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CORRELATIONS BETWEEN PREWEANING TRAITS IN DUROC SWINE

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ABSTRACT

Phenotypic, genetic and environmental correlations were determined between litter size and weight and pig weight at birth, 21 and 56 (weaning) days of age for Duroc swine raised at Estação Experimental de Zootecnia, Sertãozinho, SP, between 1957 and 1970.

Phenotypic, genetic and environmental variances were determined on the basis of sire variance and covariance components and error adjusted for the effects of year, season and sow age, using the least squares method. The correlation values obtained indicate favorable association between the traits studied, showing that selection for the improvement of one or more traits would also be effective for the improvement of any other. This situation can be better appreciated by examining the correlated response studied in 14 possibilities of indirect selection involving two traits.

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INTRODUCTION

In swine breeding, the litter traits (litter size and weight) and pig weight at birth, at 21 days and at weaning represent important indicators of herd performance. The determination of the association between these traits is a very valuable tool for precise definition of reproductive value, which also affects the set of objectives proposed in selection programs. In a review article, Fredeen (1958) stated that most correlation estimates reported in the literature favor the traits intended for improvement of productive and reproductive performance and that there is little evidence for genetic antagonism between the major traits.

According to Bernard *et al.* (1954), no clear association between individual pig weight and the traits of the litters to which they belong has been observed in animals of several herds in the U.S. Intrieri and De Paolis (1965), in a study on Casertana swine, detected positive and nonsignificant correlation between litter weight at birth and at 21 days, and litter weight at birth and at 56 days, and positive and highly significant correlation between litter weight at 21 and 56 days of age.

In a study on 125 Landrace sows, Popescu-Vifor (1971) obtained an environmental correlation of 0.63 between litter size at 21 and 60 days of age.

The objective of the present study was to determine the magnitude of the genetic, phenotypic and environmental correlations between the traits associated with reproductive performance in Duroc swine during the preweaning period, and to evaluate the application of the results obtained to animal breeding.

MATERIAL AND METHODS

The data for the present study were obtained from the files of Estação Experimental de Zootecnia of Sertãozinho, São Paulo, Brazil. They refer to 554 litters at birth, 531 litters at 21 days, and 526 at weaning (56 days), comprising 3769, 3092 and 2944 pigs, respectively, produced by 41 sires and 226 sows of the Duroc breed and raised from 1957 to 1970. The only selective criterion adopted for the herd was individual pig weaning weight. Herd management was based on the standard patterns followed by commercial breeders. A detailed description of the methods has been reported in a previous study (Schlindwein and Duarte, 1980).

Phenotypic, genetic and environmental variances were determined on the basis of sire variance and covariance components and error by the least squares method (Harvey, 1960), according to the following mathematical model:

$$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

where:

Y_{ijklm} = trait studied,
μ = general mean,
a_i = effect of year i (i = 1 . . . 14),
b_j = effect of time of year j (j = 1,2),
c_k = effect of dam age k (k = 1 . . . 8),
d_l = effect of sire l (l = 1 . . . 41),
e_{ijklm} = individual effect.

The adjustment constants for pig sex were calculated using the "p x 2" classification, with disproportional numbers, by the method of Snedecor and Cochran (1967). The correlations were obtained by the method of Becker (1975).

RESULTS

Phenotypic, genetic and environmental correlations between some of the variables involved in the present study were calculated from covariance components. Table I indicates that the phenotypic correlations between most of the traits considered are high and positive, except between individual weight at birth and at 56 days of age.

The high genetic correlations obtained are largely due to litter weight and size at the same age, and to litter weight and size at 21 and 56 days of age. The only negative genetic correlation was between litter weight at birth and at 21 days. As observed for phenotypic correlations, the lower environmental correlation values were also obtained for individual weight.

Table I -Phenotypic, genetic and environmental correlations between litter and individual traits at birth and at 21 and 56 days of age[a].

Traits	X_1	Y_1	Z_1	X_2	Y_2	Z_2	X_3	Y_3	Z_3
X_1	0.23	0.91		0.76			0.71		
Y_1	*0.96* 0.91	0.46			0.69			0.62	
Z_1			0.18			0.44			0.02
X_2	0.06 0.83			*0.35*	0.87		0.96		
Y_2		-0.61 *0.76*		0.98 *0.80*	0.40			0.85	
Z_2			0.45 *0.44*			0.10			0.61
X_3	0.14 0.79			0.99 0.93			0.36	0.81	
Y_3		0.34 *0.65*			0.76 0.86		0.85 0.81	0.72	
Z_3			0.016 *0.041*			0.22 *0.70*			0.17

[a] Phenotypic correlations: above the diagonal
Genetic correlations: below the diagonal
Environmental correlations: below the diagonal, below the genetic correlations
X, litter size; Y, litter weight; Z, individual weight; 1, at birth; 2, at 21 days; 3, at 56 days.

DISCUSSION

The correlations presented in Table I indicate in general favorable association between the various traits involved. Thus, there would be no difficulty in setting up a selection program for the simultaneous improvement of the traits considered. The only exception is the negative genetic correlation between litter weight at birth and at 21 days.

The phenotypic and environmental values for the correlations obtained for the litters at the different ages considered in this study are within those reported in the literature. The genetic correlations involving

litter size at birth were lower than any reported in the literature. The only study consulted that reported on environmental correlations (Popescu-Vifor, 1971), reported a lower value than that obtained in this study.

The phenotypic correlation between individual weight at birth and at 21 days and the genetic correlation between individual weight at 21 and at 56 days were lower than those reported by the investigators cited, while the estimates of phenotypic and genetic correlation between individual weight at birth and at 21 days were closer to the means reported in the literature.

All the phenotypic correlations between litter traits at the same age were higher than those reported in the literature. The correlations between litter sizes at different ages were higher than the correlations between pig weight and litter weight. In this respect, the lowest values were obtained in relation to individual pig weight. The negative estimate of genetic correlation obtained between litter wiehgt at birth and at 21 days was a surprising result, which could be explained by the fact that weight at 21 days is more a reflexion of dam milk yield than a progeny characteristic, and that the genes responsible for milk yield have no effect on birth weight. However, if these hypotheses were valid, negative results should also be expected when individual pigs rather than whole litters are compared. This, however, was not the case in this study.

The litter traits observed at different ages, with the exception of the individual weights and of the preceding consideration, indicate that the genes responsible for the manifestation of a trait at a certain age condition the expression of the same trait at later ages. Similarly, the environmental correlations obtained lead us to conclude that there is a systematic influence of external factors on phenotypic characterization at the different ages considered. The opposite is observed with respect to individual weight, where phenotypic and environmental correlations at birth and at weaning and the genetic correlation between 21 and 56 days are much smaller.

The results obtained show that the effect of weight at birth decreases with age, being more limited on the final performance of the animal than on the initial suckling phases.

From an economical point of view, prolificacy could be better evaluated on the basis of number of reared pigs rather than number of pigs born. Thus, it is desirable that the highest possible number of piglets be born, so that large litters may be weaned. This argument, however, is overlooked by several investigators in favor of an ideal litter size at birth with a lower

mortality rate and with heavier and healthier pigs weaned. According to Olbrycht (1943), the ideal litter size should be 12 pigs. However, the drawbacks of larger litters could be eliminated by exercising greater watchfulness, especially during the first week of life, and by using specific management techniques, such as dividing the litter into subgroups housed in separate pens and permitting controlled access to the dam for nursing. Alternatively, some pigs from large litters could be transferred to sows with excessively small litters. A higher number of pigs per litter at weaning seems therefore to depend much more on adequate handling than on an actual increase in the number of pigs born.

According to Omtvedt *et al.* (1966), litter weight, although influenced by many factors, represents the best measurement of sow productivity because it is a function both of prolificacy and of maternal ability. Even if prolificacy is considered to be a valid criterion in a selection program, the other characteristics of the dam that constitute reproductive efficiency should not be overlooked.

The magnitude of the genetic correlation between two traits indicates the substantial proportion of improvement by selection that can be obtained simultaneously for both. Thus, as far as the material considered in the present study is concerned, reasonable progress by selection in litter traits at a certain age can be expected to be due to the selective intensity applied at a preceding age. Similarly, selection of one of the litter traits (size and weight) at the same age would be reflected on the other in view of the high genetic correlations obtained. Craig *et al.* (1956), in a discussion of the validity of genetic correlations in a process of simultaneous selection for two traits, reported that, if X and Y are genetically correlated the efficiency of indirect selection for Y by direct selection for X can be determined by comparing the values of the expressions $\sqrt{h^2_x} \cdot r_{G(xy)}$ (efficiency of selection for Y when X is selected for directly) and $\sqrt{h^2_y}$ (efficiency of direct selection for Y). The h^2 values for the sample in the present study were extracted from Schlindwein and Duarte (1980). The following selection efficiency for the variables studied was obtained by using genetic correlations as compared to direct selection for the trait:

Genetic correlations	Relative selection efficiency (%)
Litter size at birth (X) and at 21 days (Y)	4.9
Litter size at birth (X) and weaning (Y)	11.1
Litter size at 21 (X) and 56 (Y) days	98.6
Litter weight at birth (X) and weaning (Y)	27.7
Litter weight at 21 (X) and 56 (Y) days	56.1
Individual weight at birth (X) and at 21 days (Y)	61.4
Individual weight at birth (X) and weaning (Y)	1.6
Individual weight at 21 (X) and 56 (Y) days	16.7
Litter size (X) and weight (Y) at birth	67.4
Litter size (Y) and weight (X) at birth	137.1
Litter size (X) and weight (Y) at 21 days	104.8
Litter size (Y) and weight (X) at 21 days	92.1
Litter size (X) and weight (Y) at weaning	100.4
Litter size (Y) and weight (X) at weaning	49.9

When these values are considered, it can be seen that selection for litter weight at birth will have an effect on the improvement of the number of pigs per litter at 21 and 56 days, but selection for litter size at 21 days will be just as effective for litter size at weaning as direct selection. Selection for litter weight at birth and at 21 days will be reflected considerably on the improvement of litter weight at 56 days. Individual weight at birth is a valuable factor for the improvement of pig weight at 21 days, but will have little impact on weight at 56 days. Selection for individual weight at 21 days will have only a slight impact on pig weight at weaning. While selection for litter size at weaning will considerably affect litter weight at the same age and vice-versa, litter size and weight at 21 and 56 days of age are equivalent criteria, and indirect selection will contribute even more to simultaneous improvement of both traits. However, the correlations obtained here among pig weights should be looked at with caution, since the litter size effect was not included in the analyses of covariance, a fact that may have introduced some bias in the estimates.

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RESUMO

Foram determinadas correlações fenotípicas, genéticas e ambientes entre as características tamanho e peso de leitegada e peso dos leitões ao nascimento, 21 e 56 dias (desmama) de idade, em suínos da raça Duroc criados na Estação Experimental de Zootecnia de Sertãozinho, São Paulo, no período de 1957 a 1970.

A determinação das variâncias fenotípicas, genéticas e ambientais se baseiam nos componentes de variância e covariância de reprodutor e erro, ajustados para os efeitos de ano, época do ano e idade da porca, utilizando-se o método dos quadrados mínimos.

Os valores encontrados para as correlações indicaram associação favorável entre as características estudadas mostrando que a seleção destinada à melhoria de uma ou mais características, seria também efetiva no melhoramento de qualquer outra. Esta situação é melhor avaliada pela apreciação da resposta correlacionada, estudada em 14 possibilidades de seleção indireta, envolvendo duas características.

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