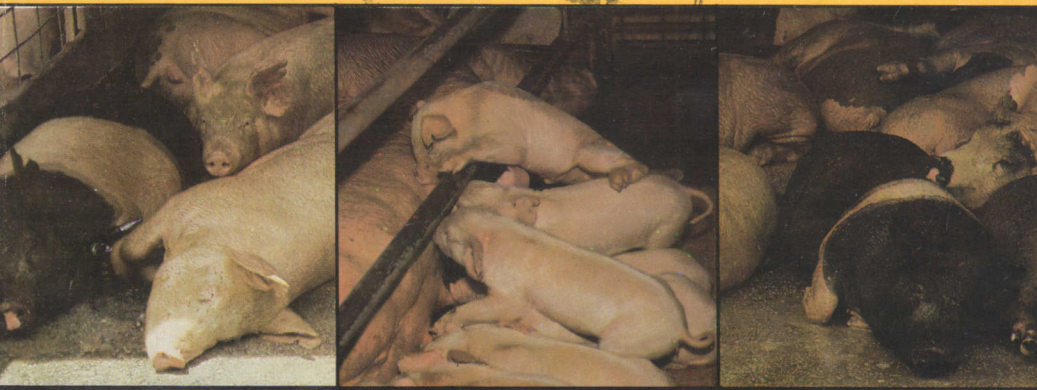
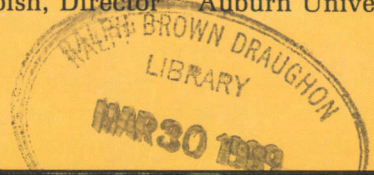


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Well T. Frobish, Director Auburn University, Alabama



**A Summary
of Swine
Crossbreeding
Research at
Auburn
University**

C O N T E N T S

	<i>Page</i>
GENERAL EXPERIMENTAL PROCEDURES	3
RESULTS OF BREED COMPARISONS	4
Landrace, Duroc-Landrace, and Yorkshire-Landrace Sows (Experiment 1)	4
Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace Sows (Experiment 2)	8
Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace Backcross Sows (Experiment 3)	11
Duroc-Landrace, Hampshire-Landrace, and Yorkshire- Landrace Sows Managed in Two Gestation Systems (Experiment 4)	13
Chester White Crossbred Sows and Yorkshire-Landrace Sows (Experiment 5)	18
Overall Rankings of Boar Breeds and Sows Breeds	22
SUMMARY	25

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*Information contained herein is available to all without
regard to race, color, sex, or national origin.*

A Summary of Swine Crossbreeding Research at Auburn University

STEVE B. JUNGST and DARYL KUHLETS¹

CCROSSBREEDING is a management practice that commercial swine producers can use to increase productivity of animals in the herd and hopefully increase profitability of the enterprise. Crossbred litters from purebred sows compared to purebred litters do not differ in the number of pigs farrowed, but crossbred litters have more pigs at 21 days of age. Crossbred pigs from purebred sows also obtain market weight in fewer days than purebred pigs. These differences are primarily due to individual heterosis effects. In addition, crossbred litters from crossbred sows have more pigs at birth and 21 days and the pigs obtain market weight at a younger age than crossbred pigs from purebred sows. Maternal heterosis is the reason for these differences in performance.

During the past 15 years, crossbreeding of swine has been a major research effort of geneticists in the United States and Canada. Researchers at Iowa State University, Oklahoma State University, Purdue University, and North Carolina State University, along with researchers at Auburn University, have contributed to this effort. Most of this work has dealt with attempting to identify superior F₁ crossbred sows. Results from the experiments conducted at Auburn University were not included in the North Central Region Publication (No. 262) entitled "Heterosis and Breed Effects in Swine." This publication summarizes crossbreeding studies completed at the Lower Coastal Plain and Upper Coastal Plain substations of the Alabama Agricultural Experiment Station, Auburn University.

GENERAL EXPERIMENTAL PROCEDURES

Five crossbreeding studies were conducted. In each, sows were produced at the substation and were not selected on reproductive or growth

¹Research Associate and Professor, respectively, of Animal and Dairy Sciences.

performance. There was a tendency to keep gilts with at least 13 functional teats. The sows were given the opportunity to farrow either three or four litters, depending on the study. Litters were not standardized at birth and milk replacers were not fed. Creep feed was provided when the litters were approximately 7 days old. Sows were culled only when a permanent injury occurred, such as a broken leg, or when conception failed to occur during the 6-week breeding period. Previous reproductive performance was not a basis for culling of sows from the herd. During the gestation period, each sow was fed 4 pounds of feed per day except during the winter months when each sow was fed 5 pounds per day.

Purebred boars used in these studies were purchased from purebred breeders located in the Southeast and Midwest regions of the United States. Selection of purebred boars was based on general condition, conformation, and soundness of feet and legs. No attempts were made to purchase performance tested boars; boars selected were considered to be representative of the breeds at that time. Boars used in a particular study were also selected to be unrelated to any of the other boars used in the study. One crossbreeding study used Farmers Hybrid boars that were purchased from sales centers located in Illinois, Indiana, and Missouri. The same selection criterion was used to purchase these boars as to purchase purebred boars. Age of the boars at first service was approximately 9 months, and the boars remained in the herd until they were approximately 15 months of age, at which time they were replaced with 9-month-old boars that had been purchased. Boars of each breed were replaced at the same time.

In this publication, the numbers of pigs born, born alive, and alive at 21 days are reported for each crossbreeding experiment. In three studies, the number of pigs alive at 42 days is presented because the number of pigs marketed from each litter was not recorded. In two studies, the number of pigs marketed was recorded. In addition, litter weights at birth and at 21 days of age are reported. Age at market weight, post-weaning average daily gain, post-weaning daily feed consumption, and feed efficiency are also summarized for each crossbreeding study.

RESULTS OF BREED COMPARISONS

Landrace, Duroc-Landrace, and Yorkshire-Landrace Sows (Experiment 1)

Four Duroc, five Hampshire, and eight Spot boars were bred in all possible combinations to Landrace, Duroc-Landrace, and Yorkshire-

Landrace sows. The 118 sows farrowed 3,438 pigs in 305 litters. Litter size and litter weight averages for boar breed, sow breed, and boar breed x sow breed combinations are presented in table 1 and table 2, respectively.

Litters sired by Duroc boars had 0.8 more live pigs at birth than Spot-sired litters. At 21 and 42 days after farrowing, Duroc-sired litters were 0.7 pig larger than Spot-sired litters and 1.2 and 1.4 pigs larger than Hampshire-sired litters. Hampshire-sired litters tended to have fewer pigs at these ages than Spot-sired litters. Litters sired by Hampshire boars weighed 2.66 and 6.72 pounds heavier than litters sired by Duroc and Spot boars, respectively, and Duroc-sired litters were 4.06 pounds heavier than litters sired by Spot boars. Duroc-sired litters weighed heavier at 21 days than litters sired by either Hampshire or Spot boars. Days required to obtain market weight by Hampshire-sired pigs was 5.3 days less than for pigs sired by Spot boars, table 3. Duroc-sired pigs were intermediate and did not obtain market weight at a significantly different age than pigs sired by the other two breeds of boars. In the post-weaning growth period, Spot-sired pigs grew 0.06 pound per day slower than pigs sired by Duroc and Hampshire boars. Duroc-sired pigs

TABLE 1. LITTER SIZE AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING LANDRACE, DUROC-LANDRACE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 1)

Breed	Litters farrowed	Pigs born	Pigs born alive	Pigs at 21 days of age	Pigs at 42 days of age
	No.	No.	No.	No.	No.
Boar breed					
Duroc (D)	87	11.3	11.0a ¹	9.0a	8.9a
Hampshire (H)	66	11.5	10.9ab	7.8b	7.5b
Spot (S)	152	10.6	10.2b	8.3b	8.2b
Sow breed					
Landrace (L)	90	10.7	10.0a	7.3a	7.1a
Duroc-Landrace (DL)	113	11.5	11.0b	8.9b	8.7b
Yorkshire-Landrace (YL)	102	11.3	10.8b	8.7b	8.5b
Boar breed x sow breed					
D x L	23	10.6	10.1	8.5	8.4
D x DL	33	12.0	11.7	9.1	8.9
D x YL	31	11.4	11.0	9.3	9.2
H x L	19	11.4	10.4	6.0	5.9
H x DL	26	12.1	11.2	9.4	9.0
H x YL	21	11.1	11.0	8.0	7.6
S x L	48	10.1	9.5	7.7	7.6
S x DL	54	10.7	10.4	8.6	8.5
S x YL	50	11.2	10.5	8.5	8.4
3-breed cross vs. single-cross litters		+ .6	+ .8	+ 1.4	+ 1.2

¹Boar breed and sow breed averages with different superscripts differ (P < .10).

TABLE 2. LITTER WEIGHT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING LANDRACE, DUROC-LANDRACE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 1)

Breed	Litters farrowed	Litter wt. at birth	Litter wt. at 21 days
	No.	Lb.	Lb.
Boar breed			
Duroc (D)	87	36.82a ¹	101.43a
Hampshire (H)	66	39.48b	86.99b
Spot (S)	152	32.76c	91.56b
Sow breed			
Landrace (L)	90	34.04a	80.89a
Duroc-Landrace (DL)	113	39.73b	100.13b
Yorkshire-Landrace (YL)	102	34.74a	97.18b
Boar breed x sow breed			
D x L	23	33.29	94.89
D x DL	33	36.73	102.07
D x YL	31	36.29	106.92
H x L	19	39.68	66.87
H x DL	26	43.48	105.98
H x YL	21	35.10	87.21
S x L	48	30.00	83.27
S x DL	54	35.32	96.81
S x YL	50	32.89	94.58
3-breed cross vs. single-cross litters		2.29	16.62

¹Boar breed and sow breed averages with different superscripts differ ($P \leq .10$).

consumed 0.35 pound of feed per day less than Spot-sired pigs and were 0.20 pound of feed per pound of gain more efficient.

The three sow breeds did not differ significantly in the number of pigs born, but litters out of purebred Landrace sows had 0.8 and 1.0 fewer live pigs at birth than litters out of Yorkshire-Landrace and Duroc-Landrace sows, respectively, table 1. At 21 and 42 days of age, Duroc-Landrace and Yorkshire-Landrace sows raised more pigs than purebred Landrace sows. Litters out of Duroc-Landrace crossbred sows weighed 4.99 and 5.69 pounds heavier at birth than litters out of Yorkshire-Landrace and purebred Landrace sows, respectively, table 2. At 21 days of age, litters farrowed by F₁ crossbred sows weighed heavier than litters farrowed by Landrace sows. Weights of litters out of the crossbred sows differed a nonsignificant 2.95 pounds. The increased litter sizes and weights of litters out of the F₁ crossbred sows can be explained by 100 percent maternal heterosis for Duroc-Landrace and Yorkshire-Landrace sows and the absence of maternal heterosis for purebred Landrace sows. Days required to obtain market weight were greater for pigs out of Yorkshire-Landrace sows than for pigs out of Duroc-Landrace sows or purebred Landrace sows, table 3. In the post-weaning period, pigs farrowed by Yorkshire-Landrace sows grew 0.03 and 0.04 pound

per day slower than pigs out of Duroc-Landrace and purebred Landrace sows, respectively. Post-weaning feed consumption was greater for pigs out of Duroc-Landrace and Landrace sows than for pigs out of Yorkshire-Landrace sows. Pigs from Duroc-Landrace sows were more efficient in converting feed consumed into weight gain than pigs farrowed by purebred Landrace sows. Differences in feed efficiency were small and not significant between pigs out of crossbred Duroc-Landrace and Yorkshire-Landrace sows, table 3.

It is noted that litters sired by Duroc boars and out of Duroc-Landrace sows were only 0.3 pig less at 21 and 42 days compared to Hampshire x Duroc-Landrace litters even though there was a loss of 50 percent of the available individual heterosis for these traits, table 1. The importance of maternal heterosis can be seen for the litter size and litter weight traits. Three-breed crossbred litters ranged from 0.6 to 1.4 pigs larger than single-cross litters and 2.29 pounds heavier at birth and 16.62 pounds heavier at 21 days of age. Pigs from single-cross litters required fewer days to obtain market weight and grew faster during the post-

TABLE 3. GROWTH TRAIT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING LANDRACE, DUROC-LANDRACE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 1)

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post-weaning daily feed consumption	Feed efficiency
		<i>Days</i>	<i>Lb.</i>		<i>Lb.</i>	<i>Lb.</i>
Boar breed						
Duroc (D)	610	171.4ab ¹	1.54a	61	5.51a	3.30a
Hampshire (H)	499	169.3a	1.54a	22	5.73ab	3.40ab
Spot (S)	1,032	174.6b	1.49b	76	5.86b	3.50b
Sow breed						
Landrace (L)	619	170.2a	1.54a	33	6.15a	3.51a
Duroc-Landrace (DL)	821	171.1a	1.53a	36	6.13a	3.40b
Yorkshire-Landrace (YL)	701	173.9b	1.50b	38	5.91b	3.43ab
Boar breed x sow breed						
D x L	162	170.1	1.55	16	5.95	3.37
D x DL	237	170.9	1.54	20	5.89	3.33
D x YL	211	173.2	1.52	21	5.75	3.31
H x L	145	165.8	1.57			
H x DL	206	170.0	1.55			
H x YL	148	172.1	1.51			
S x L	312	174.7	1.49	17	6.35	3.65
S x DL	378	172.6	1.52	16	6.35	3.46
S x YL	342	176.4	1.48	17	6.08	3.55
3-breed cross vs. single-cross pigs						
		2.7	-.02		-.09	-.07

¹Boar breed and sow breed averages with different superscripts differ (P < .10).

weaning period than three-breed cross pigs. This could be partially explained by the larger litters from the crossbred sows and the lower pig weight at weaning. Three-breed crossbred pigs consumed slightly less feed per day during the post-weaning period and were slightly more efficient in converting feed into weight gain.

Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace Sows (Experiment 2)

Single-cross Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace gilts from the first crossbreeding study were retained in the herd and bred in all possible combinations to six Duroc, six Hampshire, and eight Spot boars. The 106 females in this study farrowed 3,015 pigs in 274 litters. Averages for litter sizes, litter weights, and growth traits for this experiment are presented by boar breed, sow breed, and boar breed x sow breed combinations in tables 4 to 6, respectively. In this study, three-breed crossbred litters and backcross litters were produced. Backcross litters and pigs were produced by breeding Duroc, Hamp-

TABLE 4. LITTER SIZE AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE SOWS (EXPERIMENT 2)

Breed	Litters farrowed	Pigs born	Pigs born alive	Pigs at 21 days	Pigs at 42 days
	No.	No.	No.	No.	No.
Boar breed					
Duroc (D)	92	11.2	10.7	8.9a ¹	8.7
Hampshire (H)	97	11.5	10.8	7.8b	7.7
Spot (S)	85	10.8	10.3	8.2b	7.9
Sow breed					
Duroc-Landrace (DL)	85	11.4	10.7	8.5ab	8.2
Hampshire-Landrace (HL)	91	11.2	10.8	8.7a	8.4
Spot-Landrace (SL)	98	10.8	10.3	7.7b	7.6
Boar breed x sow breed					
D x DL	29	10.7	10.1	8.7	8.5
D x HL	29	11.9	11.5	10.6	10.1
D x SL	34	11.0	10.4	7.5	7.4
H x DL	32	11.7	10.6	7.7	7.6
H x HL	34	11.2	10.9	7.6	7.2
H x SL	31	11.6	11.0	8.2	8.2
S x DL	24	11.8	11.4	9.2	8.6
S x HL	28	10.6	9.9	7.8	7.8
S x SL	33	9.9	9.6	7.5	7.3
3-breed cross vs. back-cross litters8*	.6+	.6+	.6+

¹Boar breed and sow breed averages with different superscripts differ ($P \ll .10$).

+P $\ll .10$.

*P $\ll .05$.

TABLE 5. LITTER WEIGHT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE SOWS (EXPERIMENT 2)

Breed	Litters farrowed	Litter wt. at birth	Litter wt. at 21 days
	No.	Lb.	Lb.
Boar breed			
Duroc (D)	92	36.16ab ¹	90.39
Hampshire (H)	97	37.26a	81.35
Spot (S)	85	34.39b	84.22
Sow breed			
Duroc-Landrace (DL)	85	36.60	84.66ab
Hampshire-Landrace (HL)	91	36.82	93.70a
Spot-Landrace (SL)	98	34.61	77.60b
Boar breed x sow breed			
D x DL	29	34.61	86.42
D x HL	29	39.68	112.44
D x SL	34	34.39	72.53
H x DL	32	36.60	78.71
H x HL	34	37.48	79.15
H x SL	31	37.92	86.20
S x DL	24	38.14	89.07
S x HL	28	33.51	89.29
S x SL	33	31.53	74.08
3-breed cross vs. backcross litters		2.20*	8.16*

¹Boar breed and sow breed averages with different superscripts differ (P < .10).
*P < .05.

shire, and Spot boars to Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace sows, respectively. Three-breed crossbred litters would have 100 percent of the available individual and maternal heterosis for these traits, while backcross litters and pigs would utilize 50 percent of the individual and 100 percent of the available maternal heterosis.

Differences among the Duroc, Hampshire, and Spot boar breeds were not significant for number of pigs born per litter or number of pigs born alive. But at 21 days of age, litters sired by Duroc boars were 0.7 and 1.1 pigs larger than litters sired by Spot and Hampshire boars, respectively. This result agreed with what was observed in experiment 1. At 42 days of age, numeric differences in litter size among the three boar breeds could not be considered statistically significant even though Hampshire-sired litters were 1.0 pig per litter smaller than Duroc-sired litters. These differences in litter size have economic importance to commercial swine producers even though only the differences at 21 days of age were statistically significant. Litters sired by Hampshire boars weighed 2.87 pounds heavier at birth than litters sired by Spot boars, but litter weights at 21 days of age were similar among the three boar breeds. Duroc-sired pigs required fewer days to obtain market weight

and grew faster during the post-weaning growth period than either Hampshire- or Spot-sired pigs, table 6. Differences in age at market weight and post-weaning growth rate between Hampshire- and Spot-sired pigs were not considered to be statistically significant. Duroc- and Hampshire-sired pigs consumed 0.44 pound less feed per day during the post-weaning period than Spot-sired pigs and were more efficient in converting feed consumed into weight gain. Differences between Duroc- and Hampshire-sired pigs for these two traits were small and not of any great importance.

Litters out of Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace sows were essentially of equal size at birth. At 21 days of age, litters out of Duroc-Landrace and Hampshire-Landrace sows were 0.8 and 1.0 pig per litter larger, table 4. At 42 days of age, the differences in litter size were not significant among the three breeds of crossbred sows, although the fewest number of pigs raised per litter was by Spot-Landrace sows. Litter weights at birth did not differ significantly among the sow breeds, however at 21 days, litters out of Spot-Landrace sows

TABLE 6. GROWTH TRAIT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE SOWS (EXPERIMENT 2)

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post-weaning daily feed consumption	Feed efficiency
		<i>Days</i>	<i>Lb.</i>		<i>Lb.</i>	<i>Lb.</i>
Boar breed						
Duroc (D)	767	180.4a ¹	1.45a	35	5.07a	3.19 a
Hampshire (H)	642	189.1b	1.37b	31	5.07a	3.25 a
Spot (S)	575	185.5b	1.40b	30	5.51b	3.52 b
Sow breed						
Duroc-Landrace (DL)	602	183.5a	1.42			
Hampshire-Landrace (HL)	714	185.2ab	1.40			
Spot-Landrace (SL)	668	186.3b	1.40			
Boar breed x sow breed						
D x DL	219	182.2	1.43			
D x HL	272	178.7	1.46			
D x SL	276	180.3	1.46			
H x DL	220	184.2	1.41			
H x HL	194	194.8	1.32			
H x SL	228	188.5	1.37			
S x DL	163	184.1	1.42			
S x HL	202	182.2	1.42			
S x SL	210	190.3	1.36			
3-breed cross vs. backcross pigs		-6.2**	.06**			

¹Boar breed and sow breed averages with different superscripts differ ($P \leq .10$).

** $P \leq .01$.

weighed 16.1 pounds less than litters out of Hampshire-Landrace sows. Litters out of Duroc-Landrace sows were 7.06 pounds heavier than litters out of Spot-Landrace sows and 9.04 pounds lighter than litters out of Hampshire-Landrace sows at 21 days, table 5. Neither of these differences was statistically important. Pigs out of Duroc-Landrace sows required 2.8 fewer days to obtain market weight than pigs out of Spot-Landrace sows, but pigs from these two types of crossbred sows grew at similar rates in the post-weaning period, table 6. Feed consumption and feed efficiency data were not collected for the three breeds of F₁ sows.

In this study, differences between three-breed crossbred litters and pigs and backcross litters and pigs were large and of importance for each trait evaluated. The loss of 50 percent of the available individual heterosis for each trait resulted in poorer performance of the backcross litters and pigs compared to the three-breed crosses. In addition, there was evidence in this study that for litter size and weight at 21 days and for number of pigs at 42 days of age, the Duroc, Hampshire, and Spot boar breeds did not combine the same with the three breeds of crossbred sows.

Duroc-Landrace, Hampshire-Landrace, and Spot-Landrace Backcross Sows (Experiment 3)

Backcross gilts that were 3/4 Duroc-1/4 Landrace, 3/4 Hampshire-1/4 Landrace, and 3/4 Spot-1/4 Landrace from crossbreeding experiment 2 were kept and bred to purebred Yorkshire boars to evaluate reproductive performance of backcross sows. The 100 sows in this study farrowed 299 litters and 3,271 pigs. In these litters and pigs, 100 percent of the available individual heterosis and 50 percent of the available maternal heterosis would be expressed for each trait evaluated.

Differences in the number of pigs born and born alive among the three breeds of backcross sows were not significant, although Spot-Landrace sows did farrow 0.9 fewer pigs and 0.9 fewer live pigs than

TABLE 7. LITTER SIZE AVERAGES FOR SOW BREEDS IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE BACKCROSS SOWS (EXPERIMENT 3)

Breed	Litters farrowed	Pigs born	Pigs born alive	Pigs at 21 days	Pigs at 42 days
Duroc x Duroc-Landrace (DDL).....	No. 124	No. 10.9	No. 10.1	No. 8.4ab ¹	No. 8.2
Hampshire x Hampshire-Landrace (HHL).....	97	11.3	10.8	9.1a	8.9
Spot x Spot-Landrace (SSL).....	78	10.4	9.9	7.9b	7.8

¹Sow breed averages with different superscripts differ (P < .10).

TABLE 8. LITTER WEIGHT AVERAGES FOR SOW BREEDS IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE BACKCROSS SOWS (EXPERIMENT 3)

Breed	Litters farrowed	Litter wt. at birth	Litter wt. at 21 days
	No.	Lb.	Lb.
Duroc x Duroc-Landrace (DDL)	124	37.04a ¹	89.51
Hampshire x Hampshire-Landrace (HHL)	97	34.17ab	98.11
Spot x Spot-Landrace (SSL)	78	33.51b	89.07

¹Sow breed averages with different superscripts differ (P < .10).

Hampshire-Landrace backcross sows, table 7. At 21 days of age, Hampshire-Landrace backcross sows raised 1.2 more pigs than Spot-Landrace sows and this result was statistically significant. Although 1.1 more pigs were alive at 42 days from litters out of Hampshire-Landrace backcross sows compared to litters out of Spot-Landrace backcross sows, this difference was not considered to be statistically significant. Duroc-Landrace backcross sows were intermediate in performance to the other types of backcross sows for litter sizes at birth and at 21 and 42 days of age, and their performance was not considered to be better or poorer than that of Hampshire-Landrace and Spot-Landrace backcross sows. Litters of pigs out of Spot-Landrace backcross sows weighed 3.53 pounds less at birth than litters out of Duroc-Landrace backcross sows, table 8. By 21 days of age, however, differences in weight among the three backcross breeds were small and not of great importance. Pigs out of Duroc-Landrace backcross sows obtained market weight 5.5 days sooner than pigs out of Spot-Landrace backcross sows and 11.1 days sooner than pigs out of Hampshire-Landrace backcross sows, table 9. The number of days required to obtain market weight was 5.6 days less for pigs out of backcross Spot-Landrace sows compared to pigs out of

TABLE 9. GROWTH TRAIT AVERAGES FOR SOW BREEDS IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND SPOT-LANDRACE BACKCROSS SOWS (EXPERIMENT 3)

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post-weaning daily feed consumption	Feed efficiency
		Days	Lb.		Lb.	Lb.
Duroc x Duroc-Landrace (DDL)	972	176.6a ¹	1.63a	39	5.53	3.48a
Hampshire x Hampshire-Landrace (HHL)	779	187.7b	1.55b	35	5.62	3.63b
Spot x Spot-Landrace (SSL)	518	182.1c	1.60a	27	5.58	3.55ab

¹Sow breed averages with different superscripts differ (P < .10).

backcross Hampshire-Landrace sows. These differences are of economic importance to a commercial producer. In the post-weaning period, pigs out of backcross Hampshire-Landrace sows grew at a slower rate than pigs out of the two other types of backcross sows. Differences in feed consumption were minimal among the three breeds of backcross sows. Because of the superior growth rate of pigs out of backcross Duroc-Landrace sows, however, these pigs were 0.15 pound of feed per pound of gain more efficient than pigs out of Hampshire-Landrace backcross sows. Feed efficiency of pigs out of Spot-Landrace backcross sows was intermediate to the other two types of crossbred pigs and was not considered to be better or worse.

Duroc-Landrace, Hampshire-Landrace, and Yorkshire-Landrace Sows Managed in Two Gestation Systems (Experiment 4)

The Yorkshire-Landrace crossbred sow has been used most frequently in commercial sow herds in the United States. However, Yorkshire-Landrace sows have often been criticized as being fragile and difficult to keep in good condition. There has been a recommendation that Yorkshire-Landrace sows should be only kept in gestation stalls and should not be used in herds where sows are kept in pasture lots or in dry lots. In previous crossbreeding experiments at Auburn University, Duroc-Landrace and Hampshire-Landrace sows performed as well as or better than Yorkshire-Landrace sows when kept in pasture lots during the gestation period. In this experiment, it was of interest to compare these two types of F_1 crossbred sows with Yorkshire-Landrace sows when they were managed in two different types of gestation systems. Half the sows of each breed were confined in sow gestation stalls during the gestation period, while the remaining sows of each breed were penned by breed in 0.5-acre pasture lots. The 256 sows in this study were bred to 16 Duroc, 19 Hampshire, and 19 Yorkshire boars in all possible combinations to produce three-breed crossbred and backcross litters and pigs. These matings produced 10,169 pigs in 844 litters. Each sow had the opportunity to farrow four litters.

Differences in sizes of litters sired by Duroc, Hampshire, and Yorkshire boars were small and not significant at birth, table 10. At 21 days of age, litters sired by Hampshire boars were 0.9 pig less than Duroc-sired litters and 1.1 pigs less than Yorkshire-sired litters. One pig per litter less was marketed from litters sired by Hampshire boars than from litters sired by boars from the other two boar breeds. Differences in litter size at 21 days and at marketing of the Hampshire-sired litters compared to the Duroc- and Yorkshire-sired litters were considered to be

TABLE 10. LITTER SIZE AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND YORKSHIRE-LANDRACE SOWS MANAGED IN TWO GESTATION SYSTEMS (EXPERIMENT 4)

Breed	Litters farrowed	Pigs born	Pigs born alive	Pigs at 21 days	Pigs marketed
	No.	No.	No.	No.	No.
Boar breed					
Duroc (D)	292	12.0	11.1	9.3a ¹	9.0a
Hampshire (H)	285	11.9	10.8	8.4b	8.0b
Yorkshire (Y)	267	12.3	11.2	9.5a	9.0a
Sow breed					
Duroc-Landrace (DL)	279	12.1	11.1	9.1	8.6
Hampshire-Landrace (HL)	303	11.8	11.0	9.2	8.8
Yorkshire-Landrace (YL)	262	12.3	11.0	8.9	8.5
Boar breed x sow breed					
D x DL	93	12.4	11.1	9.1	8.7
D x HL	109	11.2	10.5	9.2	9.0
D x YL	90	12.4	11.7	9.6	9.2
H x DL	95	11.4	10.4	8.4	8.0
H x HL	99	11.5	10.7	8.3	7.8
H x YL	91	12.6	11.2	8.5	8.2
Y x DL	91	12.5	11.6	9.7	9.1
Y x HL	95	12.5	11.7	10.1	9.7
Y x YL	81	11.9	10.3	8.6	8.1
3-breed cross vs. backcross litters					
		.2	.5	.6	.7

¹Boar breed and sow breed averages with different superscripts differ (P < .10).

statistically important. The observed reduction in size of litters sired by Hampshire boars in this experiment has also been seen in previous Auburn crossbreeding experiments. In this study, litters sired by Duroc, Hampshire, and Yorkshire boars weighed essentially the same at birth, but at 21 days of age, Hampshire-sired litters weighed 6.61 pounds less than Yorkshire-sired litters, table 11. Duroc-sired pigs required 4.8 days fewer to obtain market weight than Yorkshire-sired pigs and 5.1 days less than Hampshire-sired pigs, table 12. Post-weaning growth rate was 0.07 pound per day faster for Duroc-sired pigs than for Hampshire-sired pigs and 0.06 pound per day faster than for Yorkshire-sired pigs. Differences between pigs sired by Hampshire and Yorkshire boars were not important for age at market weight and post-weaning growth rate. Hampshire-sired pigs consumed 0.15 pound of feed per day less than Duroc-sired pigs and 0.26 pound per day less than Yorkshire-sired pigs during the post-weaning growth period. Even though Duroc-sired pigs consumed more feed per day than Hampshire-sired pigs, the superior growth rate of Duroc-sired pigs resulted in their feed efficiency being essentially equal to the feed efficiency of the Hampshire-sired pigs. Yorkshire-sired pigs consumed 0.11 pound more feed per day and were

TABLE 11. LITTER WEIGHT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND YORKSHIRE-LANDRACE SOWS MANAGED IN TWO GESTATION SYSTEMS (EXPERIMENT 4)

Breed	Litters farrowed	Litter wt. at birth	Litter wt. at 21 days
	<i>No.</i>	<i>Lb.</i>	<i>Lb.</i>
Boar breed			
Duroc (D)	292	36.38	104.50ab ¹
Hampshire (H)	285	36.82	98.55a
Yorkshire (Y)	267	36.82	105.16b
Sow breed			
Duroc-Landrace (DL)	279	39.68a	103.84
Hampshire-Landrace (HL)	303	35.49b	105.16
Yorkshire-Landrace (YL)	262	34.83b	98.99
Boar breed x sow breed			
D x DL	93	39.90	101.19
D x HL	109	34.61	107.37
D x YL	90	34.83	104.94
H x DL	95	38.80	100.97
H x HL	99	35.27	96.34
H x YL	91	36.60	98.55
Y x DL	91	40.57	109.79
Y x HL	95	36.82	111.77
Y x YL	81	32.85	93.70
3-breed cross vs. backcross litters88	8.38**

¹Boar breed and sow breed averages with different superscripts differ ($P \leq .10$).

** $P \leq .01$.

0.18 pound of feed per pound of gain less efficient in converting feed to gain compared to pigs sired by Duroc boars, table 12.

The number of pigs born per litter, born alive, alive at 21 days of age, and marketed per litter were essentially equal among the three breeds of F₁ crossbred sows and were not considered to be significantly different, table 10. Litters out of Duroc-Landrace sows weighed 4.19 and 4.85 pounds more at birth than litters out of Hampshire-Landrace and Yorkshire-Landrace sows, respectively. Litters out of Hampshire-Landrace sows weighed essentially the same at birth as litters out of Yorkshire-Landrace sows. At 21 days of age, however, litter weights were numerically but not statistically different. The lightest litter weights at 21 days of age were from the Yorkshire-Landrace sows, table 11. Pigs out of Hampshire-Landrace sows required 5.0 days more to obtain market weight than pigs out of Duroc-Landrace sows and 3.5 days more than pigs out of Yorkshire-Landrace sows, table 12. During the post-weaning period, pigs out of Duroc-Landrace and Yorkshire-Landrace sows grew 0.06 and 0.05 pound per day faster, respectively, than pigs out of Hampshire-Landrace sows. Age at marketing and post-

TABLE 12. GROWTH TRAIT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND YORKSHIRE-LANDRACE SOWS MANAGED IN TWO GESTATION SYSTEMS (EXPERIMENT 4)

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post weaning daily feed consumption	Feed efficiency
		<i>Days</i>	<i>Lb.</i>		<i>Lb.</i>	<i>Lb.</i>
Boar breed						
Duroc (D)	2,620	171.9a ¹	1.66a	55	5.41a	3.15a
Hampshire (H) ..	2,256	177.0b	1.60b	46	5.26b	3.12a
Yorkshire (Y) ...	2,382	176.7b	1.59b	51	5.52c	3.33b
Sow breed						
Duroc-Landrace (DL)	2,397	173.0a	1.64a	52	5.53	3.23ab
Hampshire-Landrace (HL)	2,652	178.0b	1.58b	50	5.51	3.27a
Yorkshire-Landrace (YL)	2,209	174.5a	1.63a	46	5.49	3.17b
Boar breed x sow breed						
D x DL	812	175.4	1.62			
D x HL	980	171.9	1.65			
D x YL	828	168.3	1.71			
H x DL	755	171.6	1.65			
H x HL	767	185.0	1.51			
H x YL	734	174.3	1.63			
Y x DL	830	172.0	1.65			
Y x HL	905	177.1	1.59			
Y x YL	647	180.9	1.55			
3-breed cross vs. backcross pigs..		-7.9**	.09**			

¹Boar breed and sow breed averages with different superscripts differ (P < .10).

**P < .01.

weaning growth rate did not differ a significant amount among pigs out of Duroc-Landrace and Yorkshire-Landrace sows. Differences in daily feed consumption during the post-weaning period were small and not considered to be important; but because of the faster rate of post-weaning growth for the pigs out of Yorkshire-Landrace sows, these pigs were more efficient in converting feed into weight gain than pigs out of Hampshire-Landrace sows. Conversion of feed consumed into weight gain was essentially equal for pigs out of Duroc-Landrace and Yorkshire-Landrace sows, table 12.

A loss of 50 percent of the available individual heterosis occurs for any trait when the litters or pigs are backcrosses. This loss resulted in a significant 0.5 to 0.7 pig per litter increase in litter size in the three-breed cross litters compared to the backcross litters, table 10. Three-breed cross litters weighed 8.38 pounds heavier at 21 days of age than backcross litters. Backcross pigs required 7.9 more days to obtain market weight and grew 0.09 pound per day slower in the post-weaning period

than three-breed cross pigs, table 12. The loss of 50 percent of the available individual heterosis was large for these traits and resulted in poorer performance of the backcross litters and pigs compared to the three-breed cross litters and pigs.

Also of interest in this study was the total number of pigs produced by the three breeds of F₁ sows during four lactations. Each sow in the study had the opportunity to farrow four litters of pigs. For sows that farrowed four litters, the numbers of pigs produced in each of the four farrowings were added together. Sows that died or failed to conceive or that were culled from the herd after sustaining a permanent injury were given credit for the number of pigs produced during the time they were in the herd and zero pigs produced for any remaining lactations. The total number of pigs produced during four litters was a function of differences in longevity in the herd, fertility, milking ability, and pig survival rate. The averages for the litter size traits are presented in table 13.

Large breed differences were observed among the three breeds of F₁ sows in their ability to complete four lactations. Only 70.2 percent of the Yorkshire-Landrace sows that started the study completed four lactations, while 78.4 percent of the Duroc-Landrace and 86.9 percent of the Hampshire-Landrace sows completed four lactations. In the pasture gestation system, 85.3 percent of the Duroc-Landrace and 85.8 percent of the Hampshire-Landrace sows completed their fourth lactation, while only 70.6 percent of the Yorkshire-Landrace sows were able to complete their fourth lactation. When the sows were managed in a confinement gestation system, 88.0 percent of the Hampshire-

TABLE 13. TOTAL NUMBER OF PIGS PRODUCED BY DUROC-LANDRACE, HAMPSHIRE-LANDRACE, AND YORKSHIRE-LANDRACE SOWS IN FOUR LACTATIONS WHEN MANAGED IN TWO GESTATION SYSTEMS (EXPERIMENT 4)

Breed and system	Pigs born	Pigs born alive	Pigs at 21 days	Pigs marketed
	No.	No.	No.	No.
Sow breed				
Duroc-Landrace (DL)	40.8	37.4ab ¹	30.4a	28.1ab
Hampshire-Landrace (HL)	41.4	38.6b	31.9a	29.4b
Yorkshire-Landrace (YL)	37.1	33.4a	26.5b	24.8a
Sow breed x gestation system				
DL x pasture	43.8a	40.0a	32.5a	29.9a
HL x pasture	40.7a	38.2a	30.9a	28.5a
YL x pasture	34.9b	31.1b	24.7b	23.4b
DL x gestation stalls	37.8	34.8	28.2	26.2
HL x gestation stalls	42.1	39.0	32.9	30.3
YL x gestation stalls	39.3	35.8	28.4	26.1

¹Sow breed averages with different superscripts differ (P < .10).

Landrace sows completed a fourth lactation but only 71.4 percent of the Duroc-Landrace and 69.8 percent of the Yorkshire-Landrace sows completed four lactations. These results are interpreted to mean that Hampshire-Landrace sows are durable enough for either type of gestation system and that Duroc-Landrace sows are better suited for a pasture gestation system. Longevity of Yorkshire-Landrace sows in either gestation system was essentially equal and was less than for either of the other types of crossbred sows.

Hampshire-Landrace sows farrowed a total of 5.2 more live pigs at birth in four litters than Yorkshire-Landrace sows. Duroc-Landrace sows were intermediate to the other types of crossbred sows and not significantly different from either for the total number of live pigs farrowed in four litters. Yorkshire-Landrace sows raised 3.9 fewer pigs at 21 days in four farrowings than Duroc-Landrace sows and 5.4 fewer pigs than Hampshire-Landrace sows. In four farrowings, a total of 4.6 pigs more was marketed from litters out of Hampshire-Landrace sows than from those out of Yorkshire-Landrace sows. In the pasture gestation system, Duroc-Landrace and Hampshire-Landrace sows produced more live pigs at birth and 21 days of age and more pigs were marketed from these litters in four farrowings than from litters out of Yorkshire-Landrace sows. In the confinement gestation system, however, the total number of pigs produced by Yorkshire-Landrace sows did not differ significantly from the number produced by Duroc-Landrace and Hampshire-Landrace sows. Longevity of sows within a herd has economic importance, especially when costs of producing or purchasing replacement gilts and the lower productivity of gilts are taken into account. The results of this study are interpreted to mean a producer should select the breed of crossbred sow for the type of gestation facilities at the farm. On farms with a pasture or possibly a dry lot gestation system, the producer should consider using either Duroc-Landrace or Hampshire-Landrace crossbred sows and should not use Yorkshire-Landrace sows. With a confinement gestation system, any of the three sow breeds would perform equally well over four litters.

Chester White Crossbred Sows and Yorkshire-Landrace Sows (Experiment 5)

Yorkshire-Landrace is the breed of crossbred sow most often used in commercial swine operations in the United States. In a crossbreeding experiment conducted at Iowa State University, Chester White-Yorkshire sows were shown to excel in reproductive performance. That study did not compare Chester White-Yorkshire sows and Yorkshire-Landrace

sows, and crossbred Chester White-Landrace sows have not been evaluated in any previous crossbreeding study. Therefore, a crossbreeding study was initiated to compare the performance of Chester White-Landrace, Chester White-Yorkshire, and Yorkshire-Landrace crossbred sows.

A question often asked by commercial producers is whether boars available from corporate breeding companies are better than boars available from purebred breeders. The three breeds of crossbred sows in this study were bred in all possible combinations to purebred Duroc and Hampshire boars and to boars from lines 414 and 929 from the Farmers Hybrid Company. (Farmers Hybrid Company is a corporate breeding company in Des Moines, Iowa, that has been selling breeding stock since the early 1960's.) The 130 sows in this study farrowed 3,379 pigs in 321 litters.

Litter size averages for boar breed, sow breed, and boar breed x sow breed combinations are presented in table 14. Litters sired by purebred boars tended to have slightly fewer pigs at birth and 21 days of age, but not at market time, compared to litters sired by Farmers Hybrid

TABLE 14. LITTER SIZE AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING CHESTER WHITE-LANDRACE, CHESTER WHITE-YORKSHIRE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 5)

Breed	Litters farrowed	Pigs born	Pigs born alive	Pigs at 21 days	Pigs marketed
	No.	No.	No.	No.	No.
Boar breed					
Duroc (D).....	109	10.9	10.0	8.5	8.0
Hampshire (H).....	95	10.2	9.1	7.9	7.5
Farmers Hybrid 414 (FH414).....	66	10.8	9.9	8.2	7.5
Farmers Hybrid 929 (FH929).....	51	10.8	9.9	8.9	8.1
Sow breed					
Chester White-Landrace (CL).....	116	10.8ab ¹	9.2a	8.4	8.0
Chester White-Yorkshire (CY).....	97	11.1a	10.1b	8.5	7.9
Yorkshire-Landrace (YL).....	108	10.1b	9.2a	8.1	7.5
Boar breed x sow breed					
D x CL.....	37	11.0	9.8	8.4	8.0
D x CY.....	37	11.5	10.9	9.0	8.4
D x YL.....	35	10.2	9.2	8.1	7.8
H x CL.....	39	9.9	9.0	7.8	7.4
H x CY.....	24	10.5	9.3	7.7	7.4
H x YL.....	32	10.3	8.9	8.1	7.7
FH414 x CL.....	21	10.6	9.8	8.7	8.3
FH414 x CY.....	27	11.5	10.5	8.5	7.6
FH414 x YL.....	18	10.1	9.3	7.3	6.8
FH929 x CL.....	19	11.7	10.3	8.9	8.2
FH929 x CY.....	9	10.8	9.8	8.7	8.3
FH929 x YL.....	23	10.0	9.4	9.0	7.8
Purebred vs. Farmers Hybrid-sired litters.....					
		-3	-4	-4	-1

¹Boar breed and sow breed averages with different superscripts differ ($P \leq .10$).

TABLE 15. LITTER WEIGHT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING CHESTER WHITE-LANDRACE, CHESTER WHITE-YORKSHIRE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 5)

Breed	Litters farrowed	Litter wt. at birth	Litter wt. at 21 days
	No.	Lb.	Lb.
Boar breed			
Duroc (D)	109	32.85	97.22
Hampshire (H)	95	32.41	90.17
Farmers Hybrid 414 (FH414)	66	33.29	89.29
Farmers Hybrid 929 (FH929)	51	33.29	98.77
Sow breed			
Chester White-Landrace (CL)	116	34.39 ^{a1}	96.56
Chester White-Yorkshire (CY)	97	32.41 ^{ab}	91.71
Yorkshire-Landrace (YL)	108	32.19 ^b	91.71
Boar breed x sow breed			
D x CL	37	34.45	98.45
D x CY	37	32.61	99.08
D x YL	35	31.80	93.83
H x CL	39	32.29	91.11
H x CY	24	32.31	80.90
H x YL	32	32.53	98.38
FH414 x CL	21	32.99	95.85
FH414 x CY	27	34.82	90.30
FH414 x YL	18	31.82	82.00
FH929 x CL	19	38.00	101.27
FH929 x CY	9	29.90	96.65
FH929 x YL	23	32.17	98.39
Purebred vs. Farmers			
Hybrid-sired litters		-66	-33

¹Boar breed and sow breed averages with different superscripts differ ($P \leq .10$).

boars. This difference was primarily because of the reduction in litter size in the litters sired by Hampshire boars. Litter weights at birth and 21 days of age were essentially equal among litters sired by the purebred and Farmers Hybrid boars, table 15. Pigs sired by Duroc and Farmers Hybrid line 414 boars required 9.0 and 6.9 fewer days to obtain market weight and grew 0.12 and 0.09 pound per day faster in the post-weaning period, respectively, than pigs sired by the line 929 Farmers Hybrid boars, table 16. Hampshire-sired pigs did not differ a significant amount from pigs sired by the other boar breeds for these two traits. Differences in daily feed consumption during the post-weaning period were 0.37 and 0.28 pound per day greater for pigs sired by line 414 boars than for pigs sired by Hampshire and line 929 boars, table 16. Hampshire-sired pigs were 0.16 and 0.23 pound of feed per pound of gain more efficient than pigs sired by the line 929 and 414 Farmers Hybrid boars, respectively. Duroc-sired pigs were 0.20 pound of feed per pound of gain more efficient than Farmers Hybrid line 414-sired pigs. The feed

efficiency of pigs sired by boars from the two Farmers Hybrid lines was essentially equal. On the average, pigs sired by the purebred boars consumed 0.1 pound of feed per day less and were 0.2 pound of feed per pound of gain more efficient than pigs sired by the Farmers Hybrid boars. These results are not indicative of the performance of pigs sired by boars from other Farmers Hybrid lines relative to the performance of pigs sired by Duroc and Hampshire boars.

Chester White-Yorkshire sows farrowed 1.0 more pig per litter than Yorkshire-Landrace sows. Chester White-Landrace sows were intermediate and the litters from these sows were essentially equal in size at birth with litters from the other two breeds of crossbred sows. Lit-

TABLE 16. GROWTH TRAIT AVERAGES FOR BOAR BREEDS, SOW BREEDS, AND BOAR BREED X SOW BREED IN STUDY INVOLVING CHESTER WHITE-LANDRACE, CHESTER WHITE-YORKSHIRE, AND YORKSHIRE-LANDRACE SOWS (EXPERIMENT 5)

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post-weaning daily feed consumption	Feed efficiency
		<i>Days</i>	<i>Lb.</i>		<i>Lb.</i>	<i>Lb.</i>
Boar breed						
Duroc (D)	859	164.9a ¹	1.74a	69	5.89ab	3.32ab
Hampshire (H)	691	168.7ab	1.69ab	61	5.71a	3.29a
Farmers Hybrid						
414 (FH414)	508	167.0a	1.71a	37	6.08b	3.52c
Farmers Hybrid						
929 (FH929)	404	173.9b	1.62b	38	5.80a	3.45bc
Sow breed						
Chester White-Landrace (CL)	895	169.0a	1.68a	75	5.75a	3.37ab
Chester White-Yorkshire (CY)	741	170.4a	1.68a	59	5.78a	3.35a
Yorkshire-Landrace (YL)	826	166.4b	1.72b	71	6.08b	3.46b
Boar breed x sow breed						
D x CL	295	165.1	1.72	22	5.85	3.31
D x CY	297	167.2	1.72	23	5.85	3.30
D x YL	267	162.2	1.77	24	5.96	3.35
H x CL	281	169.0	1.68	26	5.49	3.21
H x CY	163	173.2	1.66	15	5.75	3.33
H x YL	247	163.8	1.73	20	5.89	3.33
FH414 x CL	164	166.1	1.71	12	6.00	3.55
FH414 x CY	206	170.9	1.67	14	5.85	3.50
FH414 x YL	138	164.1	1.76	11	6.39	3.52
FH929 x CL	155	175.8	1.60	15	5.64	3.42
FH929 x CY	75	170.5	1.67	7	5.68	3.29
FH929 x YL	174	175.4	1.61	16	6.09	3.63
Purebred- vs. Farmers Hybrid-sired litters		-3.7	.05		-.1*	-.2**

¹Boar breed and sow breed averages with different superscripts differ (P < .10).

* P < .05.

** P < .01.

ters out of Chester White-Yorkshire sows contained 0.9 more live pigs than litters out of Chester White-Landrace and Yorkshire-Landrace sows, but at 21 days of age and at marketing, litter sizes were essentially equal among the three breeds of F₁ crossbred sows, table 14. Litters out of Chester White-Landrace sows weighed 2.20 pounds heavier at birth than litters out of Yorkshire-Landrace sows, table 15. Differences in litter weights at 21 days of age were small among the sow breeds and were not considered significant. Pigs out of Yorkshire-Landrace sows required 2.6 and 4.0 fewer days to obtain market weight and grew 0.04 and 0.04 pound per day faster during the post-weaning period than pigs out of Chester White-Landrace and Chester White-Yorkshire sows, respectively, table 16. During the post-weaning period, appetites of pigs out of Chester White sows were smaller compared to pigs out of Yorkshire-Landrace sows. Even though pigs from Chester White-Yorkshire sows grew slower than pigs out of Yorkshire-Landrace sows, the smaller appetites of pigs out of Chester White-Yorkshire sows resulted in them being 0.11 pound of feed per pound of gain more efficient. Feed efficiency of pigs out of Chester White-Landrace sows was intermediate and not significantly different from the feed efficiency of pigs out of the other two types of F₁ crossbred sows.

Overall Rankings Of Boar Breeds and Sow Breeds

Boar breed and sow breed averages from the Auburn University experiments involving F₁ crossbred sows were pooled to obtain an overall ranking of the six boar breeds and seven sow breeds for litter size, litter weight, and growth traits evaluated in these studies, table 17-19. Litters sired by purebred boars tended to have 0.1 to 0.5 fewer pigs in the pre-weaning period than litters sired by Farmers Hybrid boars. The smaller litters sired by purebred boars were due primarily to the smaller litters sired by the Spot and Hampshire boars. The differences among the purebred-sired litters and Farmers Hybrid-sired litters were not statistically significant because of the relatively small number of Farmers Hybrid boars used. Litters sired by Yorkshire boars were 0.8 and 1.1 pigs larger than litters sired by Spot and Hampshire boars at 21 days of age, respectively. Duroc-sired litters were 0.6 and 0.9 pig larger than Spot- and Hampshire-sired litters at this age. Similar results were found at 42 days of age and at marketing. The exact reason for the reduction in litter sizes from the Hampshire and Spot boar breeds compared to the Duroc and Yorkshire breeds is unclear. One possible explanation is that young (9- to 15-month-old) boars were used in these studies. It is possible that if older boars were used, the reduction in litter sizes at 21 days of age and at market time would not be so pronounced.

TABLE 17. LITTER SIZE AVERAGES FOR SIX BOAR BREEDS AND SEVEN SOW BREEDS
IN THE AUBURN UNIVERSITY CROSSBREEDING STUDIES

Breed	Litters	Pigs	Pigs born	Pigs at	Pigs
	farrowed	born	alive	21 days	marketed
	No.	No.	No.	No.	No.
Boar breed					
Duroc (D)	580	11.4	10.7	8.9	8.6
Hampshire (H)	543	11.3	10.4	8.0	7.7
Spot (S)	237	10.6	9.9	8.3	8.0
Yorkshire (Y)	267	11.7	10.8	9.1	8.7
Farmers Hybrid 414 (FH414).....	66	11.5	10.9	8.5	7.9
Farmers Hybrid 929 (FH929).....	51	11.5	10.9	9.2	8.5
Sow breed					
Landrace (L)	90	10.6	9.6	7.1	6.7
Chester White-Landrace (CL)	116	12.0	10.4	8.8	8.7
Chester White-Yorkshire (CY)	97	12.3	11.3	8.9	8.6
Duroc-Landrace (DL)	477	11.2	10.5	8.7	8.3
Hampshire-Landrace (HL)	394	10.9	10.5	8.8	8.5
Spot-Landrace (SL)	98	10.6	10.0	7.9	7.7
Yorkshire-Landrace (YL)	472	11.3	10.4	8.5	8.2

Crossbreeding research conducted at other universities in the United States also has shown a reduction in litter sizes when Hampshire and Spot boars are used. Litters sired by purebred boars weighed 1.56 pounds less at birth than litters sired by Farmers Hybrid boars, but at 21 days of age the litters sired by purebred boars weighed the same as litters sired by Farmers Hybrid boars. Because of the reduction in litter size at 21 days in the litters sired by Hampshire and Spot boars,

TABLE 18. LITTER WEIGHT AVERAGES FOR SIX BOAR BREEDS AND SEVEN SOW BREEDS
IN THE AUBURN UNIVERSITY CROSSBREEDING STUDIES

Breed	Litters	Litter wt.	Litter wt.
	farrowed	at birth	at 21 days
	No.	Lb.	Lb.
Boar breed			
Duroc (D)	580	35.64	97.82
Hampshire (H)	543	36.30	90.00
Spot (S)	237	31.99	91.44
Yorkshire (Y)	267	36.19	97.56
Farmers Hybrid 414 (FH414)	66	36.59	89.53
Farmers Hybrid 929 (FH929)	51	36.59	99.01
Sow breed			
Landrace (L)	90	32.99	77.00
Chester White-Landrace (CL)	116	36.15	97.77
Chester White-Yorkshire (CY)	97	34.17	92.92
Duroc-Landrace (DL)	477	38.45	96.57
Hampshire-Landrace (HL)	394	35.21	99.79
Spot-Landrace (SL)	98	34.67	86.50
Yorkshire-Landrace (YL)	472	33.95	92.92

litters from these boar breeds weighed less at 21 days than litters sired by Duroc and Yorkshire boars, table 18. Age at market weight was 2.3 days less and post-weaning growth rate was 0.03 pound per day greater for the pigs sired by the purebred boars compared to pigs sired by the Farmers Hybrid boars. Differences in daily feed consumption during the post-weaning period were small between the purebred- and Farmers Hybrid-sired pigs; because of their faster growth rate, the purebred-sired pigs were 0.07 pound of feed per pound of gain more efficient than pigs sired by the Farmers Hybrid boars. Pigs sired by Duroc boars obtained market weight 4.5 to 4.9 days quicker than pigs sired by Hampshire, Spot, or Yorkshire boars. Although Hampshire-sired pigs grew slower than Duroc-sired pigs, they were as efficient in converting feed into weight gain. Spot- and Yorkshire-sired pigs were less efficient in converting feed into gain than Duroc- or Hampshire-sired pigs, table 19.

Litters out of purebred Landrace sows were 0.8 to 1.6 pigs smaller than litters out of F₁ crossbred sows. This would be expected since there would not be any maternal heterosis in purebred Landrace sows, while the F₁ crossbred sows would supply 100 percent of the available maternal heterosis for each trait. Litters out of Spot-Landrace sows were

TABLE 19. GROWTH TRAIT AVERAGES FOR SIX BOAR BREEDS AND SEVEN SOW BREEDS IN THE AUBURN UNIVERSITY CROSSBREEDING STUDIES

Breed	No. of pigs	Age at 220 lb.	Post-weaning av. daily gain	No. of pens	Post-weaning daily feed consumption	Feed efficiency
		<i>Days</i>	<i>Lb.</i>		<i>Lb.</i>	<i>Lb.</i>
Boar breed						
Duroc (D)	4,856	171.9	1.60	220	5.48	3.25
Hampshire (H)	4,088	176.4	1.55	160	5.41	3.25
Spot (S)	1,607	176.8	1.54	106	5.80	3.47
Yorkshire (Y)	2,382	176.4	1.53	51	5.62	3.44
Farmers Hybrid						
414 (FH414)	508	174.3	1.57	37	5.72	3.46
Farmers Hybrid						
929 (FH929)	404	181.2	1.48	38	5.44	3.39
Sow breed						
Landrace (L)	619	171.4	1.60	88	6.01	3.46
Chester White-Landrace (CL)	895	177.1	1.53	75	5.50	3.26
Chester White-Yorkshire (CY)	741	178.5	1.53	59	5.53	3.24
Duroc-Landrace (DL)	3,820	172.9	1.58	88	5.95	3.37
Hampshire-Landrace (HL)	3,366	177.4	1.53	50	5.89	3.43
Spot-Landrace (SL)	668	177.2	1.54			
Yorkshire-Landrace (YL)	3,736	174.5	1.57	155	5.83	3.35

smaller at 21 and 42 days of age and fewer pigs were marketed from these litters than from litters out of the other F_1 crossbred sows, table 17. Similar results were found for litter weights at 21 days of age, mainly because litters out of Spot-Landrace sows had fewer pigs compared to litters out of the other breeds of F_1 sows. Pigs out of Landrace sows required fewer days to obtain market weight than pigs out of the F_1 crossbred sows. These differences could be partially due to smaller litter sizes out of Landrace sows. The superior growth rate of the Duroc breed was also reflected in the growth of the pigs out of Duroc-Landrace sows. Pigs out of Duroc-Landrace sows required 1.6, 4.2, 4.3, 4.5, and 5.6 days fewer than pigs out of Yorkshire-Landrace, Chester White-Landrace, Spot-Landrace, Hampshire-Landrace, and Chester White-Yorkshire sows, respectively. Pigs out of Hampshire-Landrace sows were less efficient in converting feed into weight gain than pigs out of Chester White-Landrace and Chester White-Yorkshire sows.

SUMMARY

Results from crossbreeding studies conducted at Auburn University show differences in litter sizes, litter weights, and growth traits among litters sired by Duroc, Hampshire, Spot, and Yorkshire boars. In general, the Duroc and Yorkshire breeds were superior for the traits associated with reproduction and the Duroc breed was superior for those traits associated with growth.

Litters out of purebred Landrace sows had fewer pigs than litters out of F_1 crossbred sows, and this could be explained by the absence of maternal heterosis in the purebred sows. Spot-Landrace sows had the poorest reproduction of the six types of F_1 sows evaluated on a per-litter-farrowed basis. The Chester White-Landrace, Chester White-Yorkshire, Duroc-Landrace, Hampshire-Landrace, and Yorkshire-Landrace sows were similar in their reproductive performance on a per-litter-farrowed basis.

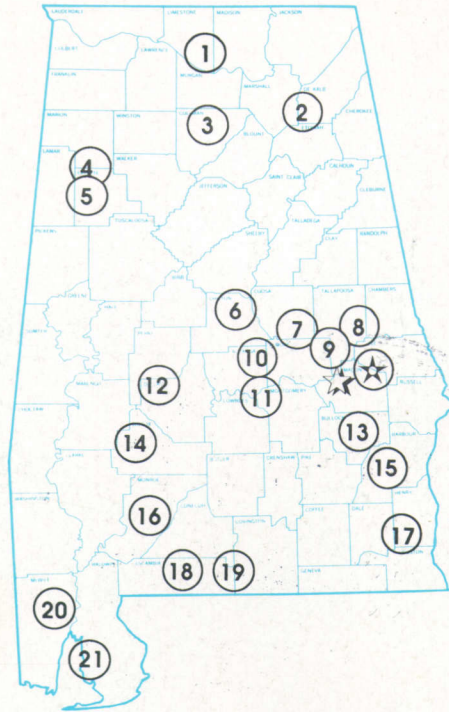
There was some evidence that, when reproduction of Duroc-Landrace, Hampshire-Landrace, and Yorkshire-Landrace sows was compared over four farrowings, a greater percentage of Duroc-Landrace and Hampshire-Landrace sows were able to complete four lactations than Yorkshire-Landrace sows. However, longevity in the herd seemed to be dependent on the type of gestation system used on the farm. The importance of longevity in the herd cannot be overlooked since it costs \$100 to \$150 above market price to purchase replacement gilts and gilts have poorer reproductive performance than mature sows. Over four parities, Duroc-Landrace and Hampshire-Landrace sows raised more total pigs to market weight than Yorkshire-Landrace sows.

The Duroc-Landrace and Hampshire-Landrace backcross sows performed better than would be expected even though there was a loss of 50 percent of the available maternal heterosis. How backcross sows would compare with F_1 sows needs to be studied.

The importance of individual and maternal heterosis for traits associated with reproduction and growth is quite evident. Three-breed crossbred litters and pigs performed better than either single-cross litters and pigs or backcross litters and pigs in these studies. The general recommendation is for producers to maximize individual and maternal heterosis in their crossbreeding programs and this probably would mean that producing single-cross and backcross litters of pigs should be avoided.

Alabama's Agricultural Experiment Station System AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

- ★ Main Agricultural Experiment Station, Auburn.
- ★ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle, Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.