

MU Guide

Terminal and Rotaterminal Crossbreeding Systems for Pork Producers

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Crossbreeding is a widely established management practice among commercial pork producers. Over the years, the industry has extensively used rotational crossbreeding programs. Rotational programs are relatively easy to operate, enable pork producers to develop their own females and exploit most of the possible heterosis.

Rotational programs do not use all the potential heterosis and cannot effectively use breeds that are above average for only one or two traits. Often breeds are included in a crossbreeding program because they are superior for certain traits such as maternal, growth or carcass. Unfortunately, rotational programs often do not maintain the desired breed composition.

Table 1 demonstrates how pigs sired by boars from Breed A are 57 percent Breed A, 28 percent Breed B and 14 percent Breed C. Pigs sired by Breed B are 14 percent breed A, 57 percent Breed B and 28 percent Breed C. If Breed C is noted for growth and carcass traits, only one-third of the pigs to be sold for slaughter will have 50 percent or more of that breed in its genetic composition. This also holds true for the sow herd. If Breeds A and B are noted for maternal characteristics,

only two-thirds of the sow herd will maintain more than 50 percent of either of these two breeds in their genetic makeup.

Terminal and rotaterminal systems described in this guide can be adapted by producers to improve the limitation of the more common rotational systems.

Table 1. Breed composition of pigs produced in a three-breed rotation.

Breed of Sire	Percent of Each Breed		
	A	B	C
A	57	28	14
B	14	57	28
C	28	14	57

Terminal Programs

Terminal programs are programs that concentrate on utilizing all possible heterosis and capitalizing on breed strengths. All effort is placed on maintaining 100 percent heterosis in both the pigs and the sows, and selecting breeds and breed crosses that excel in maternal

Table 2. Relative performance of breeds.

Breed	Conception Rate	Litter Size Raised	21-Day Wt.	Age at 220-lb.	Backfat
Berkshire	+	-	-	-	-
Chester White	+	++	-	—	A
Duroc	A	A	-	+	-
Hampshire	A	-	A	-	++
Landrace	—	++	++	A	—
Poland				A	+
Spotted		—	—	+	-
Yorkshire	-	++	+	+	-

Based on NC-103 review.

Blank cell indicates data unavailable.

A indicates performance near average of breeds studied.

+ indicates performance superior to average.

++ indicates performance substantially superior to average.

- indicates performance inferior to average.

— indicates performance substantially inferior to average.

or feedlot traits. Tables 2, 3 and 4 can be used to assess relative performance of different breeds and two-breed crosses. In general, superior sow crosses are those that are 50 percent or more of Yorkshire, Landrace or Chester White breeding. Superior crosses for postweaning performance are those that had a Duroc, Hampshire, Spotted, Berkshire or Poland China sire.

Terminal programs are characterized by using two-, three- or four-breed first cross females and should not come from a rotational crossbreeding program. They can be purchased or produced on the farm. Such specialized females are bred to boars that are from breeds or breed crosses that are superior for growth and carcass traits. All the progeny from the mating of these specialized females to terminal boars are marketed. This is further illustrated in Figure 1.

Terminal programs allow exploitation of all possible heterosis and utilize specialized breeds or breed crosses. Unfortunately, developing replacement females becomes more complex. Replacement gilts have to be purchased or a small nucleus herds must be maintained to produce the first-cross or F_1 females. If females are purchased, out-of-pocket costs increase and there could be an increased health risk. If a small purebred herd is maintained as a nucleus, the management program increases in difficulty and cost of production for the purebred herd may be higher.

However, if purchasing replacement gilts from a seedstock supplier who follows a rigid herd health program, purchased gilts can be routinely entered into

Table 3. Specific comparisons among Yorkshire, Landrace and Chester White two-breed crosses for sow productivity^a.

Trait	Female Breed Cross		
	Yorkshire-Landrace	Chester White-Landrace	Chester White-Yorkshire
Number born alive	9.2	9.8	10.1
Number at 21-days	8.1 ^b	8.4 ^c	8.5 ^c
Number at 65-days	7.8	8.1	8.0
Litter birth wgt., lbs.	32.1	34.3	32.3
Litter wgt. at 21-days, lbs.	93.1	96.4	91.6
Litter wgt. at 56-days	260.3	272.4	255.2

^aAdapted from Kuhlers et al., 1988. JAS 66:1132.

^{b,c}Means in a row with different superscripts differ ($P < .10$).

Table 4. Specific two-breed crosses among Yorkshire, Duroc, Landrace and Hampshire breeds for sow productivity^a.

Trait	Female Breed Crosses		
	York-Landrace	Duroc-Landrace	Hampshire-Landrace
Number born alive	11.0	11.1	11.0
Number at 21-days	8.9	9.1	9.2
Number at 56-days	8.8	8.8	9.0
Litter birth wgt., lbs.	34.3	39.8	35.6
Litter weight at 21-days, lbs.	98.8	103.8	104.9
Litter weight at 56-days, lbs.	279.4	292.6	284.2

^aAdapted from Kuhlers et al., 1989. JAS 67:920.

the herd with little health risk, A health agreement between the buyer and seller should be developed before the transaction is final to further secure health status.

The gilt procurement for a terminal program can be handled in two ways. The first is that all replacement gilts can be purchased. All pigs produced will be sold for market and no replacements will be saved back. This is often referred to as the Mother Option because all gilts purchased will be the mothers of all the market

hogs. The second way would be to purchase purebred or crossbred females. The purchased gilts would make up a small portion (10-20%) of the sow herd and be mated to boars from maternal breeds or lines different than the gilts. All replacement gilts for the rest of the sow herd would be chosen from the litters of the purchased females. This is called the Grandmother Option because the majority of the market hogs would have purchased grandmothers. Usually F₁ gilts of maternal breeding are purchased for the Grandmother Option.

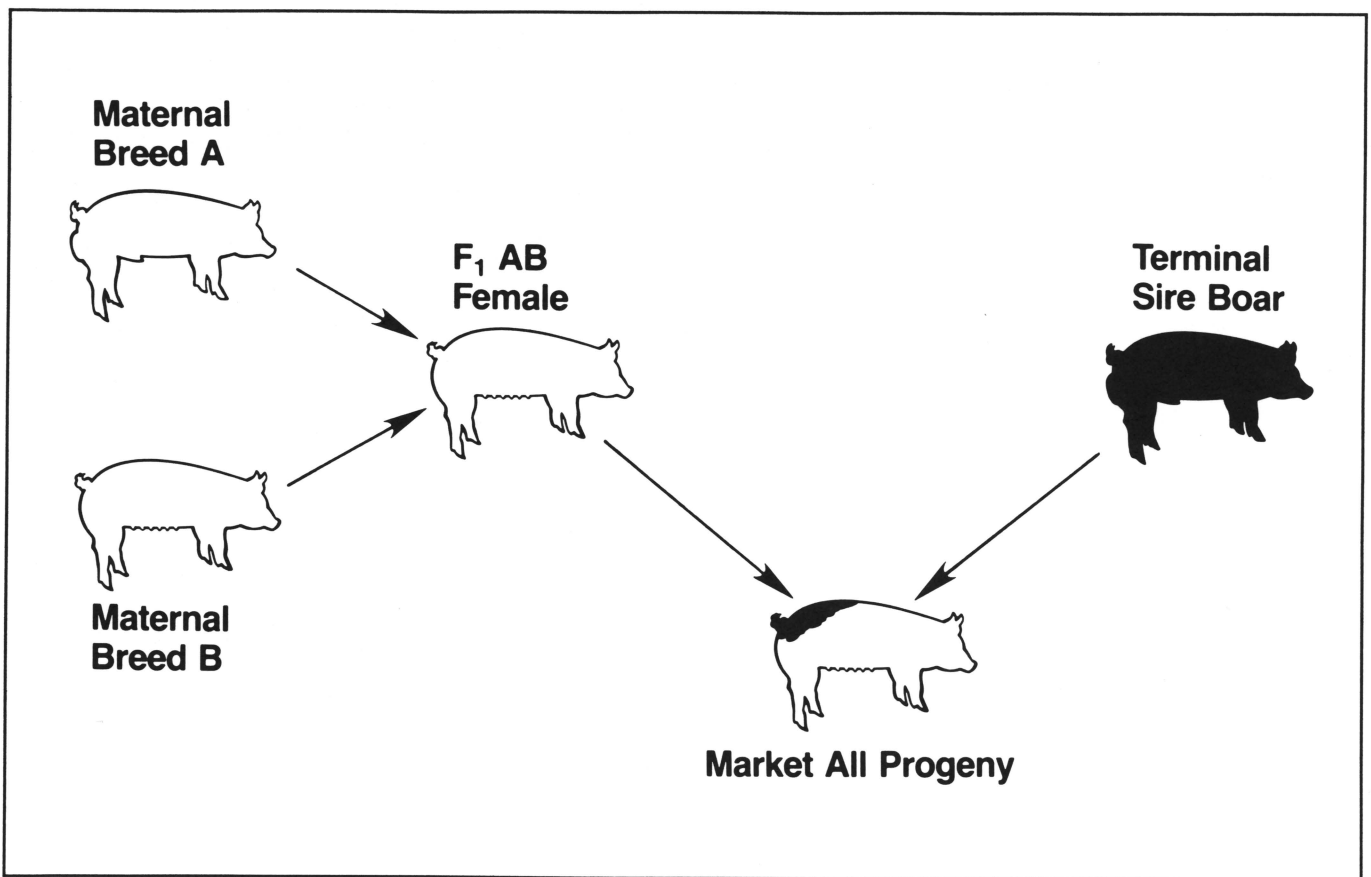


Figure 1. Terminal crossbreeding program. A terminal crossbreeding program uses F₁ females and terminal sire boars to produce market hogs.

Rotaterminal Programs

Rotaterminal programs are a compromise between rotation and terminal programs. Rotaterminal programs are characterized by having a rotational program within a small portion (15-20%) of the sow herd to produce replacement females. The breeds used in the rotation program should excel in maternal characteristics.

The majority (80-85%) of the sow herd is mated to boars of breeds or breed crosses that are superior in postweaning and carcass characteristics. Over 90 percent of the market offspring are sired by terminal boars and express 100 percent heterosis, since their sire is of different breeding than that of their dams. Only a small portion of the market offspring come from the maternal rotation since all of the replacement gilts are taken from those matings. This is further illustrated in Figure 2.

When implementing a rotaterminal program, one question often arises, "Should I use a two-, three- or four-breed rotation to produce my replacement females?" Two-breed rotation females only express 67 percent of the potential heterosis while four-breed rotation females express 93 percent of the potential heterosis (See Table 5). The real question becomes, "How much difference in maternal performance can we expect among these different rotational cross programs when all the breeds in use are maternal in nature?" An example can be found in Table 6.

When developing a rotaterminal program, the choice of maternal breeds becomes critical. If all maternal breeds under consideration are alike, then the choice could be to utilize a four-breed rotation to produce replacement females, if it is practical. If the maternal breeds are not alike, as in Table 6, then the decision becomes more difficult. Most pork producers would

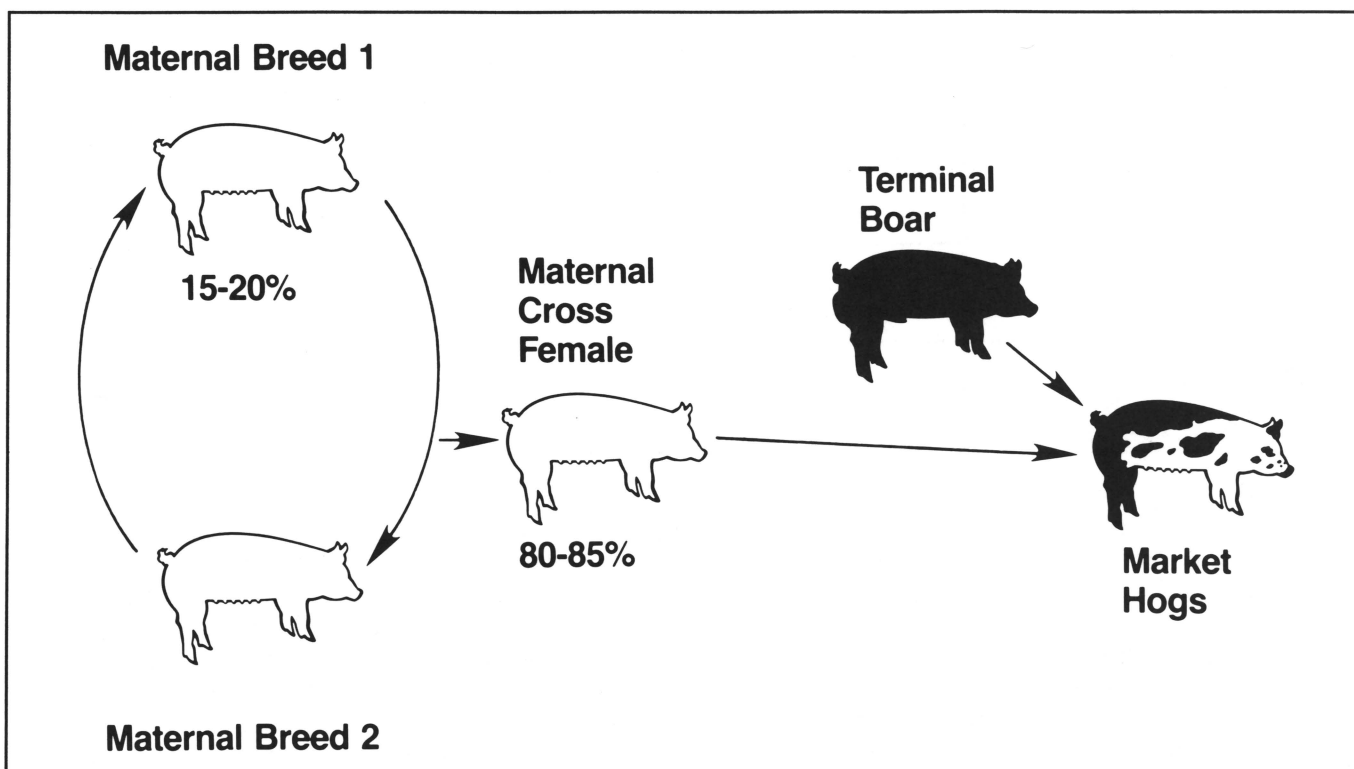


Figure 2. Rotaterminal Crossbreeding Program. A rotational crossbreeding program, using maternal breeds is conducted on a small (15-20%) portion of the sow herd to produce replacement gilts. The majority (80-85%) of the sow herd is bred to terminal sire boars to produce market hogs.

Table 5. Heterosis of different rotaterminal crossbreeding programs.

Program	Heterosis (%)	
	Maternal	Progeny
Two-breed	67	100
Three-breed	86	100
Four-breed	93	100

that rank in the top 25 percent of the herd for a Sow Productivity Index that is used by the major breed associations or recommended by the National Swine Improvement Federation (NSIF). However, these boars and gilts also should be near average for growth and backfat, when compared to the group in which they were tested to keep from decreasing the value of their market progeny. Terminal boars that are to be bred to specialized female crosses, should be better than average for both growth and backfat so their progeny excel for postweaning performance and are lean when slaughtered. No consideration should be given to their merit for maternal traits.

Table 6. Expected performance from different rotational crossbreeding programs.

Trait	Purebred Averages			
	A	B	C	D
Number born	9.2	10.8	11.6	10.5
Number weaned	7.6	7.7	8.4	7.9
Conception rate (%)	75.7	75.0	90.5	80.4
Program	Expected Performance			
	Number Born	Number Weaned	Conception Rate (%)	
Two-breed (B,C)	11.6	9.1	84.9	
Three-breed (B,C,D)	11.5	9.3	84.5	
Four-breed (A,B,C,D)	11.1	9.3	83.2	

choose the first two ranking breeds for a two-breed rotation, the top three breeds for a three-breed rotation and so on. If the fourth ranking maternal breed is inferior enough to the first three, the increase in heterosis utilized may not overcome breed differences.

In Table 6, breed A was added to produce a four-breed rotation replacement female. The number weaned did not increase over the three-breed rotation and conception rate declined. In most situations, a four-breed rotation to produce replacement females within a rotaterminal program will not be beneficial because it is difficult to find four maternal breeds that are similar in performance.

Sire Selection

When using terminal or rotaterminal crossbreeding programs, sire selection is important. Purebred boars or gilts chosen to produce commercial females must be from maternal breeds and from maternal lines within breeds. These boars or gilts should be from sows

The use of crossbred boars has often been questioned. Research has shown that crossbred boars are more aggressive at a younger age and settle a larger percentage of sows. Their progeny are no worse when compared to pigs sired by purebred boars. Crossbred boars do work well as terminal sires in terminal and rotaterminal programs. For instance, if Breed F is noted for superior postweaning performance and Breed G is superior for leanness, F₁ boars from crossing Breeds F and G would be more aggressive breeders and their progeny should be better than average for both postweaning performance and leanness. When choosing crossbred boars, evaluation of the parents is critical.

Parents of potential crossbred herd sires should rank in the top half of the herd for the traits of interest. If they do not, then progeny sired by crossbred boars, from inferior parents, will only benefit from having sires and dams of different breeding (100% heterosis), not from having above average genetic merit.



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