Comparison of Lines and Line Crosses for Economically Important Traits in Swine[1]

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Crossbreeding is used extensively in the production of slaughter hogs in the United States. It is estimated that approximately 85-90 percent of all slaughter hogs in the United States are of crossbred origin. Crossbreeding yields heterosis (depending on the traits and breeds involved) and permits breeders to combine the desirable characteristics of different breeds into the crossbred individual. Only few experimental results have been reported in this area for feedlot and carcass traits.

This study was undertaken to determine the magnitude of the advantage or disadvantage of the performance of line crosses as compared to purebred lines for various economically important traits. Three purebred lines and four line crosses from the Oklahoma swine breeding project were used.

Materials and Methods

The data included 1700 litters (7520 individual pig records) from the Duroc (OK8), Beltsville No. 1 (OK9), and Hampshire (OK14) lines of breeding and four specific crosses of these lines (Table 1) farrowed during the 23 seasons from 1954 fall through 1965 fall. Data for line 8—9×14 (purebred dam) were only available from 1954 fall through 1958 spring, so data for line 14 × 8 — 9 (crossbred dam) for only these eight seasons were used to compare the performance of purebred dams to crossbred dams.

Pig weights represented the average weight for the pigs within a particular litter. All pigs were given access to creep at three weeks and were self-fed during the postweaning period. The average daily gain from weaning to market weight represented postweaning average daily gain. The ratio of units of feed consumed to units of gain produced

Table 1: Breeding Structure for the Seven Lines of Breeding Used in This Study.

Line	No. Litters	Breed Composition of:		
		Sire	Dam	Litter
OK8	222	Duroc	Duroc	Duroc
OK9	195	Belts. No. 1	Belts. No. 1	Belts. No. 1
OK14	445	Hamp.	Hamp.	Hamp.
89	223	Duroc	Belts. No. 1	Duroc x Belts. No. 1
98	195	Belts. No. 1	Duroc	Belts. No. 1 x Duroc
14x8-9	331	Hamp.	Crossbred	Hamp. x Duroc-Belts.
8-9x14	89	Crossbred	Hamp.	Duroc-Belts. x Hamp.

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was used as the measure of feed efficiency. Feed records were based on pen averages. Carcass length was obtained on the cold carcass and represented the distance from the forward edge of the first rib to the anterior edge of the aitch bone. Carcass backfat thickness was measured at the first rib, last rib, and last lumbar vertebra on each side of the carcass and the average of the six measurements was recorded. Loin eye area was the area of the *longissimus dorsi* muscle measured between the tenth and eleventh ribs.

All lines were not represented in all seasons; therefore, all analyses were done on a within line basis. Least squares procedures were used to adjust the preweaning traits for season, age of dam, number of pigs farrowed, and number of pigs weaned. Postweaning traits were adjusted for season, sex, and management system. All preweaning traits are reported on a second litter equivalent (1.5 years) basis. Since small numbers of litters were present in various age classifications for lines 8, 9, and 14 $\times$ 8 — 9, line 14 constants were used to adjust lines 8 and 9 for age of dam, and a multicross control line maintained at Ft. Reno was used to adjust line 14 $\times$ 8 — 9 for age of dam.

All models were constructed under the assumption that no interactions existed among the effects and that all errors were normally and independently distributed about a mean of zero and had a common variance σ^2. The standard errors of the mean differences were calculated under the assumption the means were independent.

Results and Discussion

Two-Line Crosses vs. Purebreds:

The performance of two-line crosses and parental lines is summarized in Table 2. For these specific line crosses, purebred dams with crossbred litters farrowed approximately one less live pig per litter than when their litters were purebred. Minnesota workers also obtained smaller litters among backcross litters and Ohio data revealed 1.1 fewer live pigs at birth for Berkshire-Duroc crosses compared to purebred Durocs. The failure to obtain an increase in litter size for the two-line cross may have been due to the lack of genetic diversity between lines 0K8 and 0K9 for this trait or it may have been unique for these lines. There was no difference in the number of pigs born dead which indicated that fewer total pigs were farrowed per litter in two-line cross litters. This may also indicate that there was more early embryonic death loss or a smaller number of eggs fertilized for purebred dams mated to boars of a different breed.

Crossbred pigs from straightbred dams were, on the average, heavier at birth than straightbred pigs. However, litter birth weights were slightly heavier for litters containing straightbred pigs. Previous work at this station indicated that litter size accounted for 67 percent of the variation in litter birth weight; therefore, the smaller litter size for the two-line cross could account for the decreased litter birth weight.

Table 2: Performance of Two-Line Crosses and Parental Purebreds.

Trait	Crossbred Avg. (89 & 98)	Purebred Avg. (8 & 9)	Difference Crossbred-Purebred	Standard Error
PREWEANING TRAITS:				
Number litters	418	417		
Live pigs farrowed/litter	9.2	10.2	— 1.0	0.02
Pigs born dead/litter	0.32	0.32	0.0	0.08
Pig birth weight, lb.	3.09	2.82	0.27	0.06
Litter birth weight, lb.	28.4	28.8	— .4	0.7
Pigs weaned/litter	7.3	7.1	0.2	0.2
Survival rate, percent	79.9	67.2	12.7	1.9
Pig 56-day weight, lb.	43.7	42.2	1.5	1.1
Litter 56-day weight, lb.	318.8	299.9	18.9	9.2
POSTWEANING TRAITS:				
Number pigs	1777	1936		
Avg. daily gain, lb.	1.67	1.58	0.09	0.01
Lb. feed/lb. gain	3.43	3.43	0.00	0.02
Carcass length, in.	29.8	29.4	0.4	0.1
Carcass backfat, in.	1.56	1.57	— .01	0.02
Loin area, sq. in.	3.73	3.60	0.13	0.04

Approximately a 13 percent increase in survival rate was obtained for two-line cross litters compared to the average of the parental purebreds, and as a result they weaned 0.2 pigs more per litter. This slight increase in litter size at weaning was non-significant and was smaller than results reported in most other studies. Undoubtedly, the decreased litter size at farrowing was a contributing factor. Part of what was measured as an increase in survival rate may have actually been due to the smaller litter size for the two-line crosses.

Crossbred pigs were heavier than straightbred pigs both for pig 56-day weight and litter 56-day weight. Crossing two purebred lines increased pig 56-day weight approximately 12 percent (4.8 lb.) and litter 56-day weight approximately 6 percent (18.9 lb.). The increases for litter 56-day weight in the two-line cross was expected since increases were obtained for number weaned and pig 56-day weight.

Two-line cross pigs gained 0.09 lb. per day faster than the average of the purebred pigs. This study revealed no difference in the feed required per lb. of gain for crossbred pigs compared to purebred pigs. Two-line cross pigs exceeded the average of the parental purebred pigs by 0.4 in. in carcass length. No significance was found between crossbred and straightbred pigs for carcass backfat thickness. Two-line cross pigs averaged 0.13 sq. in. larger loin eye area than the purebred parental lines.

Three-Line Cross vs. Purebred Lines:

The performance of line 14 × 8 — 9 (crossbred dam) and the average of the three purebred lines is summarized in Table 3. Crossbred sows farrowed 0.8 more live pigs per litter and weaned 1.0 more pigs per litter

Table 3: Comparison of the Three-Line Cross With the Three Purebred Lines Making Up the Cross.

Trait	3-Line Cross Avg.	Purebred Avg.	Difference 3-Line Cross —Purebred	Standard Error
PREWEANING TRAITS:				
Number litters	331	862		
Live pigs farrowed/litter	10.7	9.9	0.8	0.2
Pigs born dead/litter	0.21	0.32	— .11	0.08
Pig birth weight, lb.	3.05	2.89	0.16	0.05
Litter birth weight, lb.	32.6	28.6	4.0	0.6
Pigs weaned/litter	7.9	6.9	1.0	0.2
Survival rate, percent	73.9	67.7	6.2	1.9
Pig 56-day weight, lb.	42.0	41.3	0.7	0.7
Litter 56-day weight, lb.	331.9	284.8	47.1	7.9
POSTWEANING TRAITS:				
Number pigs	1807	3477		
Avg. daily gain, lb.	1.46	1.51	— .05	0.01
Lb. feed/lb. gain	3.45	3.40	0.05	0.02
Carcass length, in.	29.9	29.4	0.5	0.1
Carcass backfat, in.	1.50	1.52	— .02	0.01
Loin area, sq. in.	3.54	3.69	— .15	0.04

than the average of the three purebred lines. With the relatively large purebred average obtained, this would indicate a definite advantage for the crossbred sow for litter size. Slightly fewer pigs were born dead in litters from crossbred sows. Pig and litter birth weights favored the crossbred pigs by 0.10 lb. and 4.0 lb., respectively. The increased litter birth weight of the crossbred pigs was expected since increases were obtained for both litter size and pig birth weight. The larger pig birth weight may account for the decreased death loss at farrowing of the crossbred pigs. Survival rate increased approximately 6 percent when crossbreeding was used. The larger litter size at weaning and a larger pig 56-day weight (1.2 lb.) undoubtedly contributed to the 47 lb. increase in litter 56-day weight of line 14 × 8 — 9.

Although line 14 × 8 — 9 was definitely superior for preweaning traits, purebred pigs appeared to be slightly superior for postweaning traits. Purebred pigs gained 0.05 lb. per day faster, required 0.05 lb. feed less per lb. of gain, and had 0.15 sq. in. more loin eye area than crossbred pigs. Crossbred pigs had 0.5 in. longer carcasses and slightly less carcass backfat.

Crossbred Sow vs. Purebred Sow:

To critically evaluate the advantage of the crossbred dam, the performance for line 14 × 8 — 9 (crossbred dam mated to Hampshire boar) was compared to the performance of line 8 — 9 × 14 (crossbred boar used on Hampshire dams). Although many of the differences in performance between these two crosses were small; of the 8 preweaning traits studied (Table 4), line 14 × 8 — 9 was superior to line 8 — 9 × 14

for seven of these traits. Litter size was in favor of the crossbred sow by approximately one pig at farrowing and 0.4 pig at weaning. Crossbred sows farrowed heavier pigs and heavier litters than purebred dams. Litter 56-day weight favored the crossbred sow by approximately 41 lb. A slight, but non-significant, advantage for survival rate (1.6 percent) was noted for straightbred dams but this may have been due to their smaller litter size.

Line 8 — 9 × 14 pigs gained 0.02 lb. per day faster during the postweaning period and their loin eye area was 0.10 sq. in. larger (Table 4). Line 14 × 8 — 9 pigs had 0.06 in. less backfat than 8 — 9 × 14 pigs.

Although the magnitude of the observed differences were small, the crossbred sow was consistently superior to the purebred sow when the breed composition of the pigs was the same.

SUMMARY

The performance of lines and line crosses was studied using 1700 litters (7520 individual pig records) from the Duroc (OK8), Beltsville No. 1 (OK9), and Hampshire (OK14) lines of breeding and four specific crosses of these lines farrowed during the 23 seasons from 1954 fall through 1965 fall. All analyses were done on a within line basis using least squares procedures.

Purebred dams with crossbred litters farrowed smaller litters (—10 percent) than purebred dams with purebred litters, but their crossbred litters were larger at weaning. Crossbred pigs were 3 percent heavier at birth and 12 percent heavier at weaning. Crossbred litters were not larger at birth but were larger at 56 days. Crossbred pigs gained faster and had longer carcasses with a larger loin eye area.

Table 4: Comparison of Three-Line Crosses.

Trait	Line 14x8-9	Line 8-9x14	Difference	Standard Error
PREWEANING TRAITS:				
Number litters	141	89		
Live pigs farrowed/litter	10.4	9.4	1.0	0.4
Pigs born dead/litter	0.29	0.42	— .13	0.16
Pig birth weight, lb.	3.06	2.98	0.08	0.06
Litter birth weight, lb.	31.8	28.0	3.8	1.1
Pigs weaned/litter	7.8	7.4	0.4	0.4
Survival rate, percent	74.8	76.4	— 1.6	3.3
Pig 56-day weight, lb.	41.6	38.4	3.2	0.9
Litter 56-day weight, lb.	324.9	283.8	41.1	13.6
POSTWEANING TRAITS:				
Number pigs	705	459		
Avg. daily gain, lb.	1.37	1.39	— .02	0.01
Carcass length, in.	29.6	29.5	0.1	0.1
Carcass backfat, in.	1.55	1.61	— .06	0.02
Loin area, sq. in.	3.30	3.40	— .10	0.07

Crossbred dams with three-line cross litters were superior to the average of the three purebred lines for 10 of the 13 traits studied. Significant differences were obtained for 8 of the 10 traits. These traits were live pigs farrowed per litter (0.8 pig), birth weight (0.10 lb.), litter birth weight (4.0 lb.), pigs weaned per litter (1.0 pig), survival rate (6.2 percent), litter 56-day weight (47.1 lb.), carcass length (0.5 in.) and carcass backfat thickness (-.02). Purebred pigs were superior for average daily gain (0.05 lb./day), feed efficiency (0.05 lb. feed/lb. gain) and loin eye area (0.15 sq. in.).

Crossbred dams with crossbred pigs were definitely superior to purebred dams with crossbred pigs for 5 of the 12 traits studied. These traits were number of live pigs farrowed per litter (1.0 pig), pig birth weight (0.13 lb.), litter birth weight (3.8 lb.), litter 56-day weight (41.1 lb.) and carcass backfat thickness (—.06 in.). Crossbred pigs from purebred dams were significantly superior to crossbred pigs from crossbred dams only for average daily gain.

Pork Can Be Processed Before Chilling

R. L. Henrickson

It is well to have meat animal production efficiency but unless slaughtering and processing are also efficiently accomplished, the whole industry is placed in jeopardy. The actual reversal of physical movement of product in its trip through a plant is wasteful. These plant inefficiencies could be called "thermal backtracking", since many cuts are chilled and reheated.

When it is considered that more than 70 percent (ham, picnic, belly, butt, and fat) of the carcass will be heated to a temperature in excess of 137°F (58.3°C), it seems desirable to critically examine the existing processing method. Particularly when the original body temperature of the hot carcass is approximately 102°F (38.8°C) and is chilled down to a temperature of 35°F (1.7°C) for cutting. Chilling, reheating, and rechilling tons of pork (10,736,000,000 lbs. Federally Inspected) annually is not only costly, but adds time and opportunity for fat oxidation and microbial contamination to occur. Under present processing procedures it takes 12 to 18 hours of refrigeration to reduce the carcass temperature below a harmful bacteria level. The carcass is then cut and moved back through the bacterial incubation zone for smoking and cooking.