January 2002

Growth and Carcass Responses in the NE Index Line Estimated in Pure-line and Crossbred Litters

D. B. Petry
University of Nebraska-Lincoln

J. W. Holl
North Carolina State University

Rodger K. Johnson
University of Nebraska-Lincoln, rjohnson5@unl.edu

Growth and Carcass Responses in the NE Index Line Estimated in Pure-line and Crossbred Litters

D. B. Petry
J. W. Holl
R. K. Johnson[1]

Summary and Implications

The objective was to estimate responses in growth and carcass traits in the NE Index line (I) that was selected 19 generations for increased litter size. Responses in pure-line, F_1 and 3-way cross litters were compared. In Exp 1, 694 gilts that were retained for breeding, including 448 I and control (C) and 246 F_1 I and C by Danbred™ Landrace (L), were evaluated. Direct genetic effects of I and C did not differ for backfat or days to 230 lb; however, I had 0.24 in^2 smaller longissimus muscle area (LMA) than C ($P < 0.05$). F_1 gilts had -0.13 in less backfat, 0.67 in^2 greater LMA and –31 d less to 230 lb than pure-line gilts ($P < 0.05$). Exp 2 used individually-penned barrows and gilts including 43 I and C, 77 F_1 produced from pure-line females mated to (L) or Danbred® USA DH boars (T), and 76 3-way crosses produced from F_1 females mated to T boars. Direct genetic effects of I did not differ from C for average daily feed intake (ADFI), average daily gain (ADG), feed conversion (FC), days to 250 lb, backfat (BF), LMA, ultimate pH of the longissimus, longissimus Minolta l score, and % lean estimated by TOBEC. Responses (I minus C) in growth and carcass merit did not differ when measured in pure-line and crossbred pigs. Interactions between responses in F_1 and pure lines were not significant except for pH. F_1 and 3-way cross pigs averaged 0.51 lb/d greater ADFI, -0.53 less feed/gain and 0.44 lb/d more ADG than pure-line pigs ($P < 0.01$). F_1 and 3-way crosses had -0.35 in less BF, 0.89 in^2 greater LMA, 6.2 % greater lean, and 5.3 higher Minolta l* score than pure lines ($P < 0.05$). No correlated responses to selection for increased litter size in overall growth or carcass traits occurred. Mating Line I to leaner, faster growing sires will increase ADFI, ADG, LMA, and percentage lean , decrease feed/gain ratio, decrease backfat, and lighten meat color.*

Materials and Methods

The mating design and selection of parents are described in the preceding paper and are not repeated here. Data for this paper were collected in two experiments on pure-line I and C pigs and F_1 and three-way cross pigs produced by crossing I and C with Danbred Landrace and terminal Duroc-Hampshire sires as described in the preceding paper. The experiment was conducted during three year/season environments.

Experiment 1

A total of 694 gilts that were retained for breeding, including 538 pure-line (I and C) and 156 F1 (L x I and L x C) were evaluated. Backfat (BF) and longissimus muscle area (LMA) at the tenth rib measured with an Aloka 500 instrument and adjusted to weight of 194.5 lb and days to 230 lb were recorded in these gilts.

Experiment 2

A total of 196 barrows and gilts were individually penned. The genetic makeup of these pigs included 21 I, 22 C, 22 L x I, 22 L x C, 17 T x I, 16 T x C, 39 Tx(LxI) and 38 Tx(LxC). Pigs were selected at random from the available litters except for pure line pigs, which were selected at random after replacement gilts and boars were selected. One pig was sampled from as many different litters as possible in order to broadly represent the populations. Pigs were moved from the nursery to the individual feeding unit at approximately 65 days of age. After a 7-day acclimation period, they were placed on test. Pigs were weighed and scanned for BF and LMA at 3-week intervals, and weigh-backs on feeders were taken. A diet formulated to contain 16% crude protein, 0.81% lysine, 0.65% calcium, 0.55% phosphorus, and 1,502 kcal/lb ME was fed throughout the trial. Temperature was maintained at a range of 65 to 80°F depending on season. Pigs were on test until they weighed a minimum of 236 lb when they were transported to SiouxPreme Packing Co. in Sioux C enter, Iowa, for processing and evaluation.

Average daily feed intake (ADFI), average daily gain (ADG), feed conversion ratio (feed/gain), BF, and LMA were recorded on pigs at three-week intervals. Percentage carcass lean estimated by TOBEC, ultimate longissimus pH 24 hours after slaughter, and Minolta l* color score on loins were collected at SiouxPreme.

Statistical Analysis

Data for group-fed gilts, and pen-fed barrows and gilts were analyzed separately. Weight at final age (approximately 170 days), BF, and LMA were recorded for group-fed gilts with genetic group and year/season fitted as fixed effects and with weight at final age as a covariate.

Data for individually-fed pigs were

(Continued on next page)

Table 1. Contrasts among means for traits measured on gilts retained for breeding (Exp. 1).

	Traits measured[b]					
Contrast[a]	BF (in)	SE	LMA (in^2)	SE	Days to 230 lb	SE
I – C	-0.003	0.02	-0.24*	0.09	3.52	3.77
R: P – F_1	0.10*	0.04	-1.24*	0.56	NS	
$(I - C)_P$	-0.05**	0.01	-0.10	0.20		
$(I - C)_{F1}$	0.03	0.02	-0.67*	0.26		
F_1 – P	-0.13**	0.02	0.66**	0.07	-31.32**	4.34

[a]I – C is the contrast of the overall effect of the index line vs. the control.
R: P – F_{1L} tests the selection response between I and C in pure-line pigs vs. F_{1L} pigs.
$(I - C)_P$ tests the difference between pure-line I and C pigs.
$(I - C)_{F1}$ tests the difference between F_1 I and C pigs.
F_1 – P tests the average difference of F_1 pigs vs the average difference of pure-line pigs.
T^1 – F_1 tests the average difference of 3-way cross pigs vs the average difference of F_1 pigs.
[b]BF = Backfat, LM = Longissimus muscle area.
SE = Standard error.
**P < 0.01.
*P < 0.05.
NS = Not significant (P > 0.05).

Table 2. Contrast among means on growth traits measured on individually-penned pigs (Exp. 2).

	Traits measured[b]							
Contrast[a]	ADFI (lb)	SE	ADG (lb)	SE	FC (lb/lb)	SE	Days to 250 lb	SE
I – C	0.08	0.04	0.02	0.01	0.05	0.10	-4.40	5.25
R: P-F_{1L}	NS		NS		NS		-17.98*	8.85
$(I - C)_P$							4.58	4.00
$(I - C)_{F1L}$							-6.70	3.95
F_{1L} - P	0.12**	0.02	0.09**	0.01	-0.47**	0.06	-27.65**	2.81
T^{1L} – F_{1L}	-0.03	0.02	0.005	0.01	-0.12*	0.06	-3.33	2.82
T – F_{1T}	0.03	0.03	0.01	0.01	-0.05	0.06	-2.87	3.22

[a]I – C is the contrast of the overall effect of the index line vs the control.
R: P – F_{1L} tests the selection response between I and C in pure-line pigs vs F_{1L} pigs.
$(I - C)_P$ tests the difference between pure-line I and C pigs.
$(I - C)_{F1L}$ tests the difference between F_{1L} I and C pigs.
F_{1L} – P tests the difference between average F_{1L} pigs and pure-line pigs.
T^{1L} – F_{1L} tests the difference between average 3-way cross pigs and F_{1L} pigs.
T – F_{1T} tests the difference between the average of 3-way cross pigs and F_{1T} pigs.
[b]ADFI = Average daily feed intake, ADG = Average daily gain, FC = Feed conversion.
SE = Standard error.
**P < 0.01, *P < 0.05, NS = Not significant (P > 0.05).

collected during consecutive 3-week intervals from when pigs were placed on test at 72 days (mean weight = 60.0 lb) until they were removed from test at approximately 250 lb. Data for each period and data for the entire test period were analyzed separately. Data recorded were weight at beginning of the test and at the end of each 3-week period, feed intake during each period, BF, and LMA at the end of each period. From the feed intake and weight data, ADG, ADFI, and feed/gain ratio (FC) were calculated. These three traits were analyzed with a general linear model that included genetic group x year x season combination, sex of the animal and group x year x season by sex interaction.

Carcass traits were fitted to the same model with final live weight included as a covariate. The combined effect of season x genetic group was fitted together because all genetic groups did not occur in each season and appropriate linear contrasts of effects were used to estimate line differences and interactions with mating system.

Results and Discussion

Experiment 1

Table 1 contains contrasts among means for growth traits recorded in gilts retained for breeding. Differences between I and C within interaction subclasses (pure line and F_1) were estimated only if the interaction was significant.

There was a correlated response in LMA to selection for increased litter size. Line I gilts had 0.24 $\pm$ 0.09 in^2 (P < 0.05) smaller LMA than Line C gilts. Differences between I and C gilts in BF and Days were not significant.

An interaction in responses (I minus C) in BF and LMA in pure line gilts vs F_1 gilts occurred. Pure-line I gilts had -0.05 $\pm$ 0.01 in less BF (P < 0.01) than pure-line C gilts. The difference in BF when measured in F_1 gilts was 0.03 $\pm$ 0.02 in (P > 0.05). Pure-line I gilts had -0.10 $\pm$ 0.20 in^2 (P > 0.05) less LMA than pure-line C gilts; whereas, the difference when measured in F_1 gilts was -0.67 $\pm$ 0.26 in^2 (P < 0.05). One possible explanation for this interaction is that higher levels of inbreeding (estimated to be 22% in Line I and 15% in Line C at Generation 19) caused Line I pigs to grow slower and eat less feed as purebreds, but this difference was eliminated in F_1 pigs that expressed 100% heterosis.

Overall F_1 gilts had less BF (-0.13 $\pm$ 0.02 in), larger LMA (0.66 $\pm$ 0.07 in^2), and reached 230 lb in fewer days (-31.3 $\pm$ 4.34 d) than pure-line gilts (P < 0.0001). These differences are due to the joint effects of 100% heterosis in F_1 gilts and to the effect of the 50% genetic makeup of the F_1 gilts from the Danbred USA™ Landrace sires.

Experiment 2

Sex was significant for ADFI, ADG and Days to 250 lb and season/parity/line was significant for ADFI, ADG, FC and Days to 250 lb. Table 2 contains estimates of contrasts among means. Lines I and C did not differ for any of the traits measured (P > 0.05). Overall, Line I pigs ate 0.08 $\pm$ 0.04 lb more feed per

Table 3. Contrast among means for carcass traits measured on individually-penned pigs (Exp. 2).

	Traits measured[b]									
Contrast[a]	BF (in)	SE	LMA (in^2)	SE	% Lean	SE	pH	SE	l*	SE
I – C	0.10	0.06	-0.16	0.26	-0.40	1.56	-0.04	0.08	1.01	2.52
F_{1L} - P	-0.32**	0.04	0.81**	0.15	5.52**	0.96	-0.09	0.05	4.54**	1.49
$T - F_{1L}$	-0.02	0.04	0.16	0.14	1.39	0.83	-0.01	0.04	1.45	1.36
$T - F_{1T}$	-0.02	0.04	0.46**	0.16	0.08	0.96	-0.03	0.05	1.04	1.56

[a]I – C is the overall effect of the index line vs the control.
F_{1L} – P tests the difference between the average of F_{1L} pigs and pure-line pigs.
$T - F_{1L}$ tests the difference between the average of 3-way cross pigs and F_{1L} pigs.
$T - F_{1T}$ tests the difference between the average of 3-way cross pigs and F_{1T} pigs.
[b]BF = Backfat, LMA = Longissimus muscle area, Lean = % carcass lean measured with TOBEC, pH = Muscle pH at 24 h after slaughter, l* = Minolta l* color score.
SE = Standard error.
**P < 0 .01, *P < 0.05, NS = Not Significant (P > 0.05).

day, gained 0.02 ± 0.01 lb more weight per day, had 0.05 ± 0.10 greater food/gain ratio, and reached 250 lb 4.40 ± 5.25 days sooner than C pigs.

An interaction for days to 250 lb in selection response (I minus C) estimated in pure-line pigs vs F_{1L} pigs occurred. The response in pure-line pigs was 4.58 ± 4.00 d (P > 0.20) whereas the response in F_{1L} pigs was 6.70 ± 3.95 d (P > 0.05). The biological explanation is that pure line I pigs ate less feed than C pigs, which caused them to gain less rapidly, but L x I pigs ate more feed than L x C pigs. It is possible that the greater level of inbreeding in line I than C caused them to grow slower and eat less feed as purebreds, but this difference was eliminated in F_1 pigs. Overall F_{1L} pigs had higher ADFI (0.12 ± 0.02 lb), ADG (0.09 ± 0.01 lb/d), lower FC (-0.47 ± 0.06), and reached 250 lb in fewer days (27.7 ± 2.81 d) than pure-line pigs (P < 0.001). Overall three-way cross pigs had lower FC (-0.12 ± 0.06) than F_{1L} pigs (P = 0.05). Other differences between three-way cross pigs and F_{1T} pigs were not significant.

Responses estimated in the different crosses differ because F_1 pigs express 100% individual heterosis, whereas pure line pigs express no heterosis, and 50% of the genetic makeup of the F_{1L} pigs were from the Danbred® USA Landrace sire. The enhanced performance of 3-way crosses over F_{1L} pigs was due to the effect of the Danbred® USA Terminal sire and the expression of 100% individual and maternal heterosis.

Carcass Traits

Sex was significant for BF and percentage carcass lean and season/parity/line was significant for BF, LMA, percentage lean, and Minolta l* color score. Interactions between these effects were not significant. Traits were standardized to a live weight at slaughter of 248.2 lb. Table 3 contains estimates of contrasts among means.

Lines I and C did not differ (P > 0.05) for any of the traits measured. Overall, I had 0 .10 ± .06 in more BF, 0.16 ± 0.26 in^2 less LMA, 0.40 ± 1.56 less % lean, 0.04 ± .08 lower pH, and 1.01 ± 2.52 greater Minolta l* color score (paler meat).

Interactions of line differences and genetic background where measured were not significant. When pigs are standardized to a live weight of 248.2 lb the conclusion is that responses in I and C did not differ in carcass merit when measured in pure-line and crossbred pigs.

Overall F_{1L} pigs had less BF (-0.32 ± 0.04 in), more LMA (0.81 ± 0.15 in^2), greater percentage carcass lean (5.52 ± 0.96 %), and higher Minolta l* color score (4.54 ± 1.49 score) than pure-line pigs (P < 0.01). Differences between three-way cross pigs and F_{1L} pigs and between three-way cross pigs and F_{1T} pigs were not significant.

Conclusion

There were no correlated responses in growth and carcass traits to selection for increased litter size. Line differences were expressed equally in pure line and crossbred pigs. Carcass and growth traits were greatly improved by crossing both Lines I and C with Danbred's Landrace and Terminal sires.

[1]D. B. Petry is a graduate student and research technician in the Department of Animal Science, J. W. Holl is a graduate student at North Carolina State University, and R. K. Johnson is a professor in the Animal Science Department.