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ASSOCIATIONS BETWEEN FEED INTAKE OF GROWING GILTS, LACTATING SOWS AND OTHER REPRODUCTIVE OR PERFORMANCE TRAITS

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SUMMARY

The genetic and phenotypic associations between performance and feed intake traits of finished gilts (GFI), along with their subsequent reproductive performance and feed intake during lactation (LFI), were estimated using data collected from two maternal lines recorded under the same management system. *Ad-libitum* feed intake was heritable (h^2: 0.33±0.08) when recorded in post-finisher gilts or during lactation (h^2: 0.11±0.09). Genetic (ra) and phenotypic (rp) correlations between GFI and performance traits support the hypothesis that selection for reduced back fat (BF) and lower feed conversion ratio (FCR) are associated with a reduction in feed intake (ra: 0.36±0.11 and 0.79±0.11 for BF and FCR respectively). However, the correlations between GFI and measures of sow reproductive performance were lower (ranges: ra from -0.16 to 0.01; rp from -0.07 to 0.02). Current estimates of genetic and phenotypic correlations between GFI and LFI do not support the expectation of a positive association between these traits (ra: -0.26±0.33; rp: 0.05±0.04) although standard errors are large. More data are required to obtain accurate estimates of correlations between LFI and the other traits.

INTRODUCTION

Breeding goals for dam lines in pig breeding programs have historically included both reproductive and production traits. Due to correlations between feed intake, leanness and efficiency traits in particular, it is generally thought that the current outcome for modern sows includes improved grower-finisher performance along with larger litter size and milk production potential, with an antagonistic combination of lower appetite and higher maintenance requirements (Eissen 2000). Lower feed intake potentially places constraints on a sow's ability to eat enough during lactation both to rear her litter and maintain body condition for successful rebreeding post-weaning. This phenomenon might therefore be a major biological driver of increasing piglet mortality, limitations to piglet weaning weight and poor sow longevity in modern production systems.

Typically however, dam lines are not recorded directly for feed intake or efficiency as grower-finishers. Thus, literature values for associations between feed intake, performance and reproductive traits are obtained from sire line data, which often have poor reproductive performance in any case, where the correlation is estimated from feed intake data recorded for males linked via pedigree with reproductive performance of females. Further, other reproductive traits included in dam line breeding goals might reduce the extent of a detrimental correlated response in feed intake. Finally, many breeders operate step-up feeding systems during lactation that limit the expression of appetite at this time. Thus, the actual extent of genetic associations between grower-finisher or lactation feed intake and reproductive performance or longevity in dam lines is poorly established. In this paper we report

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preliminary estimates of genetic parameters between feed intake of grower-finisher gilts and performance traits, along with first parity reproductive traits and lactational feed intake.

MATERIALS AND METHODS

Commencing 2003, pedigree and performance test records were obtained for females from two commercial (Large White and Landrace based) maternal lines located at QAF Meat Industries. Data for all females included the following production traits recorded either at 20 or 22 (pre 2006) weeks in a conventional pen-test environment: average daily gain (ADG); back fat (BF: an average from the P2 and P4 sites); and muscle depth (MD). Gilts that became parents also had records for their age at first farrowing (AGEF), first parity number born alive (NBA) and average piglet birth weight (ABWT). Commencing March 2006, gilts were additionally recorded post-selection for *ad-libitum* feed intake between 21 and 26 weeks of age (average weights: ~89 to 126kg) under group housing with electronic feeders. Feed intake and growth rate (ADG2) recorded in this phase were used to calculate feed conversion ratio (FCR). From November 2006, these gilts were further recorded for feed intake throughout their first lactation. Selected gilts that had farrowed thus had feed intake measured both as unmated gilts (GFI) and during lactation (LFI). Delivery of feed during lactation was "to demand" as much as possible, to ensure adequate expression of appetite during the lactation phase. Feed intake traits are expressed as averages: GFI averaged over 35 days and LFI averaged for individual sows over a range of eight to 35 days.

Data were subsequently edited based on trait distributions. Proc UNIVARIATE (SAS Institute Inc. 1990) was used to identify outliers, whereby trait records that deviated by more than 3 times the interquartile range from the mean value were deleted. After editing, the pedigree consisted of 40 842 animals in the pedigree, representing 480 sires and 5 555 dams across the 4-year period.

Models for analyses were developed using ASREML software, which estimates variance components under a linear mixed model by residual maximum likelihood (Gilmour *et al*. 1999). Univariate analyses were used to develop models for both systematic and random effects, and to obtain initial estimates of genetic parameters. F-tests were used to assess the significance of systematic effects and/or their interactions, while the significance of litter as an additional random effect was determined using the likelihood ratio test. Contemporary groups for both performance test or reproductive records were formed separately as year/month of recording (levels: 35 for production and reproductive records; 9 for GFI and 6 for LFI). In addition, farrowing location (2 levels) and mating type (3 levels: purebred, F1 from a maternal line cross, or cross-bred to terminal sires) were included in the models for reproductive traits. Line differences (2 levels) were accommodated in the models for all traits, excluding ADG2 and AGEF. Finishing weight was fitted as a linear covariate for BF and MD. Correlations between specific traits were subsequently estimated using trait specific models noted above, fitted in a series of bivariate analyses.

RESULTS AND DISCUSSION

Characteristics of the data. Feed intake of *ad-libitum* fed gilts recorded post selection was on average 2.6% of their body weight (Table 1: 2.59 kg/day). The coefficient of variation (CV) for gilt feed intake was similar to that observed for their growth rate and feed conversion ratio recorded at the same time. Lactation feed intake for sows with lactation lengths between eight and 35 days inclusive averaged 4.32 kg/day (or ~2.2% of sow body weight after farrowing). For sows with lactation lengths exceeding 21 days, higher average feed intake levels were evident (4.60 kg/day), indirectly illustrating that sows weaned earlier than the targeted lactation length of 27 to 33 days tended to have lower feed intakes during early lactation. Variability of lactation feed intake between sows was relatively high (CV~24%) despite the practice of cross-fostering after birth to standardize suckled litter sizes. Characteristics for other traits are consistent with expectations.

Table 1. Characteristics of the data after editing for outliers

Trait	Abbreviation	N	Mean (SD)	Min	Max	CV
Average daily gain (g/day)	ADG	37 243	593 (73)	329	936	12.3
Back fat (mm)	BF	37227	11.0 (2.40)	5	22	21.8
Muscle depth (mm)	MD	37215	42.7 (5.47)	22	68	12.8
Daily gain from 21-25 weeks (g/day)	ADG2	1387	898 (137)	393	1393	15.3
Average gilt feed intake (kg/day)	GFI	1387	2.59 (0.41)	1.14	4.38	15.8
Feed conversion ratio (kg/kg)	FCR	1387	2.92 (0.46)	1.43	4.83	15.9
Age at first farrowing (days)	AGEF	10540	344 (16.0)	301	414	4.66
Number born alive (pigs/litter)	NBA	10631	10.2 (2.77)	0	18	27.2
Average piglet birth weight (kg)	ABWT	4032	1.40 (0.25)	0.66	2.52	17.9
Average lactation feed intake	LFI	516	4.32 (1.03)	0.19	6.53	23.8

Genetic parameters. Estimates of heritabilities from univariate analyses were moderate to high for all traits, excluding ADG2, NBA and LFI (Table 2). Lactation feed intake in primiparous sows was lowly heritable (h^2: 0.11±0.09). Hermesch (2007) obtained an estimate of 0.19±0.05 using data from a different population of mixed parity sows. Common litter effects were significant for production traits, excluding FCR, but were generally not significant for reproductive traits. Genetic parameters for all remaining traits were similar to those reported elsewhere (Clutter and Brascamp 1998). Estimates of heritabilities from bivariate analyses were similar to estimates from univariate analyses.

Table 2. Phenotypic variance (σ^2_p), heritability (h^2), and common litter effects (c^2), along with genetic (ra) and phenotypic (rp) correlations with feed intake traits (±se)

Trait	Univariate parameters			Genetic (ra) and phenotypic (rp) correlations			
				GFI		LFI	
	h^2	c^2	σ^2_p	ra	rp	ra	rp
ADG	0.18±0.01	0.17±0.01	4943	0.58±0.10	0.18±0.03	0.57±0.41	0.00±0.05
BF	0.37±0.01	0.08±0.01	3.56	0.36±0.11	0.11±0.03	-0.35±0.27	-0.14±0.05
MD	0.20±0.01	0.05±0.01	20.1	-0.26±0.11	-0.06±0.03	0.06±0.27	0.02±0.05
ADG2	0.10±0.06	0.13±0.05	17649	0.34±0.23	0.47±0.02	-0.22±0.49	0.04±0.05
GFI	0.33±0.08	0.12±0.05	0.137	na	na	-0.26±0.33	0.05±0.04
FCR	0.24±0.07	0.09±0.05	0.203	0.79±0.11	0.43±0.02	-0.08±0.35	0.00±0.04
AGEF	0.22±0.02	0.13±0.01	237	0.01±0.16	-0.07±0.05	0.15±0.35	-0.01±0.06
NBA	0.09±0.01	ne	7.32	-0.16±0.18	-0.05±0.04	-0.54±0.32	0.12±0.04
ABW	0.30±0.03	ne	0.062	-0.16±0.15	0.02±0.04	0.11±0.32	-0.02±0.05
LFI	0.11±0.09	ne	1.04	na	na	na	na

ne: not estimated; na: not applicable.

Genetic correlations between GFI and ADG, BF, ADG2 or FCR were generally moderate to high and positive. Phenotypic correlations were consistent in direction with estimates of genetic correlations. Thus, animals with high feed intake post-selection had increased growth rates and back fat deposition as grower-finishers, along with poorer FCR and reduced muscle depth. In contrast, gilt feed intake was only lowly correlated, if at all, with the reproductive performance traits, such as age at first farrowing, first parity litter size and piglet birth weights.

Estimates of genetic correlations between lactation feed intake and performance traits were variable in sign and magnitude, and were generally accompanied by phenotypic correlations not significantly different to zero. The primary exception was the negative genetic and phenotypic correlations between BF and lactational feed intake. A predisposition to increased fatness at the end of performance testing was associated with a lower lactational feed intake in the subsequent first parity. This phenomenon has been observed previously (see review by Eissen 2000). The preliminary bivariate estimate of the genetic correlation between gilt and lactating sow feed intakes was moderate and unexpectedly negative, but accompanied by a large standard error. A 5-trait analysis simultaneously estimating correlations between ADG, BF, NBA (traits under selection) along with GFI and LFI gave similar results (not presented). More data will be required to provide accurate estimates of correlations between LFI and the other traits.

CONCLUSIONS

Feed intake of gilts was a highly heritable trait. Genetic and phenotypic correlations between feed intake of gilts and their performance traits supports the hypothesis that breeding goals which incorporate lowering FCR and BF will result in reduced feed intake for grower/finisher gilts, particularly where an increase in ADG does not confer a selective advantage. Sow feed intake during lactation also appears heritable. However, there was no strong evidence for a positive genetic or phenotypic correlation between feed intake of grower/finisher gilts and their intake as lactating sows. This implies that reduced intake of grower-finisher gilts is not necessarily accompanied by reduced lactational intake.

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