Genetic Parameter Estimates Among Scale Activity Score And Farrowing Disposition With Reproductive Traits In Swine

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Introduction

A majority of animals culled because of reproductive failure are skewed towards first parity or younger females, leading to an overall reduction in the herd's sow lifetime productivity. The ability to identify young females with superior reproductive potential would have a large economic impact on swine production.

Limited information is available in the literature regarding swine behavior in early life and how early behavior affects performance of the adult animal. Hessing and others (1993, 1994) reported indicators (i.e., backtest, heart rate, and open field response) obtained early in life were indicative of coping characteristics in adult pigs. Similarly gilts subjected to a single backtest between 10-17 d of age were categorized as either high- or low-resisting (Geverink et al., 2004). High-resisting females at 13 months of age had decreased ADG and lower energy metabolizability (ME/GE) when compared to low-resisting animals. This suggested that high-resisting gilts may have more difficulty adapting to environmental alterations.

Material and methods

Animals. A composite population was developed using Large White, Duroc, and two sources of Landrace. Boars and gilts were randomly selected within sire-line origin. Matings were random with the exception of avoidance of full- and half-sib matings. Twelve original sire-lines were maintained and approximately 300 females produced litters per generation. Additional details of the development of this population were reported (Holl et al., 2008). All gilts available at 22 wk of age were used for this study.

Methods of observation. The 5,455 Landrace-Duroc-Yorkshire females were scored for behavioral tendencies at approximately 154 days of age during a scheduled weighing. Animals were scored (SA) from 1 to 5 while confined to the scale. A description of rated activity is as follows:

1) Remains calm with little or no movement
2) Walks forward and backward at a slow pace
3) Continuously moves forward or backward at a rapid pace
4) Continuously moves forward or backward at a rapid pace with vocalization
5) Continuously moves forward or backward at a rapid pace with vocalization and attempts to escape

The distribution of SA is shown in Table 1.

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Various phenotypic traits were recorded for subsets of activity-scored animals including age at puberty (AP) measured as first detected estrus (n = 1,224), farrowing disposition (FD; n = 1,356), (Table 2), number born alive (NBA; n = 1,109), number born dead (NBD; n = 1,109), litter birth weight (LBW; n = 1,090), average birth weight (ABW; n = 1,090), number weaned (NW; n = 932), litter wean weight (LWW; n = 932), average wean weight (AWW; n = 932), and weaning-to-estrus interval (WEI; n = 755).

Farrowing disposition scoring was as follows: 1) quiet and careful with her litter; 2) nervous; 3) agitated and required sedative.

Table 1: Distribution of scale activity scores

SA	1	1.5	2	2.5	3	3.5	4	4.5	5
Gilts	1,839	756	1,466	261	637	82	269	20	122
%	34%	14%	27%	5%	12%	2%	5%	0%	2%

Table 2: Distribution of farrowing disposition scores

FD Score	1	2	3
Gilts scored	1,326	15	32
Per Cent	97.6%	1.1%	2.4%

Statistical analyses. All statistical computations were completed using MTDFREML (Boldman et al. 1995) and incorporated an animal direct genetic effect. Heritabilities were estimated from a series of single trait analyses with birth-year-season as a fixed effect for pre-farrow traits, and farrow-year-season and parity as fixed effects for farrowing and post-farrowing traits. Covariates such as age, weight, backfat, weight loss, backfat loss, and lactation length were included in relevant analyses (Table 3). Correlations were estimated using models that included either SA or FD, and each of the reproductive traits taken one at a time. Each model was fit using the appropriate effects for each trait as described in Table 3.

Table 3: Significant effects in the statistical models

Trait		Fixed Effects		Covariates			
SA	Animal	BYS		D154WT	D154BF	Saage	
FD	Animal	FYR		D154WT			
AP	Animal	BYS		D154WT	D154BF		
NBA	Animal	FYR				D110WT	D110BF
NBD	Animal	FYR	Parity				D110BF
LBW	Animal	FYR	Parity			D110WT	D110BF
ABW	Animal	FYR	Parity			D110WT	
NW	Animal	FYR		WWT	WWTLoss	WBF	
LWW	Animal	FYR		WWT	WWTLoss	WBF	LactLngt
AWW	Animal	FYR		WWT	WWTLoss		LactLngt
WEI	Animal	---				WBFLoss	LactLngt
OR	Animal	FYR		WWT		WBF	ORage

BYS = Birth year season, FYS = Farrowing year season, D154WT = Weight at 154 days,
D154BF = Backfat at 154 days, D110WT = Weight at 110 days of gestation,
D110BF = Backfat at 110 days of gestation, LactLngt = Lactation length,
ORage = Ovulation age, SAage = Age at scale activity score, WWT = Sow's weaning weight,
WWTLoss = Weight change from D110WT to WWT, WBF = Sow's backfat at weaning,
WBFLoss = Sow's backfat change from D110BF to WBF

Results and discussion

Estimates of genetic parameters are shown in Table 4. The heritability value for SA is in close agreement with Holl et al. (2010). Heritability estimates for FD were not found in the literature. Holm et al. (2004) found estimates for heritability for age at first mating, NBA and WEI that are in close agreement with AP, NBA and WEI. Chen et al. (2003) estimated heritabilities for NBA, LWW and NW to be similar to the estimates shown in Table 4. Estimates for ABW and AWW (Table 4) are higher than those found in the literature but still acceptable.

Genetic correlations for reproductive traits and SA or FD were not found in the literature. Although non-significant, genetic correlations of SA with AP, NBA, and NBD all suggest favorable relationships. In contrast, signs of genetic correlations of SA with LBW, ABW (P <. 01), LWW, and AWW indicated an unfavorable relationship. Genetic correlations of FD with NBD, LBW, ABW, and NW were all beneficial but only ABW (P < .10) and NW (P < .05) were significant. Other FD genetic correlations were small and not significant. The lack of variation in FD scores may have prevented more meaningful and significant genetic correlations from being found.

Table 4: Genetic parameters for reproduction and behavior traits

Traits	Heritabilities	Genetic Correlations with SA	Genetic Correlations with FD
SA	0.26 ± 0.03***		-0.05 ± 0.30
FD	0.05 ± 0.03	-0.05 ± 0.30	
AP	0.41 ± 0.08***	0.19 ± 0.18	-0.11 ± 0.39
NBA	0.10 ± 0.05*	-0.30 ± 0.26	-0.08 ± 0.49
NBD	0.04 ± 0.03	0.57 ± 0.37	0.34 ± 0.64
LBW	0.19 ± 0.06**	0.30 ± 0.20	-0.47 ± 0.42
ABW	0.32 ± 0.06***	0.38 ± 0.14**	-0.64 ± 0.34†
NW	0.11 ± 0.05*	0.01 ± 0.25	-0.74 ± 0.37*
LWW	0.09 ± 0.05†	0.25 ± 0.28	---
AWW	0.32 ± 0.07***	0.34 ± 0.17*	0.16 ± 0.36
WEI	0.04 ± 0.05	-0.92 ± 0.58	---

† P < .10
* P <.05
** P< .01
*** P < .0001

Conclusion

Most behavioral and reproductive trait heritability estimates were statistically significant and similar to those found in the literature. Comparisons of calculated genetic correlations to those in the literature were not available. Indications that selection based on the combination of SA and FD could improve reproductive performance were observed. Prior to attempting selection, FD needs to be redefined to provide more variation than demonstrated in Table 2. If the "quiet and careful" score for FD was split into three or more sub-categories, additional variation in FD should be found. Assuming the new genetic parameters calculated for FD are similar in direction and magnitude, and greater in statistical significance than the current estimates, using SA and FD becomes a viable aid in selection.

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