and over survived. It is readily apparent from examination of the death losses for the various weight groups that birth weight is of tremendous importance to the swine producer.

The data in Table 3 also reveal that preweaning growth rate is closely related to birth weight with the larger pigs at birth weighing more at 21-days and at weaning. Postweaning gain was also influenced by birth weight with almost 0.3 lb. per day faster daily gain by pigs weighing over 4 lbs. at birth compared to those weighing under 2 lbs. at birth. On an average, it took the 2-lb. pigs 27 days longer than the 4-lb. pigs to reach market weight. Backfat thickness also tended to be influenced by birth weight in that the 3-lb. and 4-lb. pigs had less backfat probe at 200 lbs. than those weighing 1 and 2 lbs. at birth.

These data clearly indicate that the importance of birth weight should not be underestimated. Maximum production and performance from a swine herd is dependent upon starting out with good sized pigs at birth.

Genetic Aspects of Sow Productivity, Growth Rate and Backfat Thickness*

Ronnie L. Edwards and I. T. Omtvedt

Story in Brief

Variation in litter records and performance records involving 3860 pigs in the swine breeding herd at Ft. Reno was analyzed. Based on regression of offspring on sire, it was concluded that most of the observed variation in sow productivity traits was due to non-genetic causes since the heritability estimates were low for number of pigs per litter, pig

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*In cooperation with USDA Agr. Research Service, Animal Husbandry Research Division

weight, and litter weight at birth and at weaning. Moderate heritability estimates were obtained for daily gain, age at 200 pounds, and probe backfat, indicating that a larger proportion of the observed variation in these traits was due to genetic causes.

A study of the relationship between the traits indicated that as birth weight increased, average daily gain increased and probe backfat decreased. Genetic correlations were calculated to determine the extent to which the same genes were involved in different traits. Results indicated that the majority of the genes causing heavier weaning weight were also involved in increasing daily gain and decreasing age at 200 pounds. In general, genetic correlations between probe backfat and other traits were small and of little significance.

Introduction

Productivity of the sow herd is of major economic importance to the swine producer. However, numerous studies have indicated that most of the observed differences in litter size and weight at birth are due to non-genetic sources of variation. Most of the estimates available were based on data from swine herds under a wide variety of breeding and selection procedures. The purpose of this investigation was to evaluate the genetic aspects of sow productivity, growth rate and backfat thickness using data collected from an experimental control population that had been maintained at a rather constant level of performance for a number of years.

Materials and Methods

The data for this study included observations on 3860 pigs born in 363 litters from 1962 spring to 1968 fall. The population in question was a zero-selection control herd maintained in connection with the swine breeding project at the Ft. Reno experiment station. Propagation of the line was carried out by selecting two boars and two gilts of average weight and thriftiness prior to weaning from each litter. One boar and gilt from each litter was then selected after postweaning rate of gain and probe backfat thickness information were available on all boars and gilts initially chosen. The boar and gilt from each pair that were nearest the average for rate of gain and probe backfat were retained for breeding. Each female was mated to a different boar to keep inbreeding to a minimum in the herd.

Heritability estimates for individual pig traits were calculated from regression of individual offspring on sire. Estimates of the heritabilty of litter traits were calculated from regression of daughter on dam.

Results and Discussion

Heritability Estimates: Heritability describes the proportion of observed variation that is due to genetic causes. Therefore, if a trait has a low heritability, most of the observed variation in this trait is due to non-genetic causes and one would expect rather slow progress through selection. On the other hand, if a trait has a moderate to high heritability, greater progress from selection would be expected.

Heritability estimates for individual pig traits and litter traits obtained in this study are presented in Table 1. Number of pigs per litter, pig birth weight and pig weaning weight had low heritabilities. The observed variation in traits of this nature is due primarily to mothering ability and environmental conditions.

Litter birth weight and litter weaning weight also had relatively low heritabilities. Although the estimates obtained for litter weights were of greater magnitude than those for number of pigs born and pig weight, the variation associated with these estimates indicated that they were probably not significantly different from zero. Very little progress would be expected from selection for total litter weight at birth or at weaning.

Estimates of the heritability of average daily gain, age at 200 pounds and probe backfat were higher than those for other traits in this study. Also, the variation associated with these three traits was not as great as the variation for other traits. Based on the estimates of heritability, one could expect continued progress through selection for daily gain, age and probe backfat thickness.

Phenotypic Correlations: The phenotypic correlations between litter traits are presented in Table 2. All of these correlations are large and positive as would be expected since phenotypic correlations do no more than measure the extent to which two traits are associated. This does

Table 1. Heritability Estimates For Individual Pig Traits And Litter Traits

Trait	Heritability
Individual Pig Traits:	
Birth weight	0.04
Weaning weight	0.08
Avg. daily gain	0.29
Age at 200 pounds	0.34
Probe backfat thickness	0.30
Litter Traits:	
Pigs born per litter	0.01
Pigs weaned per litter	0.24
Litter wt. at birth	0.27
Litter wt. at weaning	0.29

not indicate that the large positive associations obtained between litter traits are due only to genetic causes, but rather to both genetic and environmental causes.

Table 3 gives the phenotypic correlations between individual pig traits. As birth weight increased, weaning weight and daily gain increased while age at 200 pounds and probe backfat decreased. The large, negative correlation between average daily gain and age at 200 pounds would be expected since faster gaining pigs would reach 200 pounds at an earlier age. Phenotypic correlations between individual pig traits were considerably lower than the correlations obtained between litter traits.

Genetic Correlations: Also appearing in Table 3 are the genetic correlations between various traits in this study. A genetic correlation between two traits gives an estimate of the extent to which the two traits are associated genetically. Knowledge of the genetic relationship between various traits allows the swine producer to select for one trait and at the same time make genetic improvement in other traits that have a favorable relationship. Genetic correlations are subject to large sampling errors and the magnitude cannot be taken as an accurate and precise estimate of the genetic association between the traits. However, the direction of the association is very important to the swine producer. For example, there is a large positive genetic correlation between weaning weight and average daily gain and a large negative genetic correlation between weaning weight and age at 200 pounds. This suggests that the majority of the genes causing heavier weaning weights also act to increase daily gain and to decrease age at 200 pounds. In the same manner, the large negative genetic correlation between daily gain and age would indicate that genes causing an increase in daily gain also cause a decrease in age at 200

Table 2. Phenotypic Correlations Between Litter Traits[1]

Traits Correlated	Phenotypic Correlation
No. pigs born and:	
No. pigs weaned	0.73
Litter birth wt.	0.89
Litter weaning wt.	0.64
No. pigs weaned and:	
Litter birth wt.	0.74
Litter weaning wt.	0.91
Litter birth weight and:	
Litter weaning wt.	0.75

[1]Based on 202 daughter-dam pairs.

pounds. Genetic correlations between other traits had very large standard errors and were not considered significant correlations.

Although the population from which these data were obtained was quite different from most other experimental populations previously used to estimate various parameters, the results obtained in this study were quite similar to those reported by other research workers.

Table 3. Phenotypic and Genetic Correlations Between Individual Pig Traits[1]

Traits Correlated	Phenotypic Correlation	Genetic Correlation
Pig Birth weight and:		
Pig weaning wt.	0.51[3]	
Avg. daily gain	0.27[3]	
Age at 200 lbs.	—.46[2]	
Probe backfat	—.18[2]	
Pig weaning weight and:		
Avg. daily gain	0.32[2]	1.00[3]
Age at 200 lbs.	—.54[3]	—1.00[3]
Probe backfat	—.08[2]	0.44
Average daily gain and:		
Average at 200 lbs.	—.92[2]	— .98[3]
Probe backfat	0.03	— .31
Age at 200 pounds and:		
Probe backfat	0.02	0.14

[1]Based on individual offspring-sire relationships (1108 d.f.)
[2](P $\leq$ .01)
[3](P $\leq$ .05)