HETEROSIS IN CROSSES BETWEEN THREE LINES OF YORKSHIRE SWINE SELECTED FOR FEED EFFICIENCY AND CARCASS QUALITY

The results of numerous experiments reviewed by Skårman (1965), and more recently by Glodek (1970) and Sellier (1970) have shown that although line and breed crossing resulted in marked superiority of the crossbreds in the traits associated with reproduction, growth, and survival in swine, there was little difference between the crossbred and the straightbred pigs in carcass characters or feed efficiency.

This note presents results obtained from crossing three lines of Yorkshire pigs selected from 1956 to 1967 for feed efficiency (line 1), carcass score (carcass length, backfat thickness, loin eye area, and belly grade, line 2), or feed efficiency and carcass score simultaneously (line 3). More details concerning the origin, selection procedures, and outcome of selection have been reported by Bernard and Fahmy (1970), and Fahmy and Bernard (1970, 1972). In 1968 the three lines were mated in all combinations to produce line bred and linecross litters. Four to five boars of each line were selected according to performance in their respective lines and were mated to the gilts available at random. Data were collected on litter size and weight at birth and weaning, feed efficiency as estimated from feeding groups of three to four pigs from each litter, and carcass measurements of most of these pigs at about 90 kg liveweight. Inbreeding was estimated at about 25% in the 1967 generation.

Least squares means for each of the nine groups (carcass data corrected for weight and sex) were obtained. Percent heterosis was estimated using the formula

$$H\% = 100\left[\frac{(C_1 + C_2) - (P_1 + P_2)}{P_1 + P_2}\right],$$

where C_1, C_2, P_1, and P_2 are least squares means for the two reciprocal crosses and the two linebred strains, respectively. The data were also run with another model including the effects of line of sire, line of dam, their interaction, and mating system (linebred vs. linecross) to assess the effects of these factors. Sex and the regression on carcass weight were also included in the model for carcass data.

Litter and Pig Performance

The average heterosis of litter size at birth was low (0.3% total and 1.1% alive), whereas it was moderately high (9.3%) for average piglet birth weight. This may indicate that the effect of crossing was more pronounced on prenatal growth than on prenatal survival. At weaning, however, the linecross litters exceeded the linebreds in size and weight by 29 and 26%, respectively (Table 1). The higher heterosis in litter performance at weaning in the present study resulted mainly from the higher preweaning mortality rates of the linebreds, 36%, compared with 19% for the linecrosses, since average pig weights were very close for the different groups, and indeed the linebreds were slightly heavier (0.49 kg). The higher preweaning growth rates of the linebred piglets could be the result of the reduced competition for the sows' milk among the surviving piglets caused by the higher mortality among their littermates.

Table 1. Least squares means for the linebred and linecross pigs and percent heterosis (H %)

Characters	Linebred means and SE			Linecross means and SE									Linecrosses–linebreds	H %†
	1	2	3	1 × 2	2 × 1	H %	1 × 3	3 × 1	H %	2 × 3	3 × 2	H %		
No. litters farrowed	8	8	7	13	5		5	6		5	8			
Litter size at birth, total	10.00	7.00	7.29	8.38	8.60	−0.1	7.80	6.83	−15.4	9.00	8.12	19.8	.025	.31
	0.73‡	1.25	.42	.43	1.03		.20	.75		.83	.87			
Litter size at birth, alive	8.75	6.62	6.86	7.77	8.00	2.6	6.80	6.17	−16.9	8.60	7.62	20.3	.083	1.12
	0.64	1.08	.55	.44	.77		.58	.98		1.03	.75			
Litter size at weaning	5.25	4.25	4.71	6.92	6.60	42.3	4.80	4.50	− 6.6	7.40	6.50	55.1	1.383	29.20
	1.08	1.16	1.34	.60	1.12		1.24	1.41		.87	.68			
Litter birth wt, kg	10.66	7.48	7.50	9.68	10.83	13.1	8.92	8.02	− 6.7	9.48	9.23	24.9	0.816	9.55
	0.83	1.39	0.58	0.53	0.43		0.59	1.36		1.12	0.98			
Litter weaning wt, kg	62.03	45.70	59.16	78.86	71.76	39.8	62.51	53.38	− 4.4	71.58	83.18	47.6	14.58	26.21
	10.89	12.45	18.34	6.54	9.84		16.39	17.56		7.98	10.32			
Avg pig birth wt, kg	1.077	1.090	1.021	1.167	1.329	15.2	1.140	1.141	8.7	1.049	1.145	3.9	.099	9.33
	.063	.071	.029	.062	.148		.062	.091		.078	.038			
Avg pig weaning wt, kg	12.96	10.87	12.52	11.60	11.36	−3.7	13.07	11.35	− 4.2	9.74	12.64	−4.3	− .490	−4.04
	.90	1.48	1.07	.44	.89		.99	.95		.32	.92			
Preweaning survival, %	60.00	64.20	68.66	89.06	82.50	38.1	70.59	72.93	11.6	86.05	85.30	29.0	16.78	26.11
No. litters tested	7	4	5	6	10		4	3		7	5			
Feed/kg body gain, kg	3.656	4.058	3.550	3.574	3.716	5.5	3.808	3.393	0.1	4.046	3.736	−2.3	−0.043	1.13
	0.080	0.106	0.094	0.086	0.067		0.106	0.122		0.080	0.094			
No. pigs measured	17	11	15	14	31		11	9		22	14			
Carcass length, cm	79.06	78.25	81.16	80.07	78.77	1.0	81.31	78.85	0.0	80.34	79.75	0.4	0.358	0.45
	0.48	.58	0.49	0.52	0.36		0.57	0.64		0.45	0.51			
Backfat thickness, cm	8.33	8.63	8.28	8.13	8.88	−2.9	8.03	8.87	− 1.7	8.47	8.27	1.0	.028	−0.33
	.24	.29	.25	.26	.18		.28	.32		.22	.25			
Loin eye area, cm²	25.02	25.83	24.48	24.94	23.87	−4.0	26.76	23.62	1.8	23.98	25.01	−2.6	− .413	−1.65
	.71	.86	.75	.77	.54		.84	.95		.66	.75			
Weight of ham in side, kg	8.32	8.16	8.48	8.10	8.06	−1.9	8.23	8.18	− 2.3	8.20	8.24	−1.2	− .152	−1.82
	.08	.10	.08	.08	.06		.10	.11		.08	.09			
Area of lean in ham, cm²	122.66	127.64	125.38	122.74	122.89	−1.9	128.28	121.08	0.5	122.72	128.03	−0.9	− .937	− .75
	2.24	2.71	2.38	2.44	1.70		2.66	3.00		2.10	2.38			
Age at slaughter wt, days	194.88	206.14	198.48	199.83	201.30	0.0	208.75	190.10	−1.39	206.99	217.22	−4.8	4.20	− 2.1
	4.12	4.98	4.35	4.48	3.11		4.88	5.51		3.86	4.37			

†Calculated from $100\left[\frac{\text{avg linecrosses} - \text{avg linebreds}}{\text{avg linebreds}}\right]$.

‡Standard error.

Table 2. Mean squares for feed efficiency, carcass traits, and age at slaughter

Sources of variation	df	Feed efficiency	df	Carcass length	Backfat thickness	Loin eye area	Ham weight in side	Lean in ham	Age at slaughter
Line of sire (S)	2	0.549**	2	12.5*	2.73*	14.8	0.295*	8.85	177.4
Line of dam (D)	2	0.252**	2	49.8**	2.35	11.6	0.239	150.39	1420.3**
Interaction S × D	4	0.104	4	1.6	0.14	10.2	0.021	105.84	705.0*
Mating system†	1	0.038	1	4.3	0.02	4.7	0.610**	25.38	533.2
Sex			1	56.2**	42.76**	120.2**	1.365**	179.27	2486.6**
Regression on carcass wt			1	26.7**	18.12**	5.3	6.050**	843.95**	48.2
Between litters	41	0.045	39	3.2	0.78	7.0	0.090	68.13	235.6
Within litters			93	3.5	0.85	7.4	0.098	75.71	252.2

*Significant $P < 0.05$; **significant $P < 0.01$.
†Linebreeding vs. linecrossing.

Feed Efficiency

The crosses of lines 1 and 2 were 5.5% superior to the straight lines in feed efficiency, whereas the cross between lines 2 and 3 exhibited slight negative heterosis. The average superiority of the linecrosses was 1.1% (Table 1). Heterosis in feed efficiency is expected to be relatively low since this character is largely affected by additive gene action. Of the 28 reports reviewed by Sellier (1970), 20 gave estimates for heterosis in feed efficiency of less than 4%.

Carcass Characters

Except for carcass length in which the linecrosses showed a slight positive heterosis, linebreds were generally superior to linecrosses in carcass characters and were younger at slaughter (Table 1). Studies on carcass traits have shown them to be largely dependent on additive gene action ($h^2 = 0.30$–0.65). Thus, they are only slightly affected by inbreeding and crossbreeding (Skårman 1965; Sellier 1970).

The analyses of variance for feed efficiency and carcass characters presented in Table 2 show various magnitudes for the components of variance in the several traits studied. Sex of pig and regressions on carcass weight were generally the most important factors. Line of sire and line of dam were significant sources of variation in feed efficiency and carcass length. They alternated in their effect on backfat thickness, ham weight, and age at slaughter. The interaction between line of sire and line of dam was significant only for age at slaughter.

The results of the present study, although based on relatively limited data, were nevertheless in agreement with other studies reported in the literature on the effect of crossbreeding on the economic traits in swine.

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