Prediction of Number Born Alive and Weaning Weight of Litter in First Parity Sows Using Performance Test Traits in Four Breeds of Swine

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Story in Brief

The objective of this study was to examine relationships between performance test traits and subsequent reproductive performance in first parity females in 4 breeds of swine. Performance test records were collected in a commercial swine operation from 1992 to 1999. All females were grown to 100 d of age. At this time, pigs were weighed (WT100) and selected for performance testing based on a combination of maternal and performance indexes, which were different for each breed. Pigs were weighed at the end of the 77-d performance test and ADG was calculated. Backfat (BF), loin eye area (LEA), and body length (LEN) were measured. Number of live born pigs (NBA) and weight of litter at weaning (WWL) were recorded. Regression analyses were used to determine if NBA and WWL could be predicted using previous performance test records of the dam. Regression models included effects for contemporary group of the dam, maternal grandsire, and sire of the litter, as well as WT100, ADG, LEA, BF, and LEN as covariates. In Landrace, ADG was a significant covariate ($P = 0.02$) for NBA. For Yorkshire, LEN was a significant ($P < 0.01$) covariate for NBA, and ADG ($P = 0.06$) and LEA ($P < 0.01$) were significant covariates for WWL. In Duroc, WT100 ($P < 0.01$) and LEN ($P = 0.02$) were both significant covariates for NBA, whereas LEN ($P = 0.03$) was a significant covariate for WWL. In Hampshire, ADG was a significant ($P = 0.05$) covariate for NBA, and WT100 ($P < 0.01$), ADG ($P = 0.01$), and BF ($P = 0.03$) were significant covariates for WWL. Regression models accounted for 37 to 59% of the variation in NBA and WWL; however, the majority of this variation was due to contemporary group, maternal grandsire, and sire of the litter. No covariate alone contributed more than 1% to the total variation in NBA or WWL, so would probably not be useful in predicting these traits.

Introduction

Litter size (number born and number weaned) is an important economic component of sow productivity. Noguera et al. (2002a,b) reported that long-term selection experiments for directly increasing litter size by means of conventional selection have not, in general, been successful. This may be due to low heritability or the difficulty of achieving high selection intensity in practice. It is important to know how selection for other traits may affect this trait. The objective of this study, therefore, was to determine if performance test traits would be useful in predicting subsequent reproductive performance of first parity females in Landrace, Yorkshire, Duroc, and Hampshire breeds of swine.

Experimental Procedures

Data for this study consisted of performance test records of Landrace, Yorkshire, Duroc, and Hampshire pigs collected in a commercial swine operation (The Pork Group, A Division of Tyson Foods, Inc., Rogers, Ark.) from 1992 to 1999. All females were grown to 100 d of age and weighed (WT100). Fifty to sixty percent were selected for performance testing based on a combination of maternal and performance indexes, which were different for each breed. Two indexes (breeding values) for each animal were calculated. One was a maternal index based on number born alive, farrowing interval, and litter weaning weight. The other was based on growth rate, leanness, and feed efficiency (Grow-Fin). The maternal index was computed using a three-trait model that included terms for the additive genetic effect, litter effects, and maternal genetic effects, along with appropriate fixed effects. The Grow-Fin index was computed using a model that included only additive genetic effects and appropriate fixed effects. These 2 indexes were combined into an overall ranking depending on the breed. Equal emphasis was given to both indexes for Landrace; more emphasis was given to the maternal index for Yorkshire; more emphasis was given to the Grow-Fin index for Duroc; and the emphasis was totally on the Grow-Fin index for Hampshire.

Gilts were fed for ad libitum consumption a pelleted corn-soybean meal diet that was 1.14% lysine, 19% protein, and 3,344 mcal/kg ME in groups of 8 to 10 pigs in a pen, with each pig having an area of 1.2 m^2. Exact composition of the diet varied due to ingredient cost. Different size pens were available in different facilities, so pens in some barns held 8 pigs and in other barns 10 pigs. All pigs had ad libitum access to water. Barns were curtain-sided buildings that were tunnel ventilated in the winter. All pigs were weighed at the end of the 77-day performance test (WT177), and ADG was calculated. Backfat (BF), loin eye area (LEA), and body length (LEN) were measured. Backfat and LEA were measured at approximately the 12th rib using B-mode ultrasound equipment. Body length was measured from the top of the tail to the point of the shoulder when the head is down.

Gilts were ranked on an overall index at the end of the test. Those ranking highest were examined for acceptable phenotype (leg structure, vulva, etc.), and then retained for great-grandparent replacements if of acceptable phenotype; the next tier was used for grandparent replacements. Approximately 16% of the gilts were retained and bred to produce first parity litters. Gilts entered the breeding unit at 205 d of age, and received twice daily boar exposure. Any gilt not bred by d 250 was culled. Gilts were normally bred on their first heat after entering the barn. Beginning around 1997, gilts were given boar exposure prior to entering the breeding unit; before that time, they were not. Litter size, measured as num-

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ber of pigs born alive (NBA), and total weaning weight of the litter (at an average of approximately 17 d of age, WWL) were recorded.

Linear regression was used to adjust WT100 to 100 d of age. Other performance test traits were adjusted to 177 d of age, and weaning weight of the litter was adjusted to 17 d of age. Regression coefficients used to adjust these traits are shown in Table 1.

Contemporary group (CG) of the dam was defined as all females in the same house and started on test within a 6-mo period. Number of CG, along with number of sires and maternal grandsires, is shown in Table 2. Regression analyses using PROC GLM of SAS (SAS Inst., Inc., Cary, N.C.) were performed for NBA and WWL. Models included terms for CG, maternal grandsire, and sire of the litter, as well as the performance test traits WT100, ADG, LEA, BF and LEN as covariates.

Results and Discussion

Means and standard deviations for all traits are given in Table 3. There were 805 Landrace, 2,970 Yorkshire, 624 Duroc, and 376 Hampshire females weighed at 100 d of age that were kept long enough to produce a first parity litter.

Results of regression analyses are presented in Table 4. Contemporary group was an important source of variation for both NBA and WWL for all breeds. Maternal grandsire was important ($P < 0.01$) for NBA in the Yorkshire breed and approached significance ($P = 0.07$) for NBA in the Duroc breed, but did not contribute to variation in this trait above that accounted for by CG for Landrace or Hampshire. Sire of the litter was also an important source of variation ($P < 0.01$) for NBA in Yorkshire and approached significance for NBA in Duroc ($P = 0.07$) and Hampshire ($P = 0.12$). Variation due to maternal grandsire was not significant ($P > 0.05$) for WWL in any breed; however, the P-value was < 0.20 in all breeds. Variation due to sire of the litter approached significance ($P = 0.11$) only in the Yorkshire breed.

In Landrace, ADG was the only covariate ($P = 0.02$) for NBA, whereas for WWL, no performance test trait showed a significant regression. For Yorkshire, LEN was a ($P < 0.01$) covariate for NBA; ADG ($P = 0.06$) and LEA ($P < 0.01$) were covariates for WWL. In Duroc, WT100 ($P < 0.01$) and LEN ($P = 0.02$) were both covariates for NBA, whereas LEN ($P = 0.03$) was a covariate for WWL. In Hampshire, ADG was a ($P = 0.05$) covariate for NBA, and WT100 ($P < 0.01$), ADG ($P = 0.01$) and BF ($P = 0.03$) were covariates for WWL.

Regression coefficients for covariates with P-values < 0.10 are shown in Table 5. For NBA, these may be interpreted as follows: 1) for a 1 lb increase in ADG, litter size should increase by 1.72 pigs in Landrace and by 1.91 pigs in Hampshire; 2) for a 1 lb increase in WT100, NBA should increase by 0.02 in Duroc; and 3) an increase in body length of 1 inch should increase NBA by 0.11 in Yorkshire and 0.20 in Duroc. For WWL in Yorkshire, an increase in ADG or LEA would decrease weaning weight of the litter. Small, negative genetic correlations between WWL and ADG (-0.04) and between WWL and LEA (-0.05) were found in the Yorshire breed (Johnson and Nugent, 2004). In contrast, an increase in WT100, ADG or BF would increase WWL in Hampshire, whereas a 1 inch increase in body length would increase WWL by 4.55 lb in Duroc.

Regression models accounted for 38 to 59% of the variation in NBA and for 37 to 53% of the variation in WWL (Table 4); however, the majority of this variation was due to contemporary group, maternal grandsire and sire of the litter. Although some covariates were significant sources of variation for NBA and WWL, none contributed more than 1% to the variation in these traits above that accounted for by CG, maternal grandsire, and sire of litter. An exception was that WT100, ADG, and BF contributed 2.3, 1.6, and 1.1%, respectively, of the 53% of the variation in WWL for Hampshire. These results implied that performance test traits would probably not be useful in predicting the reproductive traits of NBA and WWL.

Implications

Regression analyses indicated that relationships do exist between performance test traits and subsequent reproductive performance, although the amount of variation accounted for above that accounted for by contemporary group and sire effects is small. These relationships vary by breed and population.

Literature Cited

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Table 1. Regression coefficients used to adjust data.

	Breed			
Trait[a]	Landrace	Yorkshire	Duroc	Hampshire
WT100, lb	1.634232	1.796254	1.603868	1.712756
WT177, lb	1.522738	1.933629	1.550914	2.140678
LEA, in^2	0.017444	0.033095	0.008587	0.024875
Backfat, in	0.002377	0.002819	0.003603	0.004339
Body length, in	0.087661	0.044705	0.059315	0.060399
Weaning wt of litter, lb	15.752126	15.747428	11.600902	12.766232

[a]WT100 is weight at approximately 100 d of age and was adjusted to 100 d of age; WT177, loin eye area, backfat, and body length were measured at the end of the 77-d performance test and were adjusted to 177 d of age. Weaning weight of litter was adjusted to 17 d.

Table 2. Descriptive statistics for data sets.

Item	Breed			
	Landrace	Yorkshire	Duroc	Hampshire
Number of contemporary groups	46	79	48	41
Number of maternal grandsires	110	301	107	58
Number of sires	151	361	111	69

Table 3. Mean and standard deviation for performance test traits and subsequent reproductive performance in the first parity for Landrace, Yorkshire, Duroc and Hampshire females.

Trait[a]	n	Mean	SD
Landrace			
AGE100, d	805	98.87	3.11
WT100, lb	805	111.49	12.25
ADG, lb	795	1.84	0.19
AGE177, d	795	175.51	4.01
WT177, lb	795	253.20	19.35
Body length, in	795	38.84	1.89
Backfat, in	795	0.64	0.14
Loin eye area, in^2	795	6.50	0.85
Litter size	805	7.63	2.53
Total weaning weight of litter, lb	740	193.74	63.91
Age at weaning, d	740	16.66	4.99
Yorkshire			
AGE100, d	2,970	99.66	2.87
WT100, lb	2,970	107.19	12.63
ADG, lb	2,950	1.99	0.23
AGE177, d	2,950	176.26	3.79
WT177, lb	2,950	260.63	21.71
Body length, in	2,950	38.50	1.92
Backfat, in	2,949	0.64	0.14
Loin eye area, in^2	2,949	6.76	0.85
Litter size	2,970	8.44	2.82
Total weaning weight of litter, lb	2,741	188.74	61.94
Age at weaning, d	2,741	16.98	4.47
Duroc			
AGE100, d	624	99.20	2.81
WT100, lb	624	103.76	12.45
ADG, lb	619	1.95	0.21
AGE177, d	619	175.89	3.88
WT177, lb	619	253.74	19.03
Body length, in	619	37.28	1.66
Backfat, in	618	0.69	0.13
Loin eye area, in^2	618	6.43	0.70
Litter size	624	7.95	2.29
Total weaning weight of litter, lb	624	149.97	48.03
Age at weaning, d	624	16.54	5.00
Hampshire			
AGE100, d	376	100.52	2.33
WT100, lb	376	97.03	10.41
ADG, lb	372	1.83	0.19
AGE177, d	372	177.25	3.41
WT177, lb	372	237.49	18.46
Body length, in	372	36.85	1.77
Backfat, in	372	0.58	0.11
Loin eye area, in^2	372	6.89	0.78
Litter size	376	7.66	2.13
Total weaning weight of litter, lb	375	156.69	57.25
Age at weaning, d	375	16.70	4.70

[a] AGE100 and WT100 are age and weight at 100 d of age; ADG is average daily gain on the 77-d performance test; and AGE177 is age at the end of the 77-d performance test. WT177, body length, backfat thickness and loin eye area were measured at the end of the 77-d performance test and were adjusted to 177 days of age by linear regression. WT100 was adjusted to 100 d of age by linear regression and total weaning weight of litter was adjusted to an average weaning age of 17 d. Average weaning weight is adjusted total weaning weight of litter divided by number of pigs in litter at weaning. Values for ages (AGE100, AGE177, and age at weaning) are unadjusted.

Table 4. Results of regression analysis (P-values[1] from type I SS) for number born alive, total weaning weight and average weaning weight for litters of Landrace, Yorkshire, Duroc, and Hampshire first parity females.

Source of variation[2]	Breed			
	Landrace	Yorkshire	Duroc	Hampshire
		Number born alive		
CG	< 0.01	< 0.01	< 0.01	< 0.01
Maternal grandsire		< 0.01	0.07	
Sire of litter		< 0.01	0.07	0.12
WT100			< 0.01	
ADG	0.02			0.05
Loin eye area				
Backfat	0.16			
Body length	0.13	< 0.01	0.02	
R^2	0.42	0.38	0.59	0.53
		Weaning weight of litter		
CG	< 0.01	< 0.01	< 0.01	0.05
Maternal grandsire	0.11	0.13	0.16	0.11
Sire of litter		0.11		
WT100				< 0.01
ADG		0.06		0.01
LEA		< 0.01		
Backfat				0.03
Body length			0.03	
R^2	0.45	0.37	0.50	0.53

[1]P-values not shown are > 0.20.
[2]CG = contemporary group of the dam, and WT100 = 100-d weight.

Table 5. Regression coefficients for covariates having P-values < 0.10.

Source of variation[1]	Breed			
	Landrace	Yorkshire	Duroc	Hampshire
		Number born alive		
WT100, lb			0.02146	
ADG, lb	1.72484			1.90608
Body length, in		0.11472	0.20344	
		Weaning weight of litter		
WT100, lb				0.98078
ADG, lb		-7.79598		35.69416
LEA, in^2		-5.41447		
Backfat, in				84.79456
Body length, in			4.55406	

[1]WT100 = 100-d weight.