Maternal Influence in Swine as Reflected by Differences in Reciprocal Crosses

S. N. PANI, B. N. DAY, L. F. TRIBBLE AND J. F. LASLEY

CONTENTS

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The sire generally influences his offspring only through the genes he transmits to them through the sperm cell. The dam, on the other hand, not only influences her offspring through the genes she transmits to them through the ovum, but she may also influence them through the environment she supplies from conception until weaning. This environmental effect of the dam on her young is often referred to as a maternal influence.

Several factors may be responsible for a maternal influence in animals. In the lower forms the cytoplasm of the egg may be involved but this has not been proved to be true in farm animals. The intra-uterine environment may also be different in individual females within the same breed or in different breeds, and thus may affect the offspring in different ways. The milk production and mothering ability of the mother during the nursing or suckling period may also be of importance. The maternal influence may include the effect of sex-linked genes because the homogametic individuals (XY, or males, in farm animals always receive their X chromosome from their mother and the Y chromosome from their father).

In litter bearing animals such as swine, the influence of the dam becomes of greater practical importance because of her effect on the number of young at birth, which may vary quite widely in sows of different strains or breeds. As a result there can be wide differences in the total pounds of pigs weaned per sow per year because litter weight at weaning is largely dependent upon the number of pigs weaned.

Whether or not there is a maternal effect on certain traits in swine may be determined by comparing the production and performance of individuals from the reciprocal crosses of two or more breeds or by comparing maternal and paternal sib correlations or the correlations of the dam and sire with their offspring. The approach decided upon in the present study was to compare the various economic traits in reciprocal crosses of some breeds of swine.

REVIEW OF LITERATURE

Horses

Differences between reciprocal crosses were probably first observed in crosses between horses and donkeys. The mule, with the jack as the sire and the mare as the dam, has almost always been superior in draught qualities to the hinny, a hybrid with the stallion as the sire and the female donkey as the dam (Plumb, 1906).

Walton and Hammond (1938) also demonstrated a significant maternal effect in their experiments in which they made reciprocal crosses between the large Shire draft horses and the small Shetland pony through the use of artificial insemination. They found that foals at birth were approximately proportional in weight to the size of their mother and about equal to the weight of purebred foals from that mother, or to the breed to which she belonged. Crossbred foals from the Shire mares were three times the size at birth of crossbred foals from the Shetland mares. The differences between foals of the reciprocal crosses were still large at three years of age, indicating that the maternal effect for body size was permanent.

Cattle

Several studies with different breeds of dairy cattle (Hilder and Fohrman, 1948; Joubert and Hammond, 1958; Brandt, 1958 and Dickinson, 1960) indicate that there is likely to be a significant difference in the birth weights of calves in reciprocal crosses where large and small breeds are involved. In general, the birth weights of the crossbred calves will be the heaviest when the dams are from the largest breeds. In many instances the differences gradually disappear as the calves grow older and may disappear entirely at maturity. Similar results were reported by Koch and Clark (1955) in beef cattle from a comparison of the correlations between the offspring and dam and the offspring and their sire. The correlations for the offspring and dam were higher, indicating that maternal environment had a large influence on birth weight, gain from birth to weaning, and weaning score, but a small influence on yearling gain and score.

Maternal influence probably causes heavier birth weights in calves from the cows of the larger breed because of a more favorable uterine environment. Gains from birth to weaning, especially in beef calves where they are not weaned until 6 to 8 months of age, depend to a great extent upon the milk production of the dam. Neville (1962) found that the relationship between milk consumption and weight gains in calves was highest during the first 60 days of the suckling period but declined slightly by weaning time. He estimated that 68 percent of variation in the 8-month weights of calves in his study was explained by differences in milk consumption.

If cows from two or more beef breeds differ in their milk production, significant differences at weaning could be expected in calves from their reciprocal

crosses. Crossbred calves which nursed the dams from the breed with a higher level of milk production would be expected to gain more from birth to weaning and would weigh more at weaning. This is illustrated by the report of Gerlaugh et al. (1951), who compared reciprocal crosses of the Angus and Hereford breeds. They found no significant difference between reciprocal crosses in length of gestation of the cows and birth weights of the calves. However, crossbred calves from Angus cows made more gain from birth to weaning, made less gain during the post-weaning period, but were more efficient in converting feed into gains, dressed slightly higher and produced a larger proportion of choice grade carcasses, compared to calves from the reciprocal cross.

Swine

Maternal influence may be more complex in swine than in cattle and horses because of the multiple births involved. The breeding of the dam can have a very definite influence on litter size at birth. Lasley et al. (1961) found an average difference of 3.01 pigs per litter in reciprocal crosses between inbred Durocs and crossbred Landrace x Poland sows and boars with the larger litters from the Landrace x Poland sows. It is also generally recognized that average litter size is larger in some breeds than in other breeds. Breed differences in litter size are due to differences in ovulation rate, fertilization rate and embryonic death losses.

The birth weight of each individual pig is related to the size of the litter, according to Lush (1934). He found that the relation between birth weight and litter size was curvilinear with maximum birth weights in litters of 3 to 5 pigs each. Winters et al. (1947) observed that an increase in litter size at birth in swine reduced the chances of survival. They found that an increase of one pound in birth weight also increased the chances of survival and the total litter weight at weaning.

Significant individual and breed differences in milk production in sows have been observed (Allen et al, 1959). However, differences in milk production are largely reflected in heavier total litter weights at weaning rather than in heavier average pig weights, although there is not complete agreement on this latter point. Murray (1934) presented data showing a decrease in the average weight per pig at 8 weeks as litter size increased. On the other hand, Smith and Donald (1937) and Bywaters (1937) found no general relationship between litter size and the average weaning weight per pig. Moxley and McMillen (1949) made similar observations in litters which did not exceed 11 pigs. A close association between the live weight increase during the suckling period and the amount of milk consumed by Large White pigs was observed by Donald (1939) when pigs were compared that were reared on foster mothers.

Several studies have been made where paternal and maternal half-sib correlations have been determined (Bywaters, 1937; Hetzer, 1942; Whatley, 1942; Baker et al., 1943 and Nordskog et al., 1944). These studies generally indicate that maternal half-sib correlations are the highest, suggesting an important ma-

ternal influence on birth weights and weaning weights, but there is a tendency
for such effects to become of less importance as the pigs grow older.

· Sheep

Hunter *et al.* (1954) transferred fertilized ova between two different breeds
and found that the mean birth weight of Border Leicester lambs with Welsh
ewes as host mothers was 11.1 ± 0.38 pounds as compared to 13.5 to 14 pounds
for Border Leicester lambs from Border Leicester mothers. When ova transfers
were made in the reciprocal manner, Welsh lambs with Border Leicester host
mothers weighed 9.5 ± 0.18 pounds, compared to 8.0 to 8.5 pounds for Welsh
lambs from Welsh mothers. They also observed that the gestation period in-
creased in length when the dam carried a fetus of the smaller breed and vice
versa. In later studies, Hunter (1956) transferred ova and also made reciprocal
crosses between the Border Leicester and Welsh breeds of sheep. He concluded
that the maternal environment affected fetal growth when the genotype for size
of the fetus was different from that of the mother.

In summary, the evidence for most farm animals generally indicates a sig-
nificant maternal effect for birth and for weaning weights. The maternal effect
at birth as determined from reciprocal crosses appears to be greater when the
dams of the different breeds are further apart in their mature size, with dams from
the larger breeds generally producing larger young at birth. A maternal effect on
weaning weight also seems to be of importance when there are definite differ-
ences in average milk production of the breeds. These maternal effects for weight
gains seem to diminish after weaning although some of them, such as those ob-
served in the Shire x Shetland pony reciprocal crosses, may be permanent and
evident even in the mature animals.

MATERIALS AND METHODS

Source of Data

The data used in this study were collected from the swine breeding herd at
the University of Missouri. The herd was started with two inbred lines of Po-
land swine developed at the station prior to 1949. Then, swine of different lines
or strains consisting of Durocs and Landrace were obtained from productive
herds. One Duroc and two Landrace lines were selected to remain in the project
the basis of their crossing ability with the Poland lines.

During 1953, the two Poland lines were combined to form a single line as
were the two Landrace lines. After that time the three inbred lines, including a
Poland, a Landrace, and a Duroc line, were selected and reproduced on the basis
of their crossing ability with each other.

The program, in brief, was that in one year the Landrace and Poland lines
were tested for their crossing ability and in the following year the pure lines
were reproduced. In the same year that pure lines of Landrace and Polands were

reproduced, the sows and boars of the Duroc line were tested for their crossing ability with the crossbred Landrace x Poland sows and boars. The selected Durocs were then used to reproduce the pure line the following year. The details of the project have been described by Lasley et al. (1954).

During the fall season the pigs were fed entirely in confinement but in the spring they were usually pasture fed. However, within any season the feeding and management conditions remained the same.

Traits Included in the Study

Data on litter size, litter weight, and average pig weight at birth, 56-days, and 154-days were obtained from the reciprocal crosses of the Landrace and the Polands as well as that of the Landrace x Poland cross breds and the Durocs. The former cross included data for both spring and fall seasons of the years 1952, 1954, and 1956 with 187 litters from 42 sires. The reciprocal crosses between Durocs and Landrace x Polands included data for both spring and fall seasons of the years 1953, 1955, and 1957, with litters from 34 sires.

Measurements of backfat thickness, body length, and heart girth were taken when the pigs reached approximately 200 pounds in live weight. The fat thickness was determined by probing through the fat and skin with a metal ruler. Three measurements were taken, one just back of the shoulder, a second near the hip bones (hip) and a third mid-way between the hip bones and the tail head (ham). The average backfat thickness was calculated by adding twice the thickness at the shoulder to that of the hip and ham and dividing by four. Body length was measured from between the ears to the base of the tail with the head parallel to the ground. The heart girth was measured just behind the forelegs.

Data on all these traits for reciprocal crosses of the Landrace and the Poland breeds were for the fall and spring of 1954. They included 492 pigs from 124 litters and 13 sires. Data on the reciprocal crosses of the Landrace x Polands and Durocs were for the spring of 1955 and included measurements of 202 pigs from 51 litters and 7 sires.

Methods Used in Analyses

The data on litter size, litter weight, and average pig weight were adjusted to a gilt basis. The correction factors reported by Dickerson et al. (1954) were used for this adjustment. Since the inbreeding coefficients of the dams were not uniform, the data were then adjusted for the inbreeding of the dams. The correction factors reported by Lasley et al. (1961) were used for this adjustment.

Since the data on reciprocal crosses of Landrace and Poland swine were for the spring and fall seasons of three different years, the analysis of variance with unequal subclass numbers was conducted on a within-season and within-year basis. The method described by Snedecor (1961) was followed in the analysis. However, since data were limited on reciprocal crosses of crossbred Landrace x Poland and Duroc swine, the analysis of variance was conducted only on a within-season basis.

The crossbred females used in reciprocal crosses with the Duroc boars were divided into two groups based on their origin, whether from Landrace or from Poland dams. Since there were insufficient data on these for different years, the analysis of variance was done only on a within season basis. These data included 60 litters from 14 sires.

Since the data for backfat thickness, body length, and heart girth were on individual pigs of each litter and, since there can be large differences in these traits between sexes, the analysis of variance was conducted on a within-dam, within-sire, within-reciprocals, within-sexes and within-season basis for reciprocal crosses of the Landrace and Poland breeds. However, since the data on reciprocal crosses of the crossbred Landrace x Poland and the purebred Duroc breed included only those for the spring of 1955, the analysis was conducted on a within-dam, within-sire, within-reciprocals, and within-sex basis. The method described by Snedecor (1961) was followed in the analysis.

RESULTS AND DISCUSSION

Reciprocal Crosses of the Landrace and Poland Breeds

Litter Size. The average litter size at various times after farrowing for the Landrace and the Poland breeds is shown in Table 1. The differences in litter size in favor of the Landrace sows at birth, 56 days, and 154 days were 0.8, 1.3, and 1.3 pigs, respectively. All of these differences were highly significant. The advantage in litter size of 0.80 pigs at birth was due to a higher ovulation rate, to a greater fertilization rate or to less embryonic death losses. At least a part of this advantage must have been due to a higher ovulation rate, although sows of the two breeds were not compared in this respect. In addition to farrowing larger litters, the Landrace sows saved an average of 0.50 additional pigs from birth to weaning. This would indicate superior mothering ability and possibly superior milking ability in the Landrace sows. No important maternal effect on the pigs after weaning was observed since there was no increase in the difference between the two breeds in the numbers of pigs per litter surviving from 56 to 154 days of age.

The variance components from the analysis of variance due to differences in reciprocal crosses for litter size at birth, 56-days, and 154 days were 11.9, 18.0, and 18.3 percent of their respective total variances. Since the variances increased from birth to weaning this is further evidence for an important maternal influence on this important economic trait.

Weight per Pig. Data summarized in Table 1 also show the average weight per pig for the reciprocal crosses at birth, 56, and 154 days of age.

Crossbred pigs from the Landrace sows weighed an average of 0.40 pound less at birth (P$<$.005) than did the pigs from the Poland sows. However, the coefficients of variation were about the same within each breed of dam, being 15.4 percent for the Poland and 15.2 for the Landrace dams. At least a part of

TABLE 1–DIFFERENCES BETWEEN RECIPROCAL CROSSES OF LANDRACE AND POLAND BREEDS FOR VARIOUS ECONOMIC TRAITS

	(1)* Landrace Females x Poland Males		(2)* Poland Females x Landrace Males		Difference Between Means	Probability of Chance Occurrence
	Mean	S.D.	Mean	S.D.	(1) – (2)	
Litter size at birth	9.30	2.88	8.50	2.02	0.8	<.01
Litter size at 56 days	7.80	2.77	6.50	2.13	1.3	<.005
Litter size at 154 days	7.60	2.72	6.30	2.16	1.3	<.005 .
Litter weight at birth (lbs)	30.10	9.17	30.50	7.14	−0.4	<.05
Litter weight at 56 days (lbs)	301.50	110.66	254.60	87.37	46.4	<.005
Litter weight at 154 days (lbs)	1355.70	491.27	1185.30	419.13	170.4	<.005
Weight per pig at birth (lbs)	3.30	0.50	3.70	0.57	−0.4	<.005
Weight per pig at 56 days (lbs)	39.30	6.81	39.90	8.75	−0.6	<.05
Weight per pig at 154 days (lbs)	179.51	19.50	186.80	26.41	−7.3	<.005

The analysis was between reciprocals within seasons and within years.
*Includes 98 litters from Landrace sows and 89 litters from Poland sows.

the difference between the reciprocal crosses could have been due to the larger litters produced by the Landrace sows (9.30 as compared to 8.50). Lush (1934) reported that the relationship between the birth weights of individual pigs and litter size was curvilinear with maximum birth weights in litters of 3 to 5 pigs each. Since the average litter size of the sows in this experiment were considerably above the maximum reported by Lush one would expect the average birth weights of pigs from the Landrace sows to be lighter than that of the pigs from the Poland sows.

The average weight of the pigs from the Poland sows at 56 days was 0.60 pounds more ($P < .05$) than that of pigs from the Landrace sows. This represents an average increase in the difference of only 0.20 pound per pig from birth to weaning in spite of the fact that larger litters were nursed by the Landrace sows. This suggests that the milk need of the larger litters of the Landrace dams was largely filled by their higher milk yield, resulting in very little difference in the amount of milk consumed by the individual pigs as reported by Allen *et al.* (1959). Maintenance of an advantage of pigs from Poland sows from birth to weaning could be partially due to the fact that pigs that are heavier at birth tend to be heavier at weaning (Winters *et al.*, 1947; and Murray, 1934).

The percentage of variation due to differences in reciprocal crosses decreased from birth to weaning, being 18.8 percent of the total variance at birth and 7.5 percent at weaning.

Crossbred pigs from the Poland sows averaged 7.3 pounds heavier at 154 days than those from the Landrace sows ($P < .005$). This represents an increase of 6.7 pounds per pig from 56 to 154 days. The explanation for this was not apparent from the data but it could have been a maternal effect carried over from the intra-uterine and suckling period.

Total Litter Weight. The litter weights of the pigs from the reciprocal crosses are also given in Table 1. Total litter weight, of course, is the product of litter size and average weight per pig. Total litter weight at birth was slightly higher in the Poland sows ($P < .05$) mainly because of the heavier birth weights of their pigs. Variation in litter weight at birth was slightly less for Poland (C.V. of 23.4%) than for Landrace sows (C.V. of 30.5%).

The average total litter weight at weaning was 46.4 pounds more in the Landrace than in the Poland sows ($P < .005$), and was due to the larger litters weaned by the Landrace sows which in turn was a reflection of the larger litter size at farrowing by sows of this breed. Landrace sows also had litters which averaged 170 pounds heavier at 154 days of age ($P < .005$), again because they farrowed, weaned, and raised larger litters.

The results of this study show that when a crossbreeding program is followed, it is very important to use sows which farrow and wean large litters and which are superior in milk production and mothering ability.

Backfat Thickness and Body Measurements. Data for backfat thickness, body length, and heart girth measurements for pigs of the reciprocal crosses of the Landrace and Poland breeds of swine are summarized in Table 2. These data in-

TABLE 2–DIFFERENCES BETWEEN RECIPROCAL CROSSES OF THE LANDRACE AND THE POLAND BREEDS OF SWINE FOR BACKFAT THICKNESS AND BODY MEASUREMENTS

	Landrace Females* x Poland Males		Poland Females* x Landrace Males		Difference between means
	Mean	S.D.	Mean	S.D.	(1) – (2)
Fat thickness at the shoulder (mm)	45.10	5.14	44.30	6.32	0.8
Fat thickness at the hip (mm)	34.30	5.25	32.20	5.46	2.1
Fat thickness at the ham (mm)	32.70	4.85	31.70	4.54	1.0
Average fat thickness (mm)	38.30	4.55	37.00	4.95	1.3
Body length (mm)	1055.00	34.70	1049.00	32.90	6.0
Heart girth (mm)	1006.00	26.10	1008.00	26.50	-2.0

*The data included 320 pigs from Landrace sows and 172 from Poland sows.
 None of the differences between the means were significant.

dicate there was no important influence on these traits when they were measured at approximately 200 pounds body weight. Thus, from the standpoint of maternal influence on body measurements and backfat thickness, the breed of dam in a cross-breeding program does not seem to be of importance. The major importance is in the superiority in fertility and mothering ability.

Production of Crossbred Sows From Reciprocal Crosses. Some of the crossbred Landrace x Poland sows from the Landrace and the Poland dams were mated to Duroc boars in another phase of this experiment. The number of crossbred sows totaled 60 with 31 from Landrace and 29 from Poland dams. Litter size, litter weight, and average weight per pig at birth, 56 days, and 154 days for sows produced from the reciprocal crosses are shown in Table 3. The reason for studying these data was to determine if there was an important maternal influence on the fertility and performance of daughters produced by Poland and Landrace dams.

The data are of interest because crossbred Landrace x Poland sows from the Poland dams produced and raised larger and heavier litters and their pigs were heavier at birth, 56, and 154 days of age. These differences could have been due to chance although several of them reached the 0.25 level of probability and one the 0.10 level. The results do suggest that a further study involving larger numbers of sows needs to be made before a possible maternal influence on the fertility of the daughters can be proved or disproved.

Reciprocal Crosses of Crossbred Landrace x Poland with the Duroc Breed

Litter Size. Litter size in reciprocal crosses of the crossbred Landrace x Poland and the Duroc breed is shown in Table 4. Since the genetic constitution of the pigs was ¼ Landrace, ¼ Poland and ½ Duroc in all instances, the basic differences in litter size and weight and individual pig differences should be largely due to differences in the breeding of the dams.

Landrace x Poland crossbred sows farrowed litters which averaged 2.6 more pigs per litter than the Duroc sows (P<.005). This difference is much larger than was observed between the reciprocal crosses of the Landrace and the Poland breeds. This would be expected because the Landrace x Poland crossbred sows should show added fertility and prolificacy due to heterosis whereas the Durocs should not. However, adjustments were made for the effects of inbreeding on the performance of Duroc sows before the data were analyzed. The advantage of the crossbred Landrace x Poland sows for litter size at birth no doubt was due to a higher ovulation rate as reported by Squiers *et al.* (1952). In addition, embryonic death losses might also have been less in the crossbred sows.

Litter size at 56 and 154 days was still considerably larger in litters from Landrace x Poland sows (P<.005), although the difference was not as great as at birth by 0.4 to 0.5 pigs per litter. This reflects slightly higher death losses among the crossbred pigs from the Landrace x Poland sows. A portion of this increased death loss could have been due to the increased hazards for larger lit-

TABLE 3—DIFFERENCES IN THE PRODUCTION OF LANDRACE X POLAND SOWS FROM POLAND AND FROM LANDRACE DAMS

	(1) Crossbred Sows* From Landrace Dams		(2) Crossbred Sows* From Poland Dams		Difference Between Means (1) − (2)	Probability of Chance Occurrence
	Mean	S.D.	Mean	S.D.		
Litter size at birth	9.90	1.84	10.00	2.49	−0.1	>0.25
Litter size at 56 days	8.00	2.17	8.80	2.50	−0.8	>0.25
Litter size at 154 days	7.80	2.06	8.30	2.10	−0.5	>0.25
Litter weight at birth (lbs)	31.60	6.22	33.10	8.07	−1.5	>0.25
Litter weight at 56 days (lbs)	315.40	94.18	359.30	98.17	−43.9	<0.25
Litter weight at 154 days (lbs)	1469.00	407.04	1626.00	502.88	−157.0	<0.25
Weight per pig at birth (lbs)	3.20	0.49	3.40	0.51	−0.2	>0.25
Weight per pig at 56 days (lbs)	37.10	6.61	42.00	9.01	−4.9	<0.10
Weight per pig at 154 days (lbs)	188.00	16.30	197.00	2.20	−9.0	<0.25

*Data are from 31 sows from Landrace dams and 29 from Poland dams.

TABLE 4—DIFFERENCES BETWEEN RECIPROCAL CROSSES OF CROSSBRED LANDRACE X POLANDS
AND PUREBRED DUROCS FOR VARIOUS ECONOMIC TRAITS

| | (1) L. xP. Females* x Duroc Males | | (2) Duroc Females* x L. xP. Males | | Difference Between Means | Probability of Chance |
	Mean	S.D.	Mean	S.D.	(1) − (2)	Occurrence
Litter size at birth	9.90	2.17	7.30	1.73	2.6	<.005
Litter size at 56 days	8.40	2.35	6.20	2.08	2.2	<.005
Litter size at 154 days	8.10	2.35	6.00	2.02	2.1	<.005
Litter weight at birth (lbs)	32.30	7.15	23.50	5.55	8.8	<.005
Litter weight at 56 days (lbs)	326.10	100.65	219.00	66.68	107.1	<.005
Litter weight at 154 days (lbs)	1544.60	458.80	1137.30	386.22	407.3	<.005
Weight per pig at birth (lbs)	3.30	0.47	3.20	0.41	0.1	<.100
Weight per pig at 56 days (lbs)	39.50	8.18	36.30	6.74	3.2	<.050
Weight per pig at 154 days (lbs)	192.40	21.20	188.80	17.88	3.6	>.250

*Data includes 60 litters from Landrace X Poland sows and 34 from Duroc sows.

ters from crossbred sows from accidents and the failure of the sow to give sufficient milk for all pigs in the litter.

Weight per Pig. In spite of the fact that crossbred Landrace x Poland sows farrowed larger litters than Duroc sows, their pigs were still heavier at birth by 0.10 pounds (P<.10). This advantage had increased to 3.20 pounds per pig at weaning (P<.05) and 3.60 pounds at 154 days (P.<25). These data show plainly the superiority of the Landrace x Poland sows over the Duroc sows in their intra-uterine environment and their milk producing capacity.

Litter Weight. Litter weights at birth, 56 days, and 154 days were much larger for the Landrace x Poland sows (P<.005) than for the Duroc sows, which is a reflection of the combination of larger litters and heavier pig weights. This again demonstrates the importance of the breed of dam in a crossbreeding program and emphasizes the importance of using crossbred sows to take full advantage of heterosis both in the sows and in the pigs.

Backfat Thickness and Body Measurements. More extreme differences existed between the Landrace x Poland and the Duroc sows in backfat and in body proportions than existed between sows of the Landrace and the Poland breeds. The crossbred Landrace x Poland sows were much longer in body and thinner in backfat than the Duroc sows.

Data are summarized in Table 5 to show differences between the reciprocal crosses of the Landrace x Polands and the Durocs for backfat thickness, body length and heart girth measurements. The pigs from the Duroc dams had more backfat thickness at the shoulder, hip, and ham than did those from the Landrace x Poland dams. They were also shorter in body (P<.005), but only slightly larger in heart girth. Although these differences in degree of backfat thickness were small, they were consistent and suggest that the Landrace x Poland sows produced pigs which possessed less fat. The differences were not large enough, however, to be of any great practical significance to the pork producer.

TABLE 5–DIFFERENCES BETWEEN RECIPROCAL CROSSES OF CROSSBRED LANDRACE X POLANDS AND PUREBRED DUROCS FOR BACKFAT THICKNESS AND BODY MEASUREMENTS

| | (1) L. xP. Females* x Duroc Males | | (2) Duroc Females* x L. xP. Males | | Differences Between Means | Probability of Chance |
	Mean	S.D.	Mean	S.D.	(1) – (2)	Occurrence
Fat thickness at shoulder (mm)	45.10	7.78	47.60	6.39	–2.5	<.250
Fat thickness at hip (mm)	33.00	4.89	34.20	6.50	–1.2	>.250
Fat thickness at ham (mm)	32.50	5.36	33.60	4.98	–1.1	>.250
Average fat thickness (mm)	38.60	4.93	40.30	5.35	–1.7	>.250
Body length (mm)	1063.00	32.96	1029.00	26.08	34.0	<.005
Hearth girth (mm)	1001.00	25.70	1003.00	21.21	–2.0	<.250

*Data includes 135 pigs from Landrace x Poland sows and 67 from Duroc sows. The analysis was between reciprocals within sexes.

SUMMARY AND CONCLUSIONS

Data from the swine breeding herd of the University of Missouri were studied to determine if the breeding of the dam had an important influence on economic characteristics of crossbred hogs. The data included records on 187 litters from 42 sires involving reciprocal crosses between the Landrace and the Poland breeds, and 94 litters from 34 sires from reciprocal crosses of the crossbred Landrace x Polands and purebred Durocs. All data were adjusted for inbreeding of the dam, where applicable, and to a gilt litter basis before the data were analyzed. The traits studied were litter size, litter weight, and average pig weight, at birth, 56, and 154 days. Also measured were fat thickness at the shoulder, hip, and ham, average fat thickness, body length and heart girth. All backfat and body measurements were taken on the live pigs when they reached approximately 200 pounds body weight.

In reciprocal crosses of the Landrace and the Poland breeds, the Landrace sows produced larger litters at birth ($P < .01$), 56 days ($P < .005$), and 154 days of age ($P < .005$) than did the Poland sows, but the average weights of their pigs were lighter at each of the ages mentioned ($P < .05$). Total litter weight at weaning averaged 46.4 pounds heavier at 56 days ($P < .005$) and 170.4 pounds heavier at 154 days ($P < .005$) for the Landrace sows. No significant differences were noted between the reciprocal crosses in backfat thickness, body length, and heart girth measurements.

A comparison of the performance of crossbred Landrace x Poland sows from Landrace dams with that of sows from Poland dams, both groups mated to Duroc boars, showed that litter size and pig weight and total litter weight at all ages were slightly larger when the Poland sows were mothers of the crossbred dams. The differences at any one age were below the 0.05 level of probability, however.

In reciprocal crosses between the crossbred Landrace x Poland and the Durocs, litter size, litter weight, and average pig weight were all higher in the crossbred sows although differences in average pig weight were small. Landrace x Poland sows weaned 2.2 more pigs per litter ($P < .005$) and their litters averaged 107 pounds more at weaning ($P < .005$) and 407 pounds more at 154 days ($P < .005$) than did the litters from the Duroc sows. Small average differences between reciprocal crosses were noted in the backfat thickness and body measurements, with crossbred pigs from the Duroc sows being shorter ($P < .005$) and fatter than those from the Duroc sows. These differences were not large enough to be important from the practical standpoint, however.

It was concluded that the breeding of the dam can have a very important influence on the litter size and weight at almost any age with the greatest effect being through the number of pigs farrowed and raised. The difference was the most obvious in the three-breed cross with crossbred Landrace x Poland sows mated to Duroc boars. This suggests that a crossbreeding program should in-

clude at least three breeds in order to take advantage of hybrid vigor in both the sows and the pigs.

Although the results of this experiment were not conclusive, some evidence was obtained that there could be a significant influence of the breed of dam as measured by differences in reciprocal crosses on the fertility and litter production of her crossbred female offspring. In addition, some suggestion was found in the data that the breed of dam might also affect the backfat thickness, body length, and heart girth measurements of the crossbred pigs, although the differences were not great enough to be of much significance.

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