AN ALTERNATIVE SELECTION PROGRAM FOR LEAN GROWTH IN LANDRACE PIGS USING MIGRATION AND CULLING LEVELS

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SUMMARY

Three generations of selection for lean growth in Landrace pigs using culling levels and migration has been practiced. Two traits were under selection; 168-day weight and ultrasound backfat thickness at 105 kg. Replicated select and control lines were developed from two base populations in 1990. Adjusted weight at 168 days of age was the first culling criterion. After boars and gilts with unacceptable 168-day weights were eliminated as selection candidates, the leanest seven boars and 24 gilts were kept to produce the next generation of select line pigs. A control line boar was randomly chosen from each of eight control sire lines. One replacement gilt was randomly chosen from each control line litter. Matings were made within each line and replicate to minimize the level of inbreeding in the next generation. In the select line each generation, four of the 24 gilts selected were randomly chosen and artificially inseminated using semen from one Landrace boar which was available at a commercial boar stud. There were no overlapping generations. Different boars were selected from the boar stud each generation. Growth rates and backfat thicknesses were recorded on 1,331 boars and gilts. Longissimus area and 10th-rib backfat thickness were collected on 170 carcasses from barrows slaughtered at 102 kg. A multiple-trait DFREML algorithm was used to analyze growth rates, backfat thickness and the carcass traits. The multiple-trait model for growth rate and ultrasound backfat thickness included fixed effects for replicate, generation and sex and random animal and litter effects. The carcass traits were analyzed with a multiple-trait model with fixed effects for replicate, generation and a hot carcass weight linear covariate and random animal effects. The inverse of the numerator relationship matrix was included in all analyses. After three generations of selection, differences between average breeding values in the select and control lines were 5.37 kg for 168-day weight and -0.26 cm of backfat thickness. Differences in average breeding values between the two lines were -0.37 cm for 10th-rib backfat thickness and 2.3 cm^2 for longissimus area.

INTRODUCTION

Purebred pig breeders with small herds (<30 sows) face unique challenges in their genetic improvement programs compared to purebred breeders with larger herds. Inbreeding levels can rapidly increase in small closed herds. In addition, there are fewer animals to select replacement boars and gilts from and this leads to a smaller selection intensity (Kennedy, 1989). Genetic variability will be less in smaller herds because there will be fewer animals with extreme genotypes for any trait. Migration of new animals or germplasm into the herd may reduce inbreeding levels, increase selection intensity and increase genetic variability in the herd.

Selection indexes are traditionally used in multiple-trait selection programs. However, calculating index values for each animal can be tedious and time consuming. While not as efficient for multiple-trait selection as index selection, independent culling levels are a computationally simpler method of multiple-trait selection. The objective of this experiment was to evaluate a selection program for lean growth which uses independent culling levels and allows for limited migration of genes into the selection line each generation.

MATERIALS AND METHODS

Replicated select and control lines were developed from two base populations. The selection criteria in the select line was increased 168-day weight and decreased ultrasound backfat thickness at 105 kg.

Selection decisions were determined with independent culling levels. Weight at 168-days of age was the first culling level. After the truncation point was determined for 168-day weight, the seven leanest boars and 24 leanest gilts were selected. The INDCULL computer program (Saxton, 1989) was used to determine the percentages of animals which were kept based on 168-day weight before culling decisions were made for ultrasound backfat thickness (Table 1). Sixty percent of the selection pressure was for backfat thickness and 40% for 168-day weight.

A random bred contemporary control line was maintained to monitor year-to-year environmental changes. Each generation one boar was randomly selected from each of eight control sire lines to sire the next generation of control line pigs. One gilt was randomly chosen from each control line litter to enter the breeding herd to produce the next generation of control line pigs.

One boar pig from each select and control litter was randomly chosen to be castrated. These barrows were slaughtered at 102 $\pm$ 2 kg for carcass evaluation. Each carcass was chilled 24 hours at 2° C prior to evaluation. Carcass 10th-rib fat thickness and longissimus area were recorded.

Matings were randomly made within each replicate and line to minimize inbreeding in the next generation. Four of the 24 gilts selected from the select line each generation were randomly chosen to be bred using fresh semen artificial insemination to one boar which was available from a commercial boar stud in the United States. The same boar was not necessarily used in both select lines in the same generation. Boars selected from outside the herd were used only once in each replicate. There were no overlapping generations in the select or control lines.

A multiple-trait DFREML algorithm was used in the analyses (Boldman, et al., 1993). In the analyses of boar and gilt 168-day weights and ultrasound backfat thicknesses, the mixed model included fixed effects for replicate, generation and sex and random animal and litter effects. Fixed replicate, generation and a hot carcass weight linear covariate and random animal effects were included in the model for the analysis of the carcass traits. The inverse of the numerator relationship matrix was included in each analysis.

RESULTS

Selection for lean growth was practiced for three generations. Records from 1,331 boars and gilts and 170 carcass barrows were analyzed. Pigs in this study were out of 279 litters which were sired by 95 boars including seven boars from outside the herd. Boars introduced in the herd through the use of artificial insemination sired 17.3% of the pigs in the select line. Inbreeding levels averaged 3.2% and 3.8% in the select and control lines respectively after three generations of selection.

Selection for increased 168-day weight and decreased backfat thickness in Landrace boars and gilts has produced desirable results. Generation and line phenotypic means and breeding value means for 168-day weight and ultrasound backfat thickness at 105 kg are presented in Table 2. Average breeding values between the select and control lines differed by 5.37 kg and -0.26 cm of backfat after three generations, respectively. Heritability estimates were 0.39 for 168-day weight and 0.45 for ultrasound backfat thickness. The genetic correlation between these traits was -0.38. Ratios of litter variances to the residual variances were 0.15 for 168-day weight and 0.10 for backfat thickness.

Breeding value estimates for carcass 10th-rib backfat thickness and longissimus area indicated the carcasses were becoming leaner and more muscular. The difference in average breeding value between the select and control lines were -0.37 cm for 10th-rib backfat thickness and 2.25 cm^2 for longissimus area, respectively (Table 3). Heritability estimates were 0.52 for 10th-rib backfat thickness and 0.47 for longissimus area. It was not possible to estimate the genetic correlation between these two traits from this data set.

DISCUSSION

Purebred pig breeders with small herds are faced with several unique challenges compared to their counterparts with large herds. Inbreeding levels can increase rapidly in small purebred herds which are closed

to the introduction of new animals or germplasm. Reduced selection intensity and genetic variability are also problems when small herds are closed. The objective of this experiment was to define a selection program for lean growth which reduced the rate of inbreeding in the select line, permitted the incorporation of desirable genes into the line from outside of the herd and could be used in small purebred herds.

There have been other selection experiments for lean growth in pigs (Vangen, 1979; Cleveland et al., 1982; Freeden and Mikami, 1986). Unlike the present study, index selection for growth rate and backfat thickness in closed lines were used in these earlier studies. Relative to the mean in the base generation, growth rate in the current study increased by 2.2% per generation while backfat thickness decreased by 3.6% per generation. In the study reported by Cleveland et al. (1982), growth rate increased by 2.2% relative to the base generation mean and backfat thickness decreased by 1.4%. It was difficult to compare the effectiveness of the selection program in this study with the effectiveness of the selection program reported by Cleveland et al., (1982). Weighting for the traits were not the same between the studies, different measures of growth were used and different multiple-trait selection methods were used. Relative to the base generation means for growth and backfat thickness, the response in growth in the present study was similar to the response reported by Cleveland et al. (1982). However, the response in backfat thickness was 2.7 times greater than reported by Cleveland and co-workers. A selection program which uses independent culling levels for 168-day weight and ultrasound backfat thickness and allows limited migration of genes into the select line may be a viable selection program for purebred breeders with small herds and breeds which do not have across-herd genetic evaluation programs. Whether this selection method has usefulness for traits not generally under selection in the industry still needs to be determined.

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Table 1. Independent culling levels used for 168-day weight and backfat thickness

% of total population to be selected	% of animals selected on 168-day weight	% of animals selected on backfat thickness
10	61	10
20	72	20
30	79	30
40	84	40
50	89	50

Table 2. Generation and line phenotypic means and breeding value means for 168-day weight and ultrasound backfat thickness at 105 kg

	168-day Weight, kg				Ultrasound Backfat Thickness, cm			
	Phenotypic Means		Breeding Values		Phenotypic Means		Breeding Values	
Generation	S	C	S	C	S	C	S	C
Base		82.19		-0.81		2.41		0.01
1	88.27	86.55	1.87	0.11	2.26	2.34	-0.15	0.00
2	97.84	97.98	3.73	2.08	1.96	2.16	-0.26	-0.05
3	100.83	94.48	6.81	1.44	1.75	2.06	-0.31	-0.05

Table 3. Generation and line phenotypic means and breeding value means for 10th-rib backfat thickness and longissimus area

	10th-Rib Backfat Thickness, cm				Longissimus Area, cm^2			
	Phenotypic Means		Breeding Values		Phenotypic Means		Breeding Values	
Generation	S	C	S	C	S	C	S	C
Base		3.33		0.03		23.48		0.02
1	3.23	3.35	-0.05	0.04	25.55	25.42	0.01	-0.07
2	2.90	3.40	-0.15	0.15	28.45	25.94	0.70	-0.62
3	2.13	2.84	-0.28	0.09	32.06	27.35	1.71	-0.54