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Evaluation of the use of superior maternal sires in terminal crossbreeding systems

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The pork industry is becoming more intensively managed and competitive. Terminal crossbreeding systems, both specific crosses and rotaterminals, offer substantial benefits in terms of performance levels and profit per litter. Commercial producers operating terminal crossbreeding systems also can intensify their management, since the genetic composition of the sows and pigs are consistent.

In terminal crossbreeding systems, replacement gilts are produced in special matings. The high level of productivity experienced with gilts and sows from these special gilt-producing matings give the terminal crossbreeding systems their advantage. Operationally, the economical production of superior replacement gilts is the key to the success of terminal crosses. To further improve the profitability of terminal crossbreeding systems, commercial producers must evaluate alternative gilt replacement systems and use of superior A.I. sires.

A negative aspect of specific crossbreeding systems for mid-sized producers is the increased breeding cost of the maternal litters. For example, a 200 sow herd operating a rotaterminal crossbreeding system requires 66 maternal litters per year (15% of litters farrowed x 200 sows x 2.2 litters/year). At least two boars, one Yorkshire and one Landrace, are required to operate the crossbreeding system. With two maternal boars, each boar must sire only 33 litters per year at a cost of $35-$45 per litter. At current prices and considering that A.I. may require less time than natural service, the cost of artificial insemination with top maternal sires is less than or equal to the cost of using average natural service maternal sires.

To evaluate alternative crossbreeding systems, the expected performance levels and net returns were used from PIH-39, "Crossbreeding Systems for Commercial Pork Production." The base performance levels and system returns were used to describe the use of breed average sires. The mean values of STAGES (Swine Testing and Genetic Evaluation System) maternal line and terminal sire indexes were calculated for available superior and average sires (Table 1). Superior sires are the best 2-2.5% of sires for that index. Currently, superior Yorkshire sires have a 20 unit advantage for maternal line index (MLI) and a 30 unit advantage for terminal sire index (TSI). Currently, the advantage of superior Landrace sires is smaller, 7 MLI and 10 TSI index points. The advantage of superior Landrace sires will likely increase in the next 12 months as recently identified 116-120 MLI Landrace boars become available.

As a superior maternal sire is used, his first generation of progeny will be superior for growth, backfat and feed conversion. The advantage in postweaning traits can be estimated for the first generation as the TSI advantage of $.10 per pig per index unit x six pigs per litter that are produced and not selected as replacement gilts. The replacement gilts selected will then express a $1.00 economic advantage per litter farrowed for each MLI index point advantage for the sire. The genetic superiority of the maternal sires will be passed on to (and halved) each subsequent generation.

It was assumed that the commercial producer utilizes superior Yorkshire and Landrace sires for three generations. Consistent use of superior A.I. sires for three generations will result in substantial improvement in profitability.

In the case of specific crosses, it was assumed that Yorkshire gilts would be selected as either great-grandparents or grandparents with MLI index values 10 points above breed average.

Herds with weekly schedules should have lower replacement rates, and in those cases, specific crossbreeding systems would be advantageous. The system returns for a Hampshire-Duroc F1 boar, Yorkshire-Landrace F1 female specific cross are presented in Table 2. The returns from a specific crossbreeding system are highly dependent on the replacement rate. To determine the percent matings required at the grandparent and great-grandparent levels, assumptions must be made as to the replacement rate and the percent of available gilts selected at each level. With lower replacement rates, fewer gilt-producing matings are needed. Assuming a 25% replacement rate per litter farrowed and a 50% gilt selection rate_that is, 2.25 gilts selected per 4.5 gilts raised per litter_the percentages of matings needed of each cross are presented in Table 2. The weighted average for all three tiers, assuming no gilt replacement costs, is $99.98 per litter with average sires and $123.60 per litter using superior A.I. sires.

The question for commercial producers is which method of gilt replacement is more economical and practical? The great-grandparent program involves operating all three tiers. The grandparent program involves purchase of the grandparent gilts to produce the parent gilt. The third option is to purchase the parent gilt. Using typical prices, a 25% replacement rate per litter farrowed, and 50% gilt selection rate, the returns for the three options are in Table 3.

The most common option is for commercial producers to purchase Yorkshire-Landrace replacement gilts. The major issue in purchasing replacement gilts is the seedstock cost per litter, which is the cost of the gilts above market gilt price divided by the number of litters produced by each purchased female. Assuming a 25% replacement rate, average maternal purebred parents and an $80.00 F1 gilt cost above market price, the four breed terminal cross has a $27.96 per litter advantage over a Hampshire-Yorkshire-Duroc three breed rotation ($87.23 vs. $52.27, Table 3 and PIH-39). If superior maternal sires are used each generation, the net return of the 4 breed terminal cross increases $22.05 per litter. The second option is to develop a within-house gilt multiplication system. Great-grandparent programs involve the purchase of the maternal great-grandparent gilts which produce extra grandparent gilts. If Yorkshire-Landrace F1 gilts are produced, as in Table 2, the great-grandparent cross is the production of purebred Yorkshire gilts. The extra purebred Yorkshire gilts are bred to Landrace boars to produce the F1 Yorkshire-Landrace parent gilts. The third alternative system would be to purchase the grandparent Yorkshire gilts and mate them to purebred Landrace boars. Almost eight times more grandparent gilts will need to be purchased than great-grandparent gilts. In the long term, the great-grandparent systems result in the lowest gilt replacement cost. However, the great-grandparent systems also require the most intense management.

The use of superior maternal sires increases the profitability of specific crossbreeding systems regardless of the gilt production system used. It is important that both superior great-grandparent and grandparent sires, Yorkshire and Landrace in this example, be used. For commercial producers to realize maximum performance and profit levels, they must confirm that superior maternal sires are used at both tiers of multiplication.

Small producers with 12 or fewer groups of sows farrowing per year (farrowings monthly or less often) have high replacement rates due to increased sow culling as a result of open sows not fitting into the production schedule and potentially larger gilt pools. The most economical crossbreeding system for these producers is a rotaterminal. This uses Yorkshire and Landrace boars mated in a rotation to produce replacement gilts and terminal crosses in which terminal sires mated to the rotational cross females (Table 4). This system involves mating 15% of the rotational cross sows to maternal boars to produce replacement females. No replacement females need to be purchased. The use of artificial insemination with high indexing maternal sires improves the economic returns of a rotaterminal crossbreeding system by $25.42 per litter.

The use of known superior Yorkshire and Landrace sires in a rotaterminal crossbreeding system ($113.79, Table 4) has a $26.56 advantage over purchasing average YL F1 gilts ($87.23, Table 3). When F1 gilts are purchased which are also the result of using superior Yorkshire and Landrace sires, the economic returns of the rotaterminal and F1 specific crosses are approximately equal (113 versus 109 dollars).

The use of superior maternal sires can substantially increase pork producer profitability. The use of superior maternal sires on 12-15% of the total litters of a terminal crossbreeding system results in approximately a $25 advantage for the entire production system. If commercial producers decide to purchase parent replacement gilts, it is very important that the gilts are the result of mating superior maternal sires and dams. The $22.00/litter advantage of Yorkshire-Landrace F1 gilts produced through the use of superior maternal sires in comparison to average Yorkshire-Landrace F1 gilts is too large to be ignored. The advantage of using superior maternal sires is almost as great as the advantage of terminal crossbreeding systems versus rotational crossbreeding systems.

To remain competitive, pork producers should carefully evaluate alternative replacement options. Regardless of which gilt production system is implemented, superior maternal sires should be used based on maternal line indexes based on EPDs. STAGES EPDs are available from the breed associations, and on the World Wide Web at http://www.ansc.purdue.edu/stages/.

Table 1. Mean index values of superior and average Yorkshire and Landrace sires.*

	Yorkshire Sires		Landrace Sires	
	Average	Superior	Average	Superior
Maternal Line Index	110	130	105	112
Terminal Sire Index	110	140	105	115

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Table 2. Percent matings needed and system returns with breed average maternal sire and gilts versus superior A.I. sires.

			Dollar Return/Litter	
		% of Total	Average Sires	A.I. Sires and
Tier	Cross	Matings	and Gilts	Superior Gilts
Great-Grandparent	Y x Y	1.4	23.97	51.97
Grandparent	L x Y	11.0	51.53	87.53
Parent	HD x YL	87.6	107.28	129.28

System Average			99.98	123.60

Assumes 25% replacement rate.

Table 3. Returns with three gilt replacement systems and either average or superior parents.*

			A.I. Sires and +10 MLI			
Gilt Replacement System	Cost Above Market	Seedstock Cost/Litter	Average Sires and Gilts		Great-Grandparent Gilts	
			Gross Return/Litter	Net Return/Litter	Gross Return/Litter	Net Return/Litter
GG-parent	500	1.75	99.98	98.23	123.60	121.85
Grandparent	200	5.50	101.14	95.64	124.60	119.10
Parent	80	20.00	107.23	87.23	129.28	109.28

* Superior A.I. Yorkshire and Landrace sires used Yorkshire great-grandparent gilts with maternal line index values 10 units above breed average. Replacement rate of 25% is assumed.

Table 4. System average for a rotaterminal crossbreeding system using either average or superior A.I. sires.

		% Matings in	Average	A.I.	Net Return with
Sire	Dam	the System	Maternal Sires	Increase	A.I. Sires*
Landrace (L)	Y,L,Y	7.5	78.29	34.50	112.79
Yorkshire (Y)	L,Y,L	7.5	73.48	36.75	110.23
Hamp-Duroc	Y,L,Y	42.5	91.07	28.50	119.57
Hamp-Duroc	L,Y,L	42.5	90.07	18.75	108.82
System Average Net Return			88.37	25.42	113.79

* The A.I. sires are above breed average for the STAGES maternal line index, 20 index points for Yorkshires and 10 index points for Landrace. Replacement rate of 25% is assumed.