CROSSBREEDING SYSTEM FOR THE 80'S AND BEYOND

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Crossbreeding has been a routine practice for market hog production for 40 years in this country. The choices of breeds and systems are part of the genetic arsenal available to pork producers to keep production profitable. However, the last ten years have been muddy water times with respect to crossbreeding systems. We produce pigs differently, pay much higher interest and have a broader range of seedstock sources than we did ten years ago. The time has come to put our breeding systems in order.

The talk of the trade is crossbred boars, Landrace, sow productivity indexes, computers, white sows and an occasional optimistic voice suggesting "merit" buying. The time is ripe to make sense out of the breeding system talk. The time is now to adopt the genetic technology available to us. It's a matter of being in or out of business for commercial pork producers.

The performance and economic value of a crossbreeding system are affected by many things. Breed choice and heterosis level are primary. With many traits affecting production value and many particular crossbreeding systems to choose from, sorting out the advantages is difficult and tedious. In attempting to come to grips with the various factors, we have developed a computer program which predicts the performance of crosses and estimates an economic outcome. This allows us to compare the economic value of various crossbreeding systems.

Breed Values

There is little question that breeds are different. Some are better in littersize than others, some grow faster or are leaner or use less feed. While each breed has its ardent supporters, no breed is blessed with the best of everything. Each breed has advantages and disadvantages. In general, rotational crossbreeding systems average the breeds used, while terminal crossbreeding systems can exploit the advantages and minimize the disadvantages of breeds.

In the comparisons reported here, the Hampshire, Duroc, Yorkshire and Landrace breeds are utilized. Four breeds are required to construct the interesting systems for comparison. These are the four breeds with adequate research based evaluations to make reasonable performance inferences. The breed averages presented in table 1 were used as inputs in the system comparisons.

Heterosis

Heterosis is hybrid vigor. Heterosis is the superiority of the crossbreed compared to the breeds crossed. Some traits exhibit large heterosis levels, others little or none. Pig survival and vigor, and

growth rate are improved by crossbreeding. Crossbred sows farrow and wean larger litters. However, carcass traits are unaffected and feed efficiency is only slightly improved. Crossbred sows have a small advantage in conception rate.

Crossbreeding systems vary in the level of heterosis expressed by sows and by pigs. The heterosis level depends upon the degree that the same breeds are represented in both parents. If the breed composition of a sow is completely different than the breed composition of the boar, their offspring would be expected to have 100% heterosis. If a half Duroc sow is bred to a Duroc boar, a 50% heterosis level is expected. In the comparisons of crossbreeding systems reported here, the heterosis level of the sire, dam and offspring are considered along with the importance of heterosis for each trait.

Expected Performance

Expected performance levels are calculated each generation based upon the breed composition of the cross, the breed averages (table 1), the heterosis levels in the boar, sow and offspring and heterosis effect for each trait. Conception rate considers sow and boar heterosis and sow breed. Littersize born is based on sow breed and heterosis. Pig survival takes into account the breed composition and heterosis of both the sow and pig. Littersize weaned is estimated by multiplying littersize born by pig survival. Age at market, fat thickness and feedlot efficiency are based upon offspring breed and heterosis.

Economic Outcome

Projected economic outcomes for crosses were made using the rules in table 2. The rules for economic projections are the method of weighing one trait against another. How much is another pig worth per litter or how much is faster gain worth?

Economic conditions do change, and often rapidly. I have chosen to leave the economic setup the same since January of 1981. I know that hogs are worth more now than then, but I prefer using the standard comparison for decision making. With this system, production costs at the base line levels (80% conception, 7.5 pigs weaned per litter, 180 days to market, 3.5 F/G from 40 to 220 lb and 7¢ feed) are about 44¢ per lb. Selling for 45¢ is just better than breaking even.

I have chosen to base the projections on a unit of 100 litters. In this way, the costs of reduced conception rates come as keeping more sows, rather than through empty farrowing crates and unused pig capacity.

Crossbreeding Systems

We have historically thought about rotational crossbreeding systems and terminal crossbreeding systems. The rotational crosses were generally preferred. Since we've put a man on the moon, we've become more interested in terminal crosses. In 1982 we generally

recommend terminal crosses. The kind of crossbreeding systems analysis that I am reporting here finally gave us a reasonable method for comparing the systems.

In table 3 are listed a whole set of crossbreeding systems. The table shows matings, heterosis levels, expected performance and economic outcomes. They are grouped into systems which are self-contained (purchased or AI boars only). Individual lines are given as well as weighted averages representing the system. The strategy with terminal crosses is to commit a maximum portion of production to highly productive matings needed to produce replacement gilts. The strategy of rotation crosses is to save replacement gilts from all crosses, rotating the breed of boar each generation. Consequently, all of the breeds used are used equally for market production and for sow production. The rotation crosses are general purpose crosses, the terminal crosses are specific, specialized crosses.

For comparison purposes and old times sake, I have included the Hampshire, Duroc, Yorkshire rotation as the first system. The expected performance and "profit" vary from generation to generation - the breeds are different and the composition changes. The system average is the average of the three generations.

The first terminal system is the four-breed cross using F_1 Yorkshire-Landrace sows. This appears to be the most productive system using these four breeds and this evaluation procedure. In the Oklahoma State University studies, the Yorkshire-Landrace F_1 female was far superior to any of the other crosses studied. Our projections are consistent with their results. The combination of the Yorkshires' large littersize at birth and the Landraces' ability to start and keep pigs coupled with the 100% heterosis level make this a superior cross. When we include a liberal number of the matings to produce all of the needed replacement females to make this system work, it projects a $3700 advantage over the H,D,Y rotation. That's a large difference. It's large enough to change the industry.

In all of the terminal crosses shown in table 3, I have used the Hampshire-Duroc F_1 crossbred boar. Research has shown that the crossbred boar leaves fewer sows open. In this system, that means about $5 per litter advantage. Hence, I routinely used this boar in the projections.

One might wonder why this discussion needs to go further. We've looked at the old standby and the four-breed terminal. As simple and compelling as the numbers and comparisons appear, there are additional considerations. It is not easy to produce purebred Yorkshires, Yorkshire-Landrace F_1's and the four-breed terminals on the same farm all at once together. Aren't there easier ways to do it? Yes, but at some cost. Some people fear that the Yorkshire-Landrace crossbred sow is not tough enough for their conditions. Can't we put something else in the sow to make her more durable? Yes, but at some cost. Can small hog farms take advantage of the terminal crosses? Yes, but some concessions may be necessary.

The remainder of table 3 is devoted to breeding stems which play out these themes.

The Yorkshire-Landrace based rotaterminal (3rd system) uses a two-breed rotation between Yorkshire and Landrace to produce replacement gilts. About 85% of the litters are terminal crosses. About 15% of the sows are bred to Yorkshire of Landrace to produce replacements. This system comes close to the F_1 sow system above it in the table. The terminal part isn't as good (less sow heterosis), but the sow producing part is considerably better and is a smaller proportion.

The next system (Y-L Grandsire) is similar in structure, but uses only one type of boar, a Yorkshire-Landrace F_1, to sire replacement gilts. Again, 85% of the litters are terminal matings, 15% to produce replacement gilts. This system retains only a 50% heterosis level in the sow herd which accounts for its reduced profitability. It is easier to operate because there is only one type of sow in the system and two types of boars. However, the price of reduced sow heterosis is about $5 per litter for each 10 points of heterosis.

There is a whole series of crossbreeding systems of this basic rotaterminal type. Each sow in the herd can be mated to produce either terminal market hogs or replacement gilts. Depending upon the breeds of boars and number of types of boars used to produce replacement gilts, the system has more or less maternal heterosis - generally 50% or more, but less than 100%.

Another general type of terminal system I call the one-way system. The F_1 sow system is of this type. Two others are shown in table 3, the Quarter Hampshire sow and the Quarter Duroc sow. With these one-way systems, offspring from matings at one level in the system always move to the next level. The specialized sows in the terminal cross of these systems are always mated to produce market hogs, never replacement gilts. Sows mated to produce replacement gilts are always mated to produce replacement gilts. With the rotaterminal systems, the sows can be mated to produce market hogs, or mated to produce replacement gilts. With the one-way systems each type of sow has a single purpose.

The Quarter Hampshire sow and Quarter Duroc sow systems are included to indicate the expected returns when some Hampshire or some Duroc is included in the sow ("to make them tougher"). On a system basis, they project out a $10-15 per litter disadvantage compared to the F_1 Y-L sow. I am not able to judge which is a better program for the tough conditions. There has been considerable interest expressed in these. The Quarter Landrace makes for quite a bit better sow than the Y-H or Y-D F_1. For my money, I'd make the conditions less tough and use the Y-L F_1.

Based upon the results of the crossbreeding systems analyzed here and upon reports from producers across the country who have installed them, terminal crosses appear to offer considerable economic advantages over rotational crosses. Terminal crosses provide for more advantageous use of breeds, exploiting their good points while diluting out

their weaknesses. Terminal crosses make heterosis control easier and attainment of higher heterosis levels possible. However, these advantages aren't exactly without cost. In many situations, particularly extensive production systems, rotational crosses are easier to manage. With intensive programs with continuous farrowing, terminal crosses are at least as easy as rotations. In a general way, the wide assortment of terminal cross systems provides opportunities to compromise heterosis level or breed inputs to make the most of farm conditions and objectives.

It appears to me that the advantage of terminal crosses is large enough that they will be used. Competitive forces will change the breeding systems within a short period of time. If a substantial number of producers choose the Y-L F_1 sow, the rest will be forced by economic pressure to follow suit. Many will choose a compromise system, but few will be happy with the straight rotation crosses. With the wide variety of terminals available, which system is an important decision. Commercial producers should reach for as much as they can handle. Systems which maximize returns for the chosen level of management are preferred.

One factor which appears critical in choice of system is sow herd size. It appears to me that with a 200 sow herd, a producer can work in any of the terminal systems, using natural mating and producing all of his own replacement gilts. The rotaterminal systems can operate with fewer sows. Using AI to sire sow mothers in the one-way systems or to sire sows in the rotaterminal systems reduces minimum herd size pressure. Reducing the proportion of terminal matings and increasing the proportion of replacement gilts producing matings reduces size pressure. The one-way systems can be bought into at any of the levels to work on smaller farms. For herds of less than 80 sows, buying the sows which produce market hogs is probably preferred. With intermediate sized farms, say 100 sows, buying the sow mother may be the route of choice. If buying into the system is the choice, then maximum heterosis and optimum breed choice (compromise only for substantial savings) are preferred.

Table 1. Breed Averages for Performance Traits Used in Analysis

Trait	Breed			
	Hampshire	Duroc	Yorkshire	Landrace
Conception	0.85	0.85	0.72	0.69
Litter size	9.00	9.60	10.80	10.00
Survival	0.66	0.66	0.72	0.84
Age, days	183.00	172.00	177.00	180.00
Fat, in.	1.00	1.20	1.20	1.40
F/G, lb.	3.30	3.33	3.35	3.60

Table 2. Rules for Budget Calculation

$300	Per litter of 7.5 pigs at 40 lb. Adjust at $5.00 per pig Based on 80% conception rate Adjust at $28 per open sow
	Non-feed costs during finishing Adjust at 5¢ per day (180 days to market)
$ 0.07	Cost per lb. of feed on 180 lb. gain
	Sale price per cwt. at 220 lb.

Compos					
3 Breed Rotation					
roc					$6
Te F1 Y-L Sow		50			
	25			091	80
Rotaterm nal Y-L Sow					
rksh				$7	
		86			43
G dh rg				$4	
					86
Termina Quarter Hamp Sow					
	100				
			30		80
Termina Quar er Duroc Sow					
	25	86	164		
					80