

pound of gain which was significantly higher ($P < .05$) than the 2.65 and 2.66 lb. required by those fed treatments 2 and 3 respectively. No significant differences were noted in average daily feed intake but boars on treatment 3 tended to consume more.

Boars on treatment 1 had significantly more backfat thickness than those on treatments 2 and 3. Boars on treatment 1 also had significantly less ($P < .01$) loin eye area than those on treatments 2 and 3.

These results indicate that a 16 percent crude protein ration from approximately 55 to 120 lb. and a 14 percent crude protein ration from approximately 120 to 220 lb. is inadequate for growing boars. Boars fed the 20-18 percent crude protein rations or the 18-16 percent during the same weight periods generally had a significant improvement in rate of gain, feed conversion, backfat thickness and loin eye area. No significant differences were noted between the boars fed a 18 percent or 20 percent crude protein ration from 55 to 120 lbs. and then decreased to a 16 percent and 18 percent respectively from 120 to 220 pounds. However, the boars fed the higher levels (20-18 percent) tended to have higher average daily gains.

Feedlot Performance and Carcass Merit of Purebred and Two-Breed Cross Pigs

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Story in Brief

The feedlot records of 2111 barrows and gilts and the carcass records of 392 barrows representing all possible crossbreds and purebreds from crossing Duroc, Hampshire and Yorkshire breeds were analyzed to evaluate heterosis, differences among straightbreds, differences among reciprocal crosses and differences among crossbred groups.

Straightbred Durocs had the highest average daily gain, were fatter and produced carcasses that had more marbling and were firmer than Hampshires and Yorkshires. Yorkshires were the most efficient straightbred while Hampshires had the largest loin eyes and leanest carcasses followed by the Yorkshires.

Significant and favorable heterosis was found for average daily gain, age at 220 lbs., feed efficiency, feed consumption and carcass length when averaged over all crosses. The general lack of heterosis for carcass traits indicates that the carcass merit of crossbred pigs can be approximated quite well by the average of the purebreds involved in the cross.

Significant differences between reciprocal crosses did exist. When Yorkshires were involved in the cross, the pigs were more efficient, consumed less feed per day and produced carcasses that had larger loin eyes and were leaner when the Yorkshire was used as the dam than as the sire. This provides evidence that the Yorkshire female provides a more favorable maternal effect on her offspring than does the Hampshire and Duroc female.

Introduction

Although crossbreeding is used widely in this country, sufficient data on how to best combine modern breeds of swine in a crossbreeding program is not readily available. Traits such as feedlot performance and carcass merit are considered to be highly heritable therefore, they are not expected to exhibit much heterosis. However, this should not stop the commercial producer from using crossbreeding to combine the best traits of two or more breeds to produce a superior market pig.

The purpose of this paper is to provide information on the feedlot performance and carcass merit of Duroc, Hampshire and Yorkshire and their crosses.

Materials and Methods

The data for this paper includes the feedlot records of 1057 barrows (289 purebred and 768 crossbred) and 1054 gilts (306 purebred and 748 crossbred) from 362 litters (125 purebred and 237 crossbred) and the carcass records of 392 barrows (133 purebred and 259 crossbred) sampled from these litters. These pigs resulted from all possible crosses among Duroc, Hampshire and Yorkshire and were farrowed in the spring and fall of 1971 and 1973.

Five to six purebred boars of each breed were used each season and seven to fifteen litters of each breeding group were produced each season. The litters were produced by mating each boar of each breed to two gilts of each breed. All litters were produced by gilts and a new set of boars used each season.

The pigs were farrowed in confinement, moved with the sow to a nursery at about 3 days of age, given creep feed at 21 days and weaned at 42 days. Two weeks later they were moved to a confinement finishing

barn and were allotted by breed group into groups of about 16 pigs per pen and were given a one week adjustment period before being weighed on test. All pigs were fed a 16 percent crude protein ration until they reached 220 lbs. Pigs were weighed off test on a weekly basis as they reached 220 lbs. and the gilts were probed for backfat at that time. Each season, a random sample of nine barrows per breed group were taken to the University Meat Laboratory for evaluation of carcass merit.

Results

Feedlot Performance

The breed group means and specific comparisons among the means for measures of growth rate, probe backfat thickness, feed consumption and feed efficiency are presented in Table 1.

Comparisons among straightbreds. Durocs gained about 0.06 lb. more per day than did Hampshires or Yorkshires and were 7.6 days younger at 220 lbs. than were the Hampshires. Durocs were also the fattest straightbred and had 0.185 and 0.144 in. more backfat than Hampshires or Yorkshires, respectively. Yorkshires were the most efficient straightbred and gained 0.013 and 0.011 more lbs. per lb. of feed consumed than did Duroc or Hampshires, respectively. However, Durocs consumed 0.46 more pounds of feed per day than did Yorkshires.

Heterosis estimates. Heterosis is the average superiority or inferiority of crossbred offspring above or below the average of purebred progeny of the breeds involved in the cross. It is calculated as the average of reciprocal crosses minus the average of the purebreds involved in the cross. The heterosis estimates for average daily gain and age at 220 lbs. were significant and in the desired direction for all crosses. Overall crossbred pigs gained 0.12 more pounds per day and were 9.9 days younger at 220 lbs. Probe backfat thickness exhibited significant heterosis only for Duroc-Hampshire crosses. Overall crossbred pigs gained 0.007 more lbs. per lb. of feed consumed than purebreds due to the positive significant heterosis for feed efficiency exhibited by Duroc-Yorkshire and Duroc-Hampshire crosses. While none of the individual heterosis estimates for feed consumption were significant, overall crossbred pigs consumed 0.17 more pounds of feed per day than did purebreds.

Comparisons among reciprocal crosses. This comparison will help provide information to decide which breed to use as a sire breed and which breed to use as a dam breed. For example, the feedlot performance of a Duroc-Yorkshire crossbred pig produced by a Yorkshire dam may not be the same as when it is produced by a Duroc dam. No significant difference existed among reciprocal crosses for average daily gain or age at 220 lbs. When Yorkshires were involved in the cross, the pigs had 0.10 in. less

Table 1. Mean and Comparisons Among Means for Feedlot Performance and Probe Backfat Thickness.¹

Item ²	No. Pigs	No. Pens	Avg. daily gain, lbs.	Age at 220 lbs., days	Probe backfat, in. ³	lb. gain/ lb. feed	Avg. daily feed intake, lb.
\bar{X}	2111	142	1.587	180.72	1.170	.3149	4.879
D	183	17	1.549	184.05	1.294	.3049	5.012
H	172	16	1.487	191.66	1.109	.3071	4.734
Y	240	23	1.485	186.19	1.150	.3181	4.548
D x H	260	17	1.670	174.90	1.171	.3106	5.241
D x Y	277	15	1.653	174.93	1.149	.3298	4.722
H x D	211	11	1.632	178.62	1.148	.3216	4.983
H x Y	198	12	1.601	177.98	1.078	.3302	4.625
Y x D	290	17	1.647	175.93	1.239	.3104	5.063
Y x H	280	14	1.557	182.24	1.191	.3013	4.978
<i>Comparisons among straightbreds</i>							
D - H	.062±.028*	-7.60±3.03*	.185±.033*	-.0023±.0060	.2785±.1637		
D - Y	.064±.028*	-2.14±3.00	.144±.032*	-.0132±.0055*	.4641±.1497*		
H - Y	.001±.028	5.47±2.95	-.041±.032	-.0110±.0056*	.1856±.1529		
<i>Heterosis estimates⁴</i>							
DH crosses	.133±.021*	-11.09±1.91*	-.042±.018*	.0101±.0044*	.2387±.1210		
DY crosses	.133±.021*	-9.69±1.89*	-.028±.018	.0086±.0040*	.1124±.1102		
HY crosses	.093±.021*	-8.81±1.91*	.005±.018	.0031±.0044	.1604±.1198		
Overall	.120±.015*	-9.86±1.34*	-.022±.013	.0073±.0030*	.1705±.0809*		
<i>Comparison among reciprocal crosses</i>							
DxH-HxD	.038±.030	-3.72±3.14	.023±.032	-.0110±.0066	.2578±.1805*		
DxY-YxD	.007±.029	-1.00±3.04	-.090±.031*	.0194±.0060*	-.3413±.1630*		
HxY-YxH	.045±.030	-4.26±3.14	-.114±.033*	.0290±.0068*	-.3589±.1859*		

¹ Backfat probe is only on gilts.

² D = Duroc, H = Hampshire, Y = Yorkshire.

³ Approximately half of the pigs were gilts which were the only pigs for backfat probe.

⁴ Average of reciprocal crosses minus average of purebreds involved in the cross.

*P < .05.

backfat, consumed about 0.35 lbs. less feed per day and gained 0.02 to 0.03 more lbs. per lb. of feed consumed when the Yorkshire was used as a dam than as a sire. Since the genetic makeup of reciprocally produced pigs is expected to be the same, any difference in performance of these pigs is probably due to a maternal effect of the dam. Thus, these data show that in crossbred litter production, Yorkshire females provide a maternal environment prior to weaning that causes their pigs to be leaner and to be more efficient and consume less feed per day in the feedlot than the same breed combination of pigs out of Hampshire or Duroc

dams. Duroc dams have a similar though nonsignificant advantage over Hampshire dams.

Carcass Merit

The breed group means and specific comparisons among the means for carcass traits are presented in Table 2.

Comparison among straightbreds. There were a large number of differences among the straightbreds for carcass traits. Hampshires were the leanest of the three straightbreds and had 5.4 and 3.1 more lbs. of lean, 3.8 and 2.1 higher percent lean of the carcass and 0.17 and 0.17 in. less backfat than Durocs and Yorkshires, respectively. The fattest straightbreds were the Durocs which had 2.3 lbs. less lean and 1.7 less percent lean in the carcass than did Yorkshires. Hampshire carcasses had loin eyes that were 0.53 and 0.36 sq. in. larger than loin eyes from Duroc and Yorkshires, respectively. Duroc carcasses were 0.73 and 0.99 in. shorter than Hampshire and Yorkshire carcasses, respectively. Hampshires and Yorkshires produced carcasses with essentially equal marbling and firmness but they had significantly less marbling and softer carcasses than Durocs. The marbling score and firmness scores for Durocs were about 2.5 and 2.0 points, respectively, higher than for the other two breeds. While no significant differences existed between Durocs and Yorkshires for color score, Hampshires had color scores that averaged about 0.6 points higher than the other two breeds.

Heterosis estimates. Most carcass traits are considered to be highly heritable and therefore, the carcass traits of a crossbred should be equal to the average of the purebreds involved in the cross. When Duroc, which was the shortest straightbred, was involved in the cross, significant and positive heterosis was seen for carcass length and overall, crossbred carcasses were 0.15 in. longer than straightbred carcasses. Duroc-Yorkshire crosses had a heterosis estimate of 1.2 lbs. for pounds of lean. Duroc-Hampshire crosses exhibited positive heterosis for marbling (0.49) while Hampshire-Yorkshire crosses showed negative heterosis for color score (-.53). The lack of significant and consistent heterosis estimates for most carcass traits indicates that carcass merit of crossbred pigs can be closely approximated by the average of the purebreds involved in the cross, thus allowing the production of an overall superior carcass by combining two or more breeds.

Comparisons among reciprocal crosses. Duroc x Hampshire pigs had a 0.54 higher firmness score than Hampshire x Duroc pigs. When Yorkshires were involved in the crosses, the carcasses averaged about 3.74 more lbs. of lean, 2.7 percent more lean in the carcass, 0.12 in. less backfat and 0.43 sq. in. more loin eye area when the Yorkshire was used as the female than as the male. This suggests that the Yorkshire female provides a mat-

Table 2. Means and Comparisons Among Means for Carcass Traits.¹

Item ²	No. Pigs	Lean, lbs.	% Lean of carcass	Length, in.	B.f.t., in.	Marbling ³	Firmness ³	Color ²	L.E.A., sq. in.
\bar{X}	392	87.11	56.72	30.55	1.211	4.26	4.79	4.83	4.731
D	43	84.38	54.77	29.88	1.264	5.83	6.16	5.24	4.480
H	46	89.77	58.56	30.61	1.093	3.25	3.78	4.52	5.012
Y	44	86.69	56.51	30.87	1.260	3.40	4.28	5.08	4.650
D x H	45	87.20	56.70	30.50	1.187	5.27	5.56	4.98	4.761
D x Y	41	88.38	57.44	30.57	1.219	5.15	5.50	5.15	4.857
H x D	42	87.65	57.06	30.53	1.165	4.79	5.02	4.83	4.775
H x Y	41	89.52	58.68	30.80	1.126	3.16	3.93	4.46	5.021
Y x D	44	85.07	55.18	30.64	1.304	4.66	5.27	5.12	4.511
Y x H	46	85.35	55.58	30.57	1.282	2.83	3.57	4.07	4.510
<i>Comparisons among straightbreds</i>									
D - H		-5.39±.78*	-3.78±.49*	-.73±.14*	.171±.029*	2.58±.28*	2.38±.27*	.72±.20*	-.532±.106*
D - Y		-2.31±.78*	-1.73±.49*	-.99±.14*	.004±.030	2.43±.28*	1.87±.27*	.16±.21	-.170±.108
H - Y		3.08±.77*	2.05±.48*	-.25±.14	-.167±.029*	-.15±.27	-.50±.27	-.56±.20	.361±.106*
<i>Heterosis estimates⁴</i>									
DH crosses		.35±.56	.21±.35	.27±.10*	-.003±.021	.49±.20*	.32±.19	.03±.15	.022±.076
DY crosses		1.19±.56*	.67±.35	.24±.10*	-.001±.021	.29±.20	.17±.19	-.02±.15	.119±.077
HY crosses		-.80±.55	-.40±.34	-.05±.10	.028±.021	-.33±.20	-.28±.19	-.53±.14*	-.066±.076
Overall		.25±.39	.16±.24	.15±.07*	.008±.015	.15±.14	.07±.14	-.18±.10	.025±.054
<i>Comparison among reciprocal crosses</i>									
D x H - H x D		-.44±.79	-.36±.49	-.03±.14	.022±.030	.48±.28	.54±.27*	.15±.21	-.014±.108
D x Y - Y x D		3.31±.79*	2.26±.50*	-.07±.15	-.085±.030*	.50±.28	.23±.27	.03±.21	.346±.109*
H x Y - Y x H		4.17±.79*	3.10±.49*	.23±.14	-.156±.030*	.33±.28	.36±.29	.40±.21	.511±.108*

*P < .05.

¹ Carcass data on barrows only.² D = Duroc, H = Hampshire, Y = Yorkshire.³ Score of 1 is devoid of marbling, pale and very soft; score of 7 is abundant marbling, dark and very firm.⁴ Average of reciprocal crosses minus average of purebreds involved in the cross.

ernal environment prior to weaning that not only affects feedlot performances but also causes their pigs to be leaner and more heavily muscled than the same breed combination out of Duroc or Hampshire dams.

Summary. The heritabilities for feedlot performance and carcass traits are moderate to high, thus the comparisons among straightbreds suggests that on the average Duroc sires should produce pigs that gain faster and produce firmer and more marbled carcasses than pigs out of Hampshire or Yorkshire sires when all are bred to the same breed of dam. Similarly, Hampshire sires should on the average produce pigs that have carcasses that have a higher percent lean, less backfat and larger loin eyes than Yorkshire or Duroc sires.

The differences in reciprocal crosses indicate that if Yorkshires are to be used in the cross, they should be used as the dam breed. Crosses involving the Yorkshire are more efficient in the feedlot and produce carcasses that are leaner and more heavily muscled when the Yorkshire is used as the dam than as the sire.

The data indicate that significant heterosis can be expected for average daily gain, age at 220 lbs., feed efficiency, average daily feed consumption and carcass length and very little heterosis is to be expected for most carcass traits.

Trends in Performance of Boars in the Oklahoma Swine Test Station

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Story in Brief

The performance records of 385 boars of seven breeds that completed the tests conducted by the Oklahoma Swine Evaluation Station have been analyzed to determine the average changes in performance over time for the tests conducted from 1971 spring to 1974 spring. The traits measured were individual average daily gain and pen feed efficiency from 70 to 220 lbs., backfat thickness and loin eye area at 220 lbs. and a performance index composed of a combination of gain, feed efficiency and backfat.