Evaluating Breeds of Swine for Crossbreeding Programs

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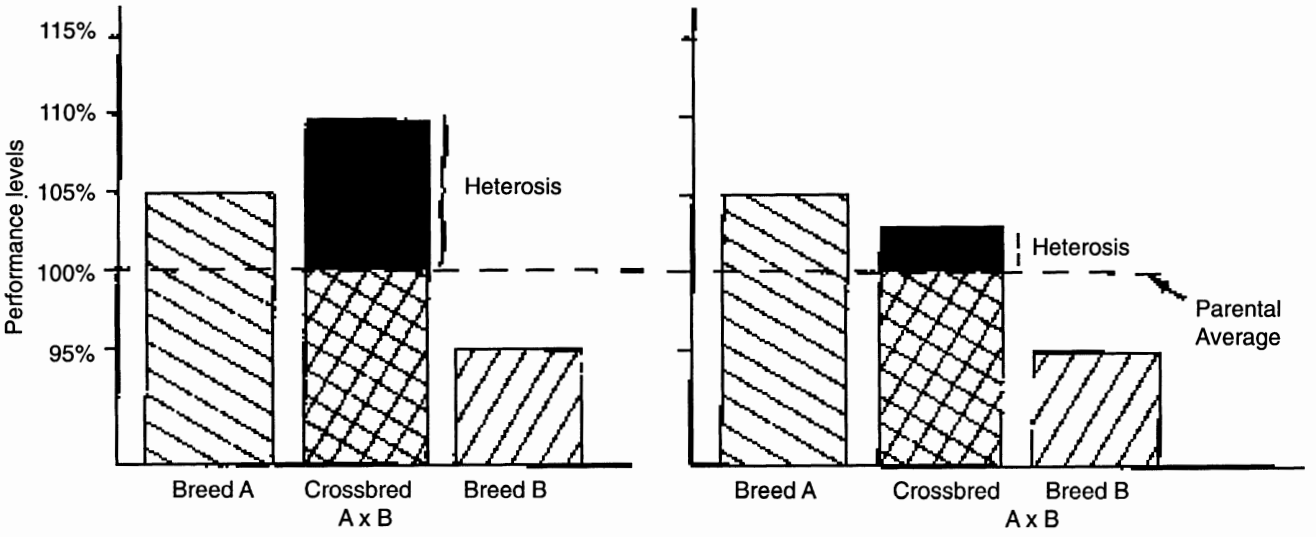
Crossbreeding is a widely accepted and recommended practice in commercial swine production. It is used to capitalize on heterosis, the superiority of crossbred individuals over the average of their purebred counterparts. An example of heterosis is shown in Figure 1. Crossbred performance may be more or less than the performance of the best purebred, depending on the breeds crossed. For there to be heterosis, crossbred performance must be above the average of the pure breeds.

Heterosis

Heterosis occurs when breeds are crossed. Heterosis tends to be largest for traits with low heritability such as litter size, litter weaning weight, and pig survival rate (Table 1). Growth trails are moderately heritable but are also improved by crossing, especially average daily gain and age at 220 pounds. Carcass traits, however, are highly heritable and benefit little from heterosis.

Increased pig survival and growth rate are the main benefits of a systematic crossbreeding program. When a boar of a different breed is used on purebred dams, litter size born is not significantly increased (Table 1). However, crossbred pigs have a higher survival rate than purebreds. Thus, at weaning two-breed cross litters are 11.3% heavier than purebred litters. In addition, crossbred pigs reach 220 lbs. 6.5% faster on 2.3% less feed per lb. of gain. Little heterosis exists for carcass traits; therefore, carcass merit of crossbred pigs is expected to be equal to the average of the purebreds.

The maximum advantage of crossbreeding is realized when a crossbred sow is used. An additional increase of 8.7% in litter size weaned can be expected (Table 1). This improvement is due to an additional increase in the number of pigs born alive (4.7%) and a higher survival rate of the pigs. The total reproductive advantage of crossbred sows over purebred sows results in 29% greater 21-day litter weights per female exposed for crossbred sows with crossbred pigs as compared to purebred sows with purebred pigs.



Heterosis response in crossbred offspring superior to both parent breeds.

Heterosis response in crossbred offspring superior to one parent breed.

Figure 1.

Table 1. Estimates of Heterosis (%) for Several Swine Traits[a,b].

	Individual heterosis	Maternal heterosis	Paternal heterosis
Ovulation rate		.3	
Testis weight			24.6
Semen volume			9.6
Sperm number			26.7
Sperm concentration	5.9		
Sperm motility			2.8
Time to first mating			23.5
% boars mating each time			156.1
Conception rate		3.8	
1st service conception rate			17.1
Litter size born	1.0	4.7	-1.1
Birth weight	3.1	1.5	-1.4
Litter size at 21 days	8.0	8.7	-1.4
21 day litter weight	11.3	13.0	
Average daily gain	9.4	0.0	1.2
Age at 230 pounds	6.5	1.2	
Feed efficiencey	2.3	0.0	-1.2
Length	0.0	.2	
Backfat thickness	2.5	4.4	1.3
Loin eye area	1.8	.4	-1.4

[a] Johnson, R.K. 1980. Heterosis and Breed Effects in Swine. NC Reg. Pub 262

[b] Buchanan, D.S. 1987. The crossbred sire: experimental results for swine. J. An. Sci. 65:117.

There is also a substantial benefit in conception rate when a crossbred boar is used. This benefit is most profound for young boars. Research conducted at the Oklahoma Agricultural Experimental Station showed a 17.1% crossbred boar advantage in conception rate at first service and a 3.4% advantage for an eight week breeding season. Use of crossbred boars had very little effect on litter size, on weight, growth rate, backfat thickness, or feed efficiency. Use of crossbred boars would allow a smaller gilt pool to be maintained and result in a more rapid return to production following weaning. This could be accomplished without negative impact on other performance traits.

Crossbreeding increased litter size, pig survival, and growth. Some improvement in feed efficiency is realized, but carcass traits show little heterosis. Overall efficiency and improvement in these characteristics is made by selecting superior parents. Real breed differences exist for nearly all traits. Therefore, the choice of breeds and their use in a systematic way is critical in a crossbreeding program. For a discussion of crossbreeding systems, see OSU Extension Fact Sheet ANSI-3603, "Swine Crossbreeding Systems."

Breed Evaluation

Choice of breeds for systematic crossbreeding programs should be based on the average differences between breeds in controlled experiments. The genetic composition of breeds and the frequency of desirable gene combinations do change over time, although the process is quite slow. Therefore, breed selection should be based on recent research.

Results of crossbreeding studies conducted since 1970 in Iowa, Oklahoma, North Carolina, and Canada are summarized in Tables 2 through 4. All breed combinations have not been adequately compared and numbers are limited for some breeds. The data are useful, however, in making breed selections for systematic crossing sequences. Recommendations are not meant to eliminate those breeds which have not been adequately compared.

A summary of crossbreeding experiments is given in Table 2. These results suggest that Chester White females are superior for litter size at birth and weaning, 21-day litter weight, and 21-day litter weight per female exposed. Yorkshire females rank second to Chester Whites for litter size born and weaned and 21-day litter weight. The high conception rate for Hampshire females causes them to have a relatively high 21-day litter weight per female exposed.

The commercial producer should be primarily concerned with the productivity of crossbred females of various breeding, since crossbred females are superior for reproductive efficiencies. Table 3 ranks 16 different crossbred female types. Hampshire x Landrace crossbred females had the highest ranking for litter size at birth and 21 days and litter 21-day weight. The Chester White x Yorkshire females had the heaviest

Table 2. Relative Reproductive Performance of Breeds as Dams[a].

Traits	Berkshire	Chester White	Duroc	Hampshire	Landrace	Spot	Yorkshire
Number of litters	96	168	790	740	179	98	848
Litter size at birth[b]	94	119	102	92	97	89	108
Litter size weaned[b]	91	116	97	94	97	NA	106
Birth weight[b]	96	86	107	105	111	104	92
Weaning weight[b]	92	96	102	106	100	NA	104
21-day litter weight[b]	83	111	99	99	97	NA	110
21-day litter weight per female exposed[b]	91	119	97	107	87	NA	99

a Composite results from Iowa, Oklahoma, North Carolina, and Canada crossbreeding projects.
b Breed performance is given as a ration where the overall average performance equals 100.
NA - Not available.

Table 3. Relative Reproductive Performance of Various Crossbred Sows[a].

Breeding of crossbred sow	No. of litters	Litter size born alive	Litter size 21-days	Litter 21-day weight [b]	Litter 21-day wt. per female exposed [b]
Chester X Duroc	82	94	99	102	116
Chester X Hamp	72	104	99	97	101
Chester X York	171	109	105	103	110
York X Land	681	100	102	103	101
Hamp X Land	432	98	104	108	100
Hamp X York	482	102	101	101	97
Berk X York	33	101	102	100	89
Berk X Land	37	103	108	105	109
Berk X Hamp	36	91	93	92	89
Berk X Duroc	39	104	99	95	92
Duroc X York	596	103	103	100	101
Duroc X Land	625	100	102	104	104
Duroc X Hamp	408	99	97	100	97
Land X Spot	196	95	97	99	97
York X Spot	99	99	93	93	97
Duroc X Spot	99	100	96	97	97

[a] Composite results from Oklahoma, North Carolina, Iowa, and Canada crossbreeding projects.
[b] Breed performance is given as a ratio where the overall average performance equals 100.

Table 4. Influence of Sire Breed on Various Production and Carcass Traits[a].

Trait	Spot	Chester White	Duroc	Hampshire	Yorkshire	Landrace
Number of Carcasses	37	131	412	260	456	38
Carcass Composition[b]						
Length	99	100	100	101	101	101
Backfat	96	100	100	108	96	100
Loin Eye Area	97	98	102	107	99	96
Number of Pigs	198	481	1443	1053	1610	193
Production[b]						
Average Daily Gain	102	96	103	100	100	100
Days at 220 lbs.	102	NA	102	99	101	101
Feed/Gain	96	NA	100	103	95	99

[a] Composite results from Iowa, Oklahoma, North Carolina, and Alabama crossbreeding NC-103 project.
[b] Breed performance is given as a ratio where the overall average performance equals 100.
NA - Not available.

21-day litter weight per female exposed because of their high conception rate. In general, females with Landrace, Yorkshire, and Chester White breeding were superior in mothering ability to those with predominantly Duroc, Hampshire, and Spot breeding.

Sire Breeds

Experimental results have shown that the breed of sire can influence the sow's reproductive performance to which they are mated. Females mated to Yorkshire boars ranked high compared to the other breeds evaluated. It appears that sire breed does not have any major influence on litter size at birth, but there were large differences apparent in litter size at weaning and 21-day litter weight per female exposed.

Sires continued to influence the post weaning performance of pigs. Duroc sired pigs had an advantage for growth rate and Hampshire sired pigs were found to be superior for carcass merit (Table 4). Regardless of the choice of breed, boars from large litters with superior individual performance for growth, feed efficiency, and carcass merit should be used.

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