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Terminal and Rotaterminal Crossbreeding Systems for Pork Producers

By Ronald O. Bates, Department of Animal Sciences

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Crossbreeding is a widely established management practice among commercial pork producers. Over the years, the industry has used rotational crossbreeding programs extensively. 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.

	Percent of each breed		
Breed of sire	A	B	C
A	57	28	14
B	14	57	28
C	28	14	57

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

Terminal programs

Terminal programs are programs that concentrate on using 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 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.

Breed	Conception rate	Litter size raised	21-day weight	Age at 220 lbs.	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.

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 use specialized breeds or breed

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

Trait	Female breed crosses: Yorkshire-Landrace	Chester White-Landrace	Chester White-Yorkshire
Number born alive	9.2	9.8	10.1
At 21 days	8.1[b]	8.4[c]	8.5[c]
At 65 days	7.8	8.1	8.0
Litter birth wt., lbs.	32.1	34.3	32.3
Wt., 21 days, lbs.	93.1	96.4	91.6
Wt., 56 days, lbs.	260.3	272.4	255.2

[a] Adapted from Kuhlers et al., 1988. JAS 66:1132.

[b, c] Means in a row with different superscripts differ (P < 0.10).

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-Yorkshire
Number born alive	11.0	11.1	11.0
At 21 days	8.9	9.1	9.2
At 56 days	8.8	8.8	9.0
Litter birth wt., lbs.	34.3	39.8	35.6
Wt. at 21 days, lbs.	98.8	103.8	104.9
Wt. at 56 days, lbs.	279.4	292.6	284.2

[a] Adapted from Kuhlers et al., 1989. JAS 67:920.

crosses. Unfortunately, developing replacement females becomes more complex. Replacement gilts have to be purchased or small nucleus herds must be maintained to produce the first cross or F_1 females. If females are purchased, out-of-pocket costs increase as well as health risks. 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 rise.

However, if you're buying replacement gilts from a seedstock supplier who follows a rigid herd health program, you can routinely add purchased gilts to the herd with little health risk. To further secure health status, develop a health agreement with the seller before the transaction is final.

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 often is 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 to 20 percent) 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 F_1 gilts of maternal breeding are purchased for the Grandmother Option.

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 to 20 percent) of the sow herd to produce replacement females. The breeds used in the rotation program should excel in maternal characteristics.

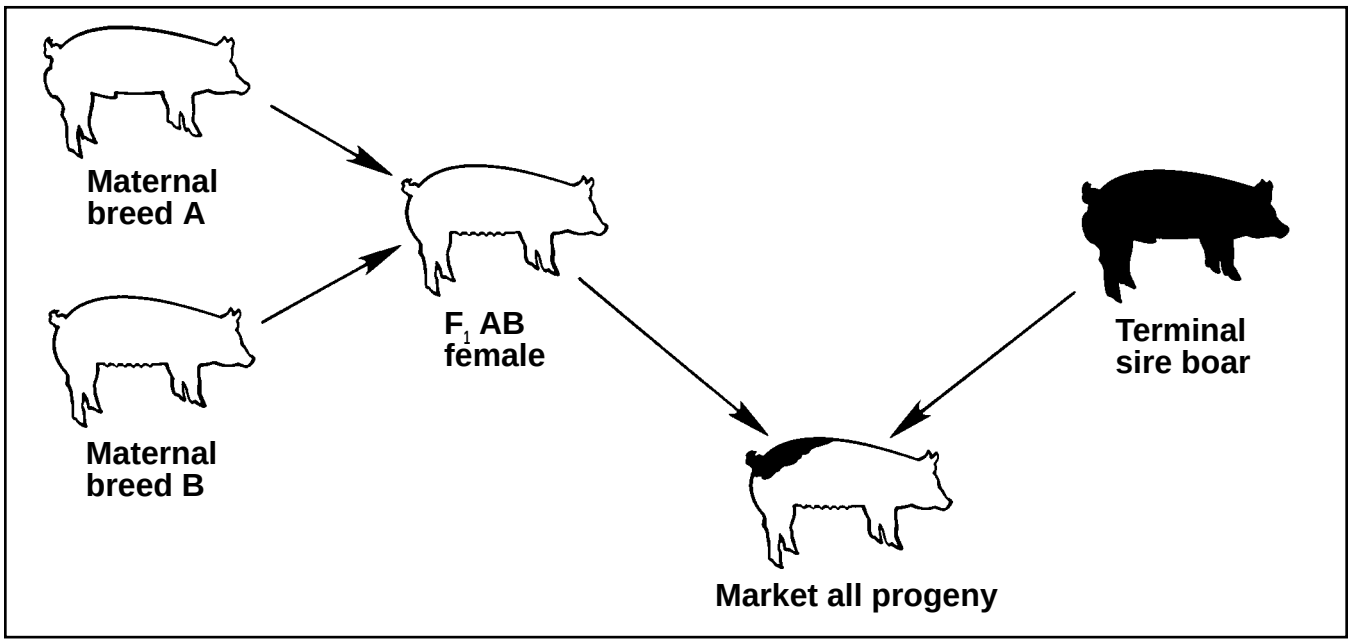

Figure 1. Terminal crossbreeding program. A terminal crossbreeding program uses F_1 females and terminal sire boars to produce market hogs.

The majority (80 to 85 percent) of the sow herd is mated to boars of breeds or breed crosses that are superior in postweaning and carcass characteristics. More than 90 percent of the market offspring are sired by terminal boars and express 100 percent heterosis because their sire is of different breeding than that of their dams. Only a small portion of the market offspring comes from the maternal rotation because 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).

Table 5. Heterosis of rotaterminal crossbreeding programs.

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

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 use 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 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 used may not overcome breed differences.

	Purebred averages			
Trait	**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

	Expected performance		
Program	**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

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.

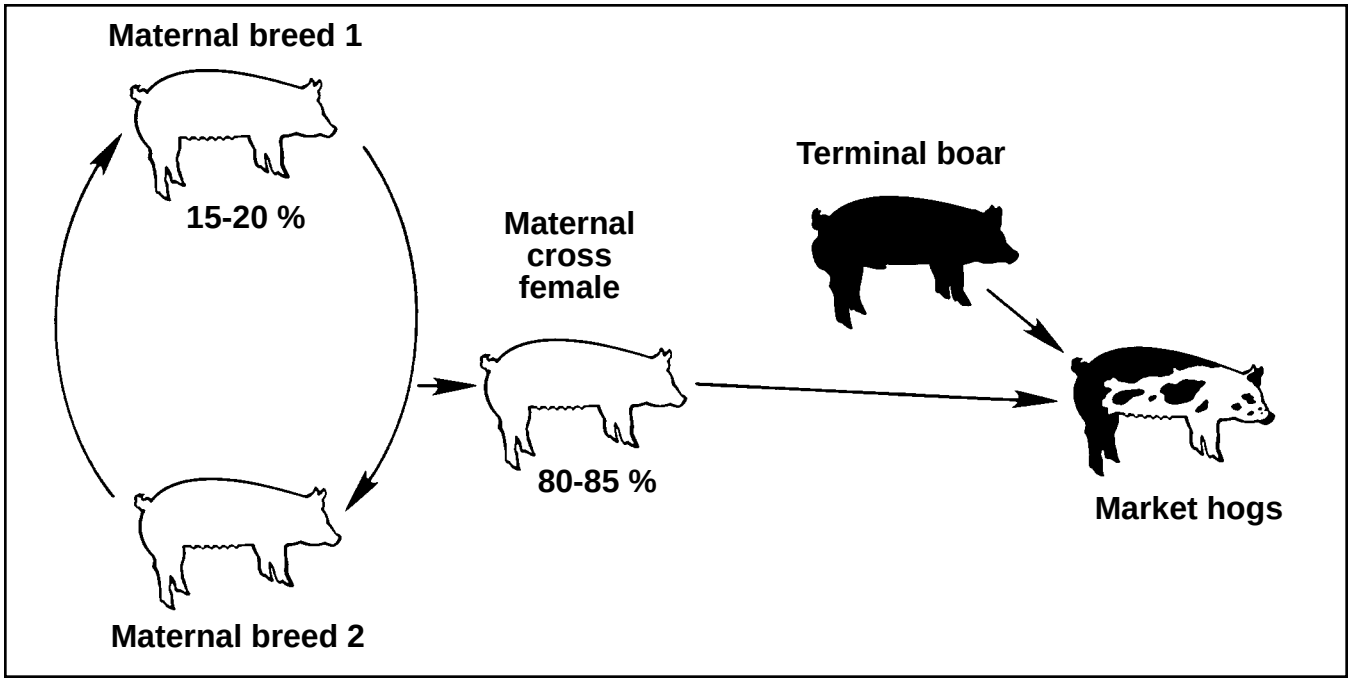

Figure 2. Rotaterminal crossbreeding program. A rotational crossbreeding program using maternal breeds is conducted on a small (15 to 20 percent) portion of the sow herd to produce replacement gilts. The majority (80 to 85 percent) of the sow herd is bred to terminal sire boars to produce market hogs.

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 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 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.

The use of crossbred boars often has 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, F_1 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, evaluating 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 percent heterosis), not from having above-average genetic merit.

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