

REPRODUCTIVE PERFORMANCE FOR FOUR BREEDS OF SWINE: CROSSBRED FEMALES AND PUREBRED AND CROSSBRED BOARS¹

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Summary

Matings and litters were studied involving all three-breed crosses (sired by purebred boars) and four-breed crosses (sired by crossbred boars) from the Duroc, Yorkshire, Landrace and Spotted breeds. There were 764 female mating records and 161 boars used over five sequential breeding seasons. A sample of pregnant gilts was slaughtered each season and the remainder were allowed to carry their litters to term so that 493 litters resulted. Crossbred and purebred boars and crossbred females were evaluated for their contributions to conception rate (first service and over an 8-wk breeding season), number of services/conception, litter size and weight at birth, 21 and 42 d and survival rate to 21 and 42 d. Crossbred boars had a 17.9% higher first service conception rate, a 5.3% higher breeding season conception rate and performed .11 fewer services/conception compared with purebred boars. There were no significant differences among the boar breeding groups for litter size, weight or survival rate. The six crossbred female groups (reciprocal crosses were combined) did not differ significantly in conception rate or number of services/conception. There were significant differences in litter weight born and differences that approached significance ($P < .10$) for litter size at 42 d and litter weight at 21 d. Yorkshire-Landrace females had the largest litters

at birth, 21 and 42 d and the heaviest litters at 21 and 42 d. The smallest litters at 21 and 42 d were from Yorkshire-Spotted females, and they also had the highest weight litters at all three stages.

(Key Words: Crossbred Boars, Conception Rate, Sow Productivity.)

Introduction

Production efficiency in a commercial swine enterprise is partially dependent upon reproductive performance. There is considerable evidence that the choice of breeds and the structure of the breeding program have large impacts on reproductive efficiency (Johnson, 1980). The advantage of a crossbred female is clear, but there has been less research concerning the use of crossbred boars. Studies on young crossbred boars have generally shown an advantage in testis weight, mating behavior and conception rate (Hauser et al., 1952; Lishman et al., 1975; Wilson et al., 1977; Conlon and Kennedy, 1978; Neely et al., 1980), but more information is needed. There is also less information on the performance of the Landrace and Spotted breeds than for Durocs, Yorkshires or Hampshires.

This study was designed to evaluate the Duroc, Yorkshire, Landrace and Spotted breeds for producing crossbred females and to compare the reproductive performance of purebred and crossbred boars of these four breeds.

Materials and Methods

Purebred and two-breed cross litters involving the Duroc, Yorkshire, Spotted and Landrace breeds were produced at the Stillwater Swine Farm of Oklahoma State University during five farrowing seasons (fall and spring) beginning in the fall of 1976. Herd foundation and management were discussed previously (Hutchens et al., 1982).

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Unthrifty pigs were culled at weaning and one remaining male/litter was selected randomly to be castrated. Following completion of the finishing period, boars and gilts with obvious difficulty in walking were culled. All remaining gilts and a random sample of each type of purebred and crossbred boar were moved to the Southwest Livestock and Forage Research Station, El Reno, Oklahoma. There were representatives of each reciprocal cross but reciprocal crosses were combined for all subsequent analyses.

Crossbred females were hand-mated during an 8-wk breeding season to a purebred or crossbred boar from breeds unlike her own. Boars that showed no interest in mounting during three exposures to an estrous gilt were replaced with an alternate boar. Boars that mounted and mated were not replaced during the breeding period. Females that did not conceive to the matings during the first estrus expressed during the breeding period were remated to the same boar at each subsequent estrus. All females that did not conceive the first mating had an opportunity to express at least one more estrus. Several females were mated during each of three estrous periods, and on rare occasions females were mated during each of four estrous periods. Females were mated on the day that they were first observed in estrus and on each successive day that they would stand for a boar. Teaser boars were used to aid in estrous detection.

All possible three-breed cross (sired by purebred boars) and four-breed cross (sired by crossbred boars) litters were produced. This procedure was followed for five breeding seasons beginning in the spring of 1977. Only gilts were mated during the first breeding season, but a random sample of sows was retained for each of the following seasons. For statistical analyses, all sows were included in a single parity group. There were 764 female mating records (556 gilts and 208 sows) and 161 boars. A sample of gilts was slaughtered before farrowing so that 493 litters resulted, and the slaughtered gilts were only used to evaluate conception rate and services/conception.

Litters were born in a farrowing house with individual farrowing crates with wood slatted floors. They were moved into concrete floor nursery pens 3 to 7 d postfarrowing. Creep feed was provided at about 14 d, the male pigs were castrated at 21 d and the

sows were removed from the litters at 42 d.

Traits Measured. Conception rate was determined for first service and for the 8-wk breeding season by scoring the matings that resulted in a pregnancy with a one and those that did not with a zero. The number of services required for each conception was also measured.

Litter size and weight were measured at birth, 21 and 42 d. All fully formed pigs were counted and weighed at birth and all live pigs at 21 and 42 d were included. Survival rate to 21 and 42 d was the number of live pigs divided by the number of fully formed pigs at birth.

Data Analyses. Conception rate and number of services/conception were analyzed by ordinary least-squares. The model included the effects of season, parity, breed of dam, breed of sire nested within breed of dam, the interactions of breed of dam with parity, breed of dam with season and breed of sire within breed of dam with season and the partial regression on the female's weight at first mating. Separate regressions for gilts and sows were included because preliminary analyses indicated that the effect of female breeding weight was different for the two age classifications. Other two-way interactions were excluded based upon results of preliminary analyses ($P > .20$). These data were not normally distributed but satisfied the sample size requirements for analysis of discrete data with least-squares procedures (Harvey, 1982a). The effects of sires and dams were not included in the analyses, which may have led to downward bias in standard errors associated with the least-squares means for the breed groups.

The sums of squares for breed of sire within breed of data were divided into 12 single degree of freedom comparisons. For each of the six breeds of dam the crossbred boars were compared with the average of the purebred boars, and the two breeds of purebred boars were compared with each other.

Litter size and weight and survival rate were analyzed by generalized least-squares procedures. Fixed effects included season, parity, breed of dam, breed of sire nested within breed of dam and the interaction of breed of dam with parity. The effect of sire within breed of sire and season was treated as random by adding the ratio of the error

and sire components of variance. Then sires were absorbed. If the variance components are known, the solutions are generalized least-squares estimates of the fixed effects (Harvey, 1982b). Because there were few estimates in the literature, variance components were estimated from these data. The dam's weight when she conceived was included as a single covariate. Other two-way interactions were tested in preliminary analyses and were excluded ($P > .20$). There were some repeated records on dams that were not accounted for in the analyses. This may have led to some downward bias in the standard errors for the fixed effects.

Results and Discussion

Conception Rate and Services per Conception. Breeding season was a significant source

of variation for first service conception rate, conception rate during the 8-wk breeding season and the number of services/conception. The main effects of parity and the crossbred group of the female did not significantly affect these traits, but the breed group of the boar, nested within the crossbred group of the female, was a significant source of variation for all three traits. The interactions of breeding season with both crossbred group of female and breed group of boar within crossbred group of female significantly affected both first service conception rate and number of services/conception. The interaction of parity with crossbred group of female was a significant source of variation for conception rate during the entire breeding season and approached significance ($P < .10$) for first service conception rate.

TABLE 1. LEAST-SQUARES MEANS FOR REPRODUCTIVE PERFORMANCE OF PUREBRED AND CROSSBRED BOARS MATED TO CROSSBRED FEMALES

Crossbred group of female	Breed group of boar ^a	No. ^b	Conception rate (%)		No. of services/ conception
			First service	Breeding season ^c	
Duroc-Yorkshire	Landrace	32	64.1	83.4	1.27
	Landrace-Spotted	46	86.1	93.7	1.09
	Spotted	37	67.5	93.0	1.33
	Average	115	72.5	90.0	1.23
Duroc-Landrace	Yorkshire	41	72.4	97.0	1.25
	Yorkshire-Spotted	58	81.5	96.3	1.16
	Spotted	41	78.9	92.2	1.16
	Average	140	77.6	95.2	1.19
Duroc-Spotted	Yorkshire	40	74.8	95.1	1.28
	Yorkshire-Landrace	56	76.1	93.6	1.20
	Landrace	42	60.4	90.0	1.36
	Average	138	70.4	92.8	1.28
Yorkshire-Landrace	Duroc	35	71.2	87.3	1.20
	Duroc-Spotted	50	85.9	99.4	1.16
	Spotted	34	83.2	89.2	1.09
	Average	119	80.1	91.9	1.15
Yorkshire-Spotted	Duroc	38	66.9	96.5	1.30
	Duroc-Landrace	49	89.7	98.9	1.09
	Landrace	37	78.4	95.5	1.23
	Average	124	78.3	97.0	1.21
Landrace-Spotted	Duroc	41	84.2	91.8	1.09
	Duroc-Yorkshire	50	92.2	96.0	1.05
	Yorkshire	37	67.3	87.5	1.28
	Average	128	81.2	91.8	1.14
Standard error (range)	Individual breed group		5.86-7.52	3.60-4.63	.059-.084
	Averages		3.89-4.11	2.39-2.71	.042-.047

^aThere were 15 to 18 boars in each breed group.

^bNumber of females available for breeding.

^cBreeding season was 8 wk.

TABLE 2. LEAST-SQUARES MEANS FOR CONCEPTION RATES OF CROSSBRED GILTS AND SOWS

Crossbred group of female	Conception rate (%) ^a			
	First service		Breeding season ^b	
	Gilt ^c	Sow ^d	Gilt	Sow
Duroc-Yorkshire	84.2	60.9	97.1	83.0
Duroc-Landrace	77.7	77.5	95.1	95.3
Duroc-Spotted	80.1	60.7	93.3	92.3
Yorkshire-Landrace	75.4	84.8	84.9	99.0
Yorkshire-Spotted	80.0	76.7	93.4	100.0
Landrace-Spotted	81.6	80.8	96.0	87.5

^aStandard errors ranged from 3.95 to 7.78 for first service and from 2.43 to 4.81 for breeding season conception rate.

^bBreeding season was 8 wk.

^cFirst parity females.

^dAny parity greater than or equal to second.

Breed group of boar and crossbred group of female least-squares means for conception rate and services/conception are presented in table 1 along with the number of attempted matings for each breed group combination. Differences among the female crossbred groups were not significant for any of the traits. The ranges for the female groups were 70.4 (Duroc-Spotted) to 81.2% (Landrace-Spotted) for first service conception rate, 90.0 (Duroc-Yorkshire) to 97.0% (Yorkshire-Spotted) for overall conception rate and 1.14 (Landrace-Spotted) to 1.28 (Duroc-Spotted) for services/conception. Other studies also have not found significant conception rate differences among types of crossbred females (Holtmann et al., 1975; Drewry, 1980).

The interaction of breeding season with crossbred group of the female was significant for both first service conception rate and number of services/conception. Examination of the means revealed no consistent pattern. The ranking of the female crossbred groups varied widely from season-to-season. The interaction of parity with crossbred group of the female (table 2) resulted from Duroc-Yorkshire and Duroc-Spotted gilts having substantially higher first service conception rates than the same groups as sows, while Yorkshire-Landrace gilts had lower first service conception rates than Yorkshire-Landrace sows. Yorkshire-Landrace females also had lower conception rates for the entire breeding season as gilts while Duroc-Yorkshire and Landrace-Spotted females had lower conception rates as sows.

Comparisons among breed groups of boar for first service conception rate are shown in table 3. Crossbred boars were superior to the average of the constituent purebreds for first service conception rate in all six comparisons. The advantage was significant for Landrace-Spotted, Duroc-Landrace and Duroc-Yorkshire crossbred boars. The average paternal or boar heterosis for first service conception rate was 17.9%. Two of the comparisons between purebred boars approached significance ($P < .10$). Landrace boars were superior to Yorkshire boars when mated to Duroc-Spotted females (74.8 vs 60.4%) and Yorkshire boars were superior to Duroc boars when mated to Landrace-Spotted females (84.2 vs 67.3%). Conversely, the direct comparison involving Duroc and Landrace boars favored the Duroc, although the difference was not significant.

TABLE 3. COMPARISONS AMONG SIRE BREED GROUPS FOR FIRST SERVICE CONCEPTION RATE PERCENTAGE

Crossbred group of female	Crossbred-purebred ^a	Purebred 1-purebred 2
Duroc-Yorkshire	LS-1/2(L+S) 20.3 ± 7.6**	L-S 3.4 ± 9.6
Duroc-Landrace	YS-1/2(Y+S) 5.8 ± 6.7	Y-S 6.5 ± 8.6
Duroc-Spotted	YL-1/2(Y+L) 8.5 ± 6.8	Y-L -14.3 ± 8.7 [†]
Yorkshire-Landrace	DS-1/2(D+S) 8.7 ± 7.4	D-S 11.9 ± 9.9
Yorkshire-Spotted	DL-1/2(D+L) 17.0 ± 7.3*	D-L 11.5 ± 9.2
Landrace-Spotted	DY-1/2(D+Y) 16.5 ± 7.1*	D-Y -16.8 ± 8.8 [†]

^aL = Landrace, S = Spotted, Y = Yorkshire, D = Duroc.

[†] $P < .10$.

* $P < .05$.

** $P < .01$.

TABLE 4. COMPARISONS AMONG SIRE BREED GROUPS FOR CONCEPTION RATE PERCENTAGE DURING AN 8-WEEK BREEDING SEASON

Crossbred group of female	Crossbred-purebred ^a		Purebred 1-purebred 2	
Duroc-Yorkshire	LS-1/2(L+S)	5.5 ± 4.7	L-S	9.6 ± 5.9 [†]
Duroc-Landrace	YS-1/2(Y+S)	1.7 ± 4.2	Y-S	-4.7 ± 5.3
Duroc-Spotted	YL-1/2(Y+L)	1.2 ± 4.2	Y-L	-5.5 ± 5.3
Yorkshire-Landrace	DS-1/2(D+S)	11.1 ± 4.6*	D-S	1.9 ± 6.1
Yorkshire-Spotted	DL-1/2(D+L)	2.9 ± 4.5	D-L	-1.0 ± 5.7
Landrace-Spotted	DY-1/2(D+Y)	6.4 ± 4.4	D-Y	-4.3 ± 5.4

^aL = Landrace, S = Spotted, Y = Yorkshire, D = Duroc.

[†]P < .10.

*P < .05.

The advantage in conception rate from using crossbred boars was less when the entire 8-wk breeding season was evaluated (table 4). Duroc-Spotted boars were significantly superior to Duroc and Spotted purebreds, and the average heterosis for all breeds was 5.33%. Despite the reduction, the crossbred boars were superior to the average of the purebred boars in all six comparisons. Use of Landrace boars resulted in a higher conception rate compared with each of the other breeds, although differences were not significant.

The number of services/conception provides an additional measure of a boar's breeding efficiency. Certain females may be unable or very slow to conceive due to problems that are unrelated to the boar. These could greatly affect the average conception rate, but would have a smaller effect on the number of services/conception. Except for the comparison involving Duroc, Spotted and Duroc-Spotted boars, the crossbred vs pure-

bred boar comparisons (table 5) were very similar to the corresponding comparisons for first service conception rate. Crossbred boars required .11 fewer services/conception than purebred boars. Duroc-Spotted boars were superior to the purebreds for first service conception rate but were slightly inferior for number of services/conception.

The interaction of breeding season and breed group of boar within crossbred group of female was significant for first service conception rate and number of services/conception. Despite the significant interaction, the crossbred boars were superior to the average of the purebred boars for 26 of the 30 breeding season by crossbred group of female combinations. There were numerous changes in rank between the two breeds of purebred boars and changes in magnitude of the crossbred boar advantage.

The advantage in conception rate when crossbred boars were used in natural service agreed with other reports (Wilson et al., 1977;

TABLE 5. COMPARISONS AMONG BREED GROUPS OF SIRE FOR NUMBER OF SERVICES PER CONCEPTION

Crossbred group of female	Crossbred-purebred ^a		Purebred 1-purebred 2	
Duroc-Yorkshire	LS-1/2(L+S)	-.211 ± .08**	L-S	.063 ± .10
Duroc-Landrace	YS-1/2(Y+S)	-.042 ± .07	Y-S	-.097 ± .09
Duroc-Spotted	YL-1/2(Y+L)	-.124 ± .07 [†]	Y-L	.081 ± .09
Yorkshire-Landrace	DS-1/2(D+S)	.019 ± .08	D-S	-.076 ± .10
Yorkshire-Spotted	DL-1/2(D+L)	-.179 ± .08	D-L	-.076 ± .10
Landrace-Spotted	DY-1/2(D+Y)	-.140 ± .07 [†]	D-Y	.193 ± .09*

^aL = Landrace, S = Spotted, Y = Yorkshire, D = Duroc.

[†]P < .10.

*P < .05.

**P < .01.

Anderson et al., 1981). Conlon and Kennedy (1978) used semen from purebred and crossbred boars to artificially breed gilts and showed a very small crossbred boar advantage in conception rate. The advantage in first service conception rate may have resulted from the crossbred boars being more mature sexually despite being similar in actual age. If so, the reduced advantage for the entire breeding season is not surprising because the purebred boars would have matured during the 8 wk of breeding. More advanced sexual maturity (measured by testis weight and sperm numbers) in crossbred boars has been demonstrated by several studies (Hauser et al., 1952; Wilson et al., 1977; Fent, 1980; Neely et al., 1980).

Litter Size, Litter Weight and Survival Rate. Breeding season was a significant source

of variation for litter weight at birth, 21 and 42 d. Parity had a significant effect on all litter size, weight and survival traits measured except litter size at birth. Crossbred group of the dam affected ($P < .05$) litter weight at birth and had an effect that approached significance ($P < .10$) for litter size at 42 d and litter weight at 21 d. Breed group of the sire, nested within crossbred group of the dam, did not significantly affect any of the litter traits. The interaction of parity with crossbred group of the dam had a significant effect only on litter size at birth.

The crossbred group generalized least-squares means for litter size and the number of litters in each group are shown in table 6. Yorkshire-Landrace females had the largest litters at all three stages (10.34, 8.39, 8.30 at birth, 21 and 42 d, respectively) while

TABLE 6. GENERALIZED LEAST-SQUARES MEANS FOR LITTER SIZE FROM CROSSBRED FEMALES MATED TO PUREBRED AND CROSSBRED BOARS

Crossbred group of female	Breed group of boar ^a	No. ^b	Litter size		
			Birth ^c	21 d ^d	42 d ^d
Duroc-Yorkshire	Landrace	20	10.34	8.03	7.83
	Landrace-Spotted	29	10.17	7.96	7.85
	Spotted	27	9.88	7.71	7.56
	Average	76	10.13	7.90	7.74
Duroc-Landrace	Yorkshire	29	10.52	8.20	7.94
	Yorkshire-Spotted	37	10.12	8.07	7.94
	Spotted	27	9.88	8.10	7.88
	Average	93	10.18	8.13	7.92
Duroc-Spotted	Yorkshire	25	9.22	6.87	6.84
	Yorkshire-Landrace	34	10.52	7.73	7.67
	Landrace	25	10.39	8.19	8.09
	Average	84	10.04	7.60	7.53
Yorkshire-Landrace	Duroc	22	10.50	8.45	8.32
	Duroc-Spotted	34	10.31	8.16	8.10
	Spotted	23	10.23	8.57	8.48
	Average	79	10.34	8.39	8.30
Yorkshire-Spotted	Duroc	26	9.33	7.34	7.11
	Duroc-Landrace	31	10.25	7.01	6.77
	Landrace	23	10.00	7.75	7.51
	Average	80	9.86	7.37	7.13
Landrace-Spotted	Duroc	29	9.88	8.09	7.84
	Duroc-Yorkshire	29	9.65	7.63	7.44
	Yorkshire	23	9.88	8.02	7.87
	Average	81	9.80	7.91	7.72
Standard error (range)	Individual breed groups		.47-.59	.40-.55	.40-.55
	Averages		.31-.37	.28-.31	.28-.34

^aThere were 15 to 18 boars in each breed group.

^bNumber of litters.

^cNumber of fully formed pigs.

^dNumber of live pigs.

TABLE 7. GENERALIZED LEAST-SQUARES MEANS FOR LITTER SIZE AT BIRTH OF CROSSBRED GILTS AND SOWS

Female crossbred group	Litter size at birth ^a	
	Gilt	Sow
Duroc-Yorkshire	10.56	9.69
Duroc-Landrace	9.50	10.85
Duroc-Spotted	9.60	10.49
Yorkshire-Landrace	10.64	10.04
Yorkshire-Spotted	10.00	9.73
Landrace-Spotted	9.61	10.00

^aStandard errors ranged from .361 to .542.

Landrace-Spotted females had the smallest litters at birth (9.80 pigs) and Yorkshire-Spotted females had the smallest litters at 21 and 42 d (7.37 and 7.13 pigs). The interaction of parity with crossbred group of dam was significant for litter size at birth (table 7). This interaction resulted from gilt

litters being larger from Duroc-Yorkshire, Yorkshire-Landrace and Yorkshire-Spotted females while sow litters were larger from the other three breed groups. Among gilts, Yorkshire-Landrace females had the largest litters (10.64 pigs) and Duroc-Landrace females had the smallest litters (9.50 pigs). However, for sows, the largest litters were from Duroc-Landrace females (10.85 pigs) and the smallest were from Duroc-Yorkshire females (9.69 pigs).

Crossbred boars sired litters that were, on the average, .17 pigs larger at birth, .18 pigs smaller at 21 d and .14 pigs smaller at 42 d than litters sired by the corresponding purebred boars. These differences did not approach significance ($P > .40$).

Crossbred group generalized least-squares means for litter weight traits are shown in table 8. Duroc-Landrace females had the heaviest litters at birth (14.6 kg). Litters from Yorkshire-Landrace females were the

TABLE 8. GENERALIZED LEAST-SQUARES MEANS FOR LITTER WEIGHT FROM CROSSBRED FEMALES MATED TO PUREBRED AND CROSSBRED BOARS

Crossbred group of female	Breed group of boar	Litter weight (kg)		
		Birth ^a	21 d ^b	42 d ^b
Duroc-Yorkshire	Landrace	14.68	43.01	94.68
	Landrace-Spotted	14.21	41.13	89.00
	Spotted	13.96	39.88	85.40
	Average	14.28	41.34	89.70
Duroc-Landrace	Yorkshire	14.55	40.23	87.47
	Yorkshire-Spotted	15.03	42.35	92.66
	Spotted	14.35	42.94	91.64
	Average	14.64	41.84	90.59
Duroc-Spotted	Yorkshire	13.25	37.18	82.15
	Yorkshire-Landrace	14.52	40.16	87.86
	Landrace	14.71	42.90	96.77
	Average	14.16	40.08	88.93
Yorkshire-Landrace	Duroc	14.54	44.89	93.69
	Duroc-Spotted	13.14	40.93	89.17
	Spotted	13.99	44.04	95.86
	Average	13.89	43.29	92.91
Yorkshire-Spotted	Duroc	11.98	38.89	84.35
	Duroc-Landrace	13.28	36.57	76.50
	Landrace	13.20	39.96	86.20
	Average	12.82	38.47	82.35
Landrace-Spotted	Duroc	13.67	42.12	89.01
	Duroc-Yorkshire	13.55	41.89	86.79
	Yorkshire	14.52	42.24	96.85
	Average	13.91	42.75	90.88
Standard error (range)	Individual breed groups	.55-.75	1.84-2.54	4.02-5.48
	Averages	.38-.46	1.32-1.60	2.77-3.36

^aWeight of all fully formed pigs.

^bWeight of all live pigs.

heaviest at 21 (43.3 kg) and 42 d (92.9 kg). Yorkshire-Spotted females had the highest weight litters at all three stages (12.8, 38.5 and 82.4 kg at birth, 21 d and 42 d, respectively). Litters sired by crossbred boars were .01 kg heavier at birth ($P>.90$) and 1.19 ($P>.20$) and 3.34 kg ($P>.10$) lighter weight at 21 and 42 d, respectively.

Litters from the three female crossbred groups that were one-half Landrace had slightly higher survival rates (table 9) than those from other female breeding groups (81.7 vs 78.0% at 21 d and 80.1 vs 76.5% at 42 d). These differences were not significant. Litters sired by crossbred boars had 2.7 and 2.4% lower ($P>.10$) survival rates to 21 and 42 d, respectively, than litters by purebred boars.

These results generally favor Yorkshire-Landrace females for traits associated with sow productivity. Other crossbred females that were one-half Landrace also performed well, particularly in traits measured at 21 and 42 d. This is in partial agreement with other

studies that included crossbred females that were one-half Landrace. Holtmann et al. (1975) reported increased litter size at birth and 21 d and heavier litters at 21 d from Yorkshire-Landrace females when they were compared with Duroc-Yorkshire and Duroc-Yorkshire females. Drewry (1980) showed an advantage in litter size and weight at both birth and 35 d for litters of Duroc-Yorkshire females when compared with Yorkshire-Landrace females. Kuhlers et al. (1981) compared the same two female crossbred groups and reported no significant differences in litter size, but pigs out of Duroc-Yorkshire dams were heavier. In another study, Kuhlers et al. (1982) found no significant differences in litter size when Duroc-Landrace and Spotted-Landrace females were compared, but Duroc-Landrace females had heavier litters at both 21 and 42 d.

Litter performance was relatively unaffected by the breed group of the sire. No change in litter size, when crossbred boars were used, has been reported elsewhere (Lishman et al.,

TABLE 9. GENERALIZED LEAST-SQUARES MEANS FOR SURVIVAL RATE OF LITTERS FROM CROSSBRED FEMALES MATED TO PUREBRED AND CROSSBRED BOARS

Crossbred group of female	Breed group of boar	Survival rate (%)	
		21 d	42 d
Duroc-Yorkshire	Landrace	79.62	77.81
	Landrace-Spotted	80.45	79.43
	Spotted	78.70	77.28
	Average	79.59	78.19
Duroc-Landrace	Yorkshire	80.32	78.01
	Yorkshire-Spotted	80.45	79.39
	Spotted	83.90	81.73
	Average	81.56	79.71
Duroc-Spotted	Yorkshire	77.20	76.84
	Yorkshire-Landrace	75.29	74.50
	Landrace	80.88	79.33
	Average	77.52	76.89
Yorkshire-Landrace	Duroc	80.55	79.60
	Duroc-Spotted	80.37	79.72
	Spotted	83.82	83.19
	Average	81.58	80.84
Yorkshire-Spotted	Duroc	80.45	78.07
	Duroc-Landrace	70.94	68.75
	Landrace	78.91	76.80
	Average	76.77	74.55
Landrace-Spotted	Duroc	82.16	79.66
	Duroc-Yorkshire	80.44	78.74
	Yorkshire	82.93	81.20
	Average	81.84	79.84
Standard error (range)	Individual breed groups	3.14-4.30	3.19-4.36
	Averages	2.23-2.71	2.26-2.74

1975; Fahmy and Holtmann, 1977; Conlon and Kennedy, 1978; Anderson et al., 1981). Wilson et al. (1977) did observe an increase in number of embryos 30 d postbreeding for litters sired by crossbred boars, but the differences were not significant.

The choices involving the breed or crossbred group of the boars and the sow herd were both important, but for different reasons. The sow's breeding had some impact upon the size and weight of the litter but, with these types of crossbred sows, had little effect on conception rate. The breeding of the boar had little effect on the litter traits but influenced the conception rate, particularly when crossbred boars were compared with purebred boars. When the traits were combined so that crosses could be compared for litter weight at 42 d per sow exposed during an 8-wk breeding period, the two best crosses were Duroc-Landrace females bred to Yorkshire-Spotted boars and Yorkshire-Landrace females bred to Duroc-Spotted boars (89.23 and 88.63 kg, respectively). These were also the two best crosses for litter weight at 21 d per sow exposed (40.78 and 40.68 kg, respectively). There was a small advantage for crossbred-sired litters for both litter weight per sow exposed during the 8-wk breeding season at 21 (2.77%) and 42 d (1.27%). For sows exposed to first service the crossbred boar advantage was larger (14.7 and 13.3% at 21 and 42 d, respectively).

These results provide direct evidence favoring the use of crossbred boars for commercial producers who breed a fixed number of females to young boars during a specified breeding season. They should expect a higher conception rate, particularly on first service. This will reduce the length of time before a gilt begins production and will reduce the length of time a sow is out of production between litters. Producers who maintain a gilt pool and have continuous farrowing should also benefit from using crossbred boars. They would not have to keep as many females in the gilt pool and still could keep their farrowing facilities full. These results do not provide any direct evidence concerning the use of more mature crossbred boars. Further studies should be conducted to determine if older crossbred boars continue to be more aggressive breeders or will remain in service longer, but if the advantages re-

ported here are just the result of crossbred boars reaching sexual maturity earlier, there may be little advantage for crossbred boars if older boars are used.

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