test body weight (BW) greater than 102 kg (n = 2,224).

The ASREML software was used to estimate variance components, EBV, and responses to selection. The mixed model for analysis of average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratio (FCR=ADFI/ADG) included the fixed effects of pen within contemporary group, sex, and a covariate of on-test age, and random effects of additive genetic, litter, and residual. The model for 10th rib ultrasound traits of backfat (BF) and loin muscle area (LMA) also included off-test BW as a covariate. Estimates for RFI were based on analysis of ADFI with additional covariates of on-age, on-test BW, off-test BW, ADG, BF, and average metabolic BW. Responses to selection based on EBV were compared to results from separate phenotype-based analyses of each generation using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) and to genetic trends obtained from separate genetic analyses by line.

Results and Discussion

Estimates of heritability of RFI, ADFI, ADG, BF, LMA, and FCR were 0.28, 0.45, 0.38, 0.49, 0.53 and 0.29, respectively. Estimates of genetic correlations of RFI with ADFI, ADG, BF, LMA, and FCR were 0.69, 0.16, 0.23, -0.32 and 0.68, respectively (see Table 1). After 9 generations of selection, the LRFI line had 201 g/d lower RFI (= 3.0 genetic SD), 277 g/d less ADFI (2.1 SD), 29 g/d lower ADG (0.5 SD), 2.3 mm lower BF (0.82 SD), 1.5 cm² greater LMA (0.43 SD), and 0.26 g/g lower FCR (1.88 SD) than the HRFI line. Line differences (LRFI - HRFI) based on least square means in the first parity of G10 were -241 g/d (P < 0.0001), -444 g/d (P < 0.0001), -75.5 g/d (P < 0.003), -2.5 mm (P < 0.046), -0.5 cm² (P > 0.05), and -0.29 g/g (P < 0.002) for RFI, ADFI, ADG, BF, LMA and FCR, respectively.

Collectively these results indicate that RFI is an effective selection trait for improvement of feed efficiency in swine and is moderately heritable. Additionally, selection based on RFI lead to other beneficial improvements such as reduced backfat depth and may increase lean growth. Therefore results indicate RFI would be a useful trait to include in an economic selection index in addition to growth traits in order to reduce feed costs.

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Table 1. Estimates (\pm SE) of heritability (diagonal), genetic and phenotypic (upper and lower diagonal) correlations.

Trait	RFI	ADFI	ADG	BF	LMA	FCR
RFI	0.28 ± 0.05	0.69 ± 0.07	0.16 ± 0.13	0.23 ± 0.12	-0.32 ± 0.11	0.68 ± 0.08
ADFI	0.65 ± 0.02	0.45 ± 0.05	0.76 ± 0.05	0.58 ± 0.07	-0.22 ± 0.10	0.22 ± 0.12
ADG	0.01 ± 0.03	0.68 ± 0.01	0.38 ± 0.05	0.31 ± 0.10	0.06 ± 0.11	-0.46 ± 0.10
BF	0.03 ± 0.03	0.52 ± 0.02	0.36 ± 0.02	0.49 ± 0.06	-0.36 ± 0.10	0.36 ± 0.12
LMA	-0.08 ± 0.03	-0.09 ± 0.03	0.05 ± 0.03	-0.23 ± 0.03	0.53 ± 0.06	-0.41 ± 0.11
FCR	0.69 ± 0.01	0.16 ± 0.03	-0.52 ± 0.03	0.10 ± 0.03	-0.17 ± 0.03	0.29 ± 0.05