Swine Crossbreeding Systems

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Crossbreeding can be a very useful tool for the pork producer to increase the efficiency and profit of an operation. Full benefits from crossbreeding can be gained only by careful combination of available breeds and selection of outstanding breeding animal replacements from within those breeds. Crossbreeding programs must be systematic and well-planned to take full advantage of heterosis and breed differences.

Crossbreeding enables the producer to take advantage of heterosis and to combine desirable characteristics of different breeds. Heterosis is the difference between crossbred animals and the average of their purebred counterparts. Desirable characteristics of different breeds can be utilized if some breeds can be identified as good maternal breeds and others as good paternal breeds. A system where males from paternal breeds (superior growth and carcass) are mated to females from maternal breeds (superior reproduction and mothering ability) can take advantage of the strengths of both breeds while minimizing some of the weaknesses. For a discussion of heterosis levels for various traits and evaluation of breeds to use in crossing systems see OSU Extension Fact Sheet ANSI-3604, "Evaluating Breeds of Swine for Crossbreeding Programs."

Carefully designed crossbreeding programs can be used to enhance improvement from selections made in the purebreds. Crossbreeding does not change the genes that are present in a population but arranges them in more favorable combinations. Therefore, the initial boost from crossbreeding can be maintained by continued crossing. Permanent improvement can result only through selection. This is illustrated in Figure 1.

Two basic systems exist, each of which has several variations. They can also be used in combination. These are the rotational cross system and the terminal cross system. Rotational cross systems combine two or more breeds, where the breed of boar used is different from the previous generation and replacement crossbred females are retained from each cross. The major difference is that rotational cross replacement females are produced within the system while terminal cross female replacements are usually purchased or produced by maintaining purebred herds that emphasize reproductive performance.

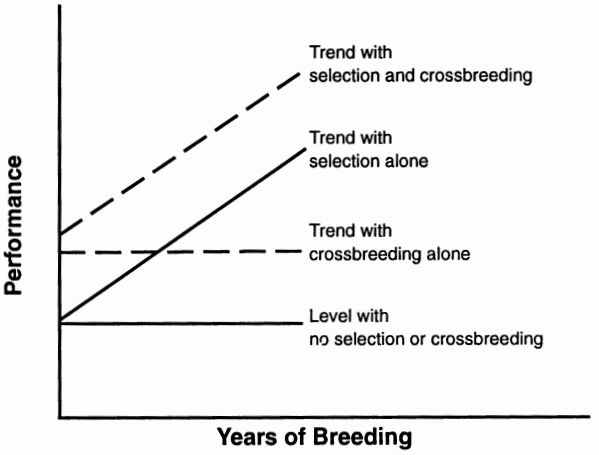

Figure 1. The effects of combining crossbreeding and selection.

Terminal Cross Systems

Terminal cross systems may involve two, three, or four breeds (Table 1). A two-breed cross will utilize purebred boars on one breed mated to purebred sows of another breed. For example, Hampshire boars and Yorkshire females could be used to produce every pig crop. This systems allows the

Table 1. Percentage Heterosis Maintained by Terminal Crosses and its Effect on One Trait.

Sire Breed	Dam Breed	% Heterosis Pig	% Heterosis Dam	% Heterosis Sire	Litter Weight (lb) at 21 days per Female Exposed
Purebred					
A	A	0	0	0	72
2-breed					
A	B	100	0	0	80.1
3-breed					
C	AB	100	100	0	93.8
4-breed					
CD	AB	100	100	100	97.0

producer to combine a dam breed superior for reproductive performance with a sire breed superior for growth and carcass characteristics. All pigs produced are crossbred, therefore this system reaps all the advantages obtained by having crossbred pigs. The sows, however, are purebred and none of the superiority obtained from crossbred sows will be realized.

A three-breed terminal cross will utilize purebred boars of one breed mated to crossbred sows of two other breeds. For example Duroc boars and Landrace x Yorkshire cross females could be used to produce each pig crop. In this system, sows that are a cross between two breeds superior for maternal characteristics are mated to a third breed of sire that is superior for growth and carcass characteristics. All pigs produced are crossbreds. Crossbred sows are utilized so that this system maximizes heterosis and is expected to be one of the most productive systems.

A four-breed terminal cross has all of the same advantages on the maternal side as the three-breed cross. In addition, there are some advantages in conception rate associated with use in crossbred boars. A disadvantage is that crossbred boars may be more difficult to obtain than purebred boars. However, since some seedstock producers maintain purebred herds of two or more breeds, they could easily produce some crossbred boars if there should be a demand for them.

In general, terminal crosses capitalize on the strengths of each breed and realize maximum gains from heterosis. Example terminal crossbreeding systems are shown in Table 1. A big disadvantage of terminal crosses can be the difficulty of obtaining replacement females. If they are purchased, there is a health risk associated with the introduction of outside breeding stock. If they are raised within the herd, the commercial producer will need at least one purebred herd to produce replacement stock.

Rotation Cross Systems

The two-breed rotational cross uses boars of two different breeds in alternate generations, retaining crossbred females for maternal stock (Figure 2). This system is fairly simple to follow once the producer chooses two breeds. Breeds used in a rotation should be generally productive (Figure 2). Two-breed rotational cross system since, over time, each breed contributes equally to both the production traits of the market

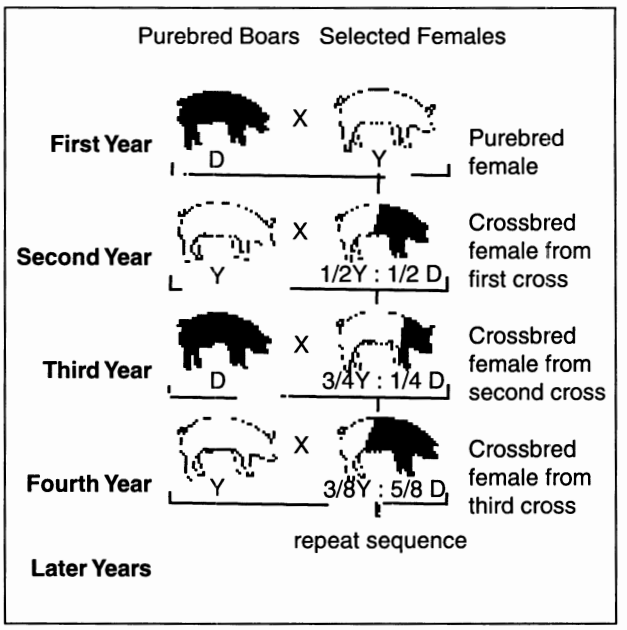

Figure 2. Two-breed rotation cross system.

offspring and the reproductive traits of replacement females. Therefore, reproductively sound breeds with adequate growth and carcass characteristics should be used.

In this system, purebred boars are mated to sows with a certain percentage of the same breed as the board. Therefore, the maximum response from heterosis will not be realized (Table 2). In fact, the actual heterosis retained changes a little each generation until the sixth generation, after which the two-breed rotation realizes about two-thirds of the total advantage obtained from crossbreeding.

More heterosis can be realized with the addition of a third breed to the rotation (Table 2 and Figure 3). A three-breed rotation realized about 86% of the advantage obtained from crossbreeding. Again, each breed contributes as both a sire and a dam so that reproductively sound breeds with adequate growth and carcass characteristics should be used. Three-breed rotations are recommended over two-breed rotations,

Table 2. Breed composition and percent of maximum heterosis expected from two-breed and three-breed rotational crossing programs.

	2-Breed Crosses				3-Breed Crosses				
	% Blood		Expected Heterosis		% Blood			Expected Heterosis	
Generation Number	A	B	Offspring	Dam	A	B	C	Offspring	Dam
1	50	50	100	0	50	50*	0	100	0
2	75*	25	50	100	25	25	50*	100	100
3	38	62*	75	50	63*	12	25	75	100
4	69*	31	62	75	31	56*	12	88	75
5	34	66*	69	62	16	28	56*	88	88
6	67*	33	66	69	58*	14	28	84	88
7	33	67*	67	66	29	57*	14	86	84
8	67*	33	67	67	14	29	57*	86	86

* Breed of sire used to produce offspring.

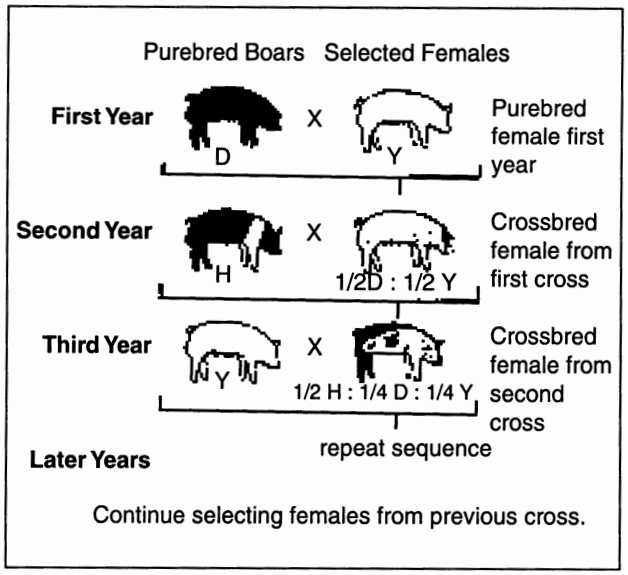

Figure 2. Three-breed rotation cross system.

since a higher percentage of the total advantage obtained from crossbreeding is realized.

A fourth breed could be added to the rotation, in which case about 92% of the total advantage from crossbreeding would be realized. Even though a higher percentage of the total heterosis is realized with a four-breed rotation, it is generally not recommended over a three-breed rotation because of the difficulty in finding a fourth breed with a higher average level of productivity. The number of breeding groups that need to be maintained also increases with the number of breeds included in the rotation since females of different parities will be at different stages of the rotation and will require different breeds of boars or mates.

The rotation cross system is more popular and thought by many to be a more practical program than the terminal cross system. This is because the only outside breeding stock that needs to be purchased, once the program is established, are boars. Thus a producer does not have the difficulty of obtaining replacement females at a reasonable cost. Also there would be less risk of introducing disease to the herd since only boars are purchased.

Combinations of desirable traits of breeds cannot be fully utilized in a rotational system. Ideally, market hogs should be out of sows with good mothering ability and sired by boars that excel in growth and carcass characteristics. This is difficult to achieve in the framework of a rotational crossing system.

A Combination System

The advantages of both systems can be utilized if all replacement females are produced in a rotational cross of prolific, highly productive breeds and the market hogs are then sired by a boar of another breed (Figure 4). The producer would maintain a small portion of his herd (10-15%) in the two-breed rotational cross. The best females would be kept in the rotation while most of the remaining rotation females would be mated to the terminal cross sire. The rotation breeds should be ones with good maternal abilities and the terminal sire should be from a breed with good growth and carcass characteristics and rank highly for those traits as an individual. All pigs are from crossbred dams so much of the maternal heterosis can be used and 100% of the individual heterosis utilized in the terminal cross pigs. Also, only boars need to be brought in from the outside, so disease problems are minimized.

This system has the disadvantages of being rather complicated and requires large numbers to allow it to operate efficiently. Unless a producer farrows at least 200 litters per year the terminal sire on a rotation female system will be hard to maintain and will make inefficient use of the boars, particularly those in the rotation breeds.

When considering a crossbreeding system there are many choices one can make. Each has several advantages and disadvantages. Some programs are simple but do not make maximum use of heterosis. Others are more complex, require more time to manage, but should have higher average levels of performance because they take more advantage of

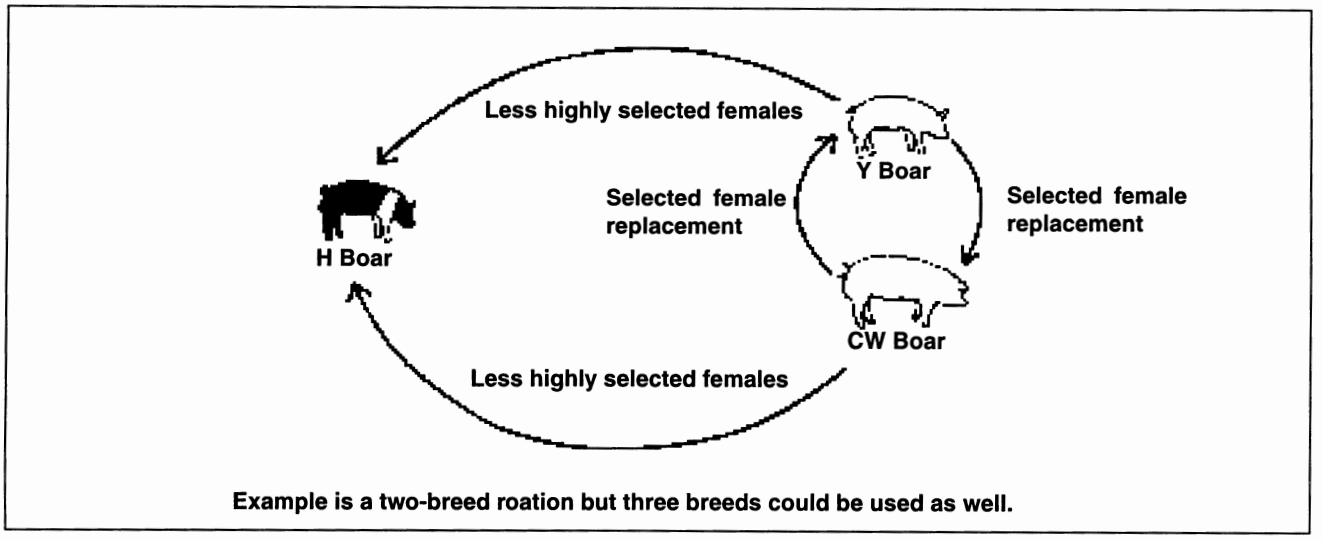

Figure 4. Terminal sire on rotation female system.

the strengths of breeds and retain a higher percentage of the heterosis. No one system will be best for every producer.

Larger producers who spend considerable time managing their swine operations can utilize more complicated systems that have higher expected levels of performance. In addition, facilities, source of breeding stock, disease control programs and perhaps other factors will be important when deciding which system is best adapted to your production unit.

The Pork Industry Handbook is a national project sponsored by State Cooperative Services, pork producers and the USDA. The handbook is considered to be the most complete current source of information on swine production available.

The handbook contains approximately 120 fact sheets on production systems, breeding and genetics, reproduction, nutrition, management, housing, waste management, herd health, marketing and pork quality.

Pork producers and other interested people may obtain the Pork Industry Handbook on a subscription basis for $30.00 by contacting their local OSU County Extension Center or by writing Central Mailing Services, Oklahoma State University, Stillwater, OK 74078. The subscription plan provides a good quality vinyl notebook containing all of the fact sheets with new or revised fact sheets to be mailed to you as they are published.

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