Performance and Body Composition of Gilts from Differing Genetic Lines as Affected by Nutritional Program

K.D. Ragland, research assistant;
L.L. Christian, professor; and
T.J. Baas, assistant professor;
Department of Animal Science
R. N. Goodwin, Director of Research
National Pork Producers Council

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Summary and Implications

Gilts restricted fed a high-protein ration were slower growing (P<.05) than gilts *ad libitum* fed a high- and moderate-protein diet. Gilts *ad libitum* fed a moderate-protein diet with added fat had significantly (P<.05) more fat accretion than gilts *ad libitum* fed and restricted fed a high-protein diet. A genetic line by diet interaction (P<.05) was observed for average daily gain. Also, gilts with the presence of a terminal breed in their ancestry were leaner and heavier muscled (P<.05) than gilts with no presence of a terminal breed in their ancestry.

Introduction

To develop biologically and economically efficient feeding strategies, a pig's meat content, leanness, and daily gain must be considered. These three traits are not only affected by genetics but also by diet.

Bereskin et al. (1) reported pigs fed a high-protein diet had greater weight gain and meat content and less carcass fat content than pigs fed a low-protein diet. Karlsson et al. (5) found pigs fed a high-protein diet had a higher total growth rate, lean tissue growth rate, and lean percentage than pigs fed a low-protein diet.

Several authors have reported compensatory gain in pigs after a period of feed restriction. Donker et al. (4) and Bikker et al. (2) reported an increase in feed intake and body gain in pigs fed *ad libitum* after a period of restriction. Campbell et al. (3) reported an increase in efficiency of gain in animals fed restrictedly after an interval of decreased feeding.

The objective of this study was to investigate possible differences in performance and body composition of genetic lines that are due to gilt development nutrition programs.

Materials and Methods

Animals and feeding. Six hundred and forty-six gilts of five different genetic lines (Genetic Improvement Services, Genetiporк, Hampshire-Duroc F_1, National Genetic Technology and Yorkshire-Landrace F_1) were used in this study. Gilts were acquired between 8–15 d of age. These gilts were sent to the Minnesota Pork Producers Association (MPPA) segregated-early-weaning (SEW) station. Pigs were fed SEW and starter diets (Table 1).

Pigs were moved to the MPPA Swine Testing Station in three stages at 35 to 40 lb. There they were first placed in the environmentally controlled facility where pigs were grouped seven or eight per pen, and fed the grower diet (Table 1).

Gilts were moved to pens in the curtain-sided, partially-slotted floored building at the station when average pig weight was approximately 90 lb. Each 8 ft by 25 ft pen accommodated approximately 19 gilts. The gilts continued to be fed the grower diet.

At an average age of 120 d (≈ 150 lb) gilts were assigned to one of three gilt development programs (Table 1); *ad libitum* high protein (T1), *ad libitum* low protein (T2), or restricted intake (4 lb/d) high protein (T3). Littermates were assigned across diets. Gilts assigned to T1 and T2 were fed a gestation diet (4.5 lb/d) (Table 1) after they weighed 250 lb and until ≈ 180 days of age. Gilts assigned to T3 received the grower diet from 150–300 lb. They were subsequently placed on T3 until 180 d of age.

Upon reaching 180 d of age, gilts were penned by genetic type in the curtain-sided facility. All gilts were restricted fed (4.5 lb/d) the gestation diet for 20 d. Gilts were fed 6 lb/d of the gestation diet from 200 d of age until they were mated. Gilts were then fed 4.5 lb/d of gestation diet until 300 d of age.

Table 1. Protein, added fat, and lysine content by diet.[1]

Diet	Protein, %	Added Fat, %	Lysine, %
SEW	25	6	1.7
Starter	24	3	1.5
Grower	21	3	1.2
(T1)	18	-	.95
(T2)	13	5	.60
(T3)	18	-	1.3
Gestation	16	-	.80

[1]T1=Treatment diet 1, T2=Treatment diet 2, T3=Treatment diet 3.

Ultrasonic evaluation. Gilts were weighed and ultrasonically evaluated for backfat thickness and loin muscle area at ≈ 120, 180, and 300 d of age. Scanning was accomplished with an ALOKA 500V (Corometrics Medical Systems, Wallingford, Connecticut) real-time ultrasonic machine fitted with a 12.5 cm, 3.5 Mhz linear array transducer. Ultrasonic images were digitized on-site by using a personal computer equipped with a frame-grabber board and controlling software. The images were stored as digitized files for later interpretation.

Ultrasonic images were taken along the dorsal midline at the tenth rib. The transducer was aligned perpendicular to the spine at the tenth rib. A crosssectional image of the loin muscle and subcutaneous fat overlying the loin muscle on the right hand side of the pig at the tenth rib was acquired using a sound-emitting transducer guide that fitted the natural contour of the pig's back.

Digitized images were interpreted using Quality Evaluation and Prediction (Iowa State University, Ames, Iowa), a computer software package developed specifically to measure linear distance and area of digitized images and matriculate to a data file. BF10 was measured as the distance from the outer edge of the skin to the start of the fascia layer in the center of the *longissimus* muscle at a point approximately 2.5 in. lateral to the spine.

Average daily gain (ADG), backfat deposition rate, and loin muscle area rate (LMAR), cm^2/d, were calculated between 120 and 180 d, 180 and 300 d, and 120 and 300 d.

Statistical analysis. A least squares analysis of variance procedure using a general linear model (6) was used to evaluate dependent variables for sources of variation. The general model included the effects of treatment, genetic line and interaction, and the linear effect of live weight. Weight at 120 d of age was used as the linear covariate in the model for traits measured between 120 and 180 d and 120 and 300 d. Weight at 180 d of age was used as the linear covariate in the model for traits measured between 180 and 300 d. Pearson product-moment correlation coefficients were used to analyze relationships between traits on a total and residual basis.

Additionally, gilts were grouped by the presence or absence of a terminal breed (Duroc or Hampshire) in their ancestry. Gilts without any influence of a terminal breed in their background were referred to as those with no terminal line influence (NTLI). Gilts with a terminal breed in their ancestry were referred to as those with terminal line influence (TLI). A least squares analysis was used to evaluate TLI and NTLI groups for sources of variation.

Results and Discussion

Total and residual correlations are given in Table 2. Residual correlations after accounting for the effects of treatment, genetic line and interaction, and the linear effect of live weight for BF10 were .60, .62, and .47 (P<.01) between the first and second scan period, the second and third scan period, and the first and third scan period, respectively. The corresponding correlations for LMA were .51, .49, and .45 (P<.01), respectively. Ultrasound measurements taken in adjacent periods were more highly correlated than those taken in nonadjacent periods.

Least squares means and standard errors for growth and composition traits across genetic line are given in Table 3. Significant genetic line differences (P<.01) were observed for ADG, BF10, and LMA in all three periods.

Least squares treatment means and standard errors for growth and composition changes between 120 and 180 d are given in Table 4. Significant treatment differences were observed for ADG, BFR and LMAR. Gilts allocated to T3 had the lowest ADG, BFR and LMAR; T2 gilts had the highest ADG and BFR, and T1 gilts were intermediate for ADG and BFR. No significant differences were observed between T1 and T2 for LMAR between 120 and 180 d.

Least squares means and standard errors for growth and composition changes between 180 and 300 d are given in Table 5. Gilts in treatments 1 and 2 had significantly more fat accretion and were faster growing (P<.05) than gilts on treatment 3. No significant treatment differences were observed in LMAR between 120 and 300 d.

Least squares means and standard errors for growth and composition changes between 120 and 300 d are given in Table 6. Gilts allocated to T3 were significantly (P<.05) slower growing than T1 and T2 gilts. Additionally, T1 and T3 gilts had significantly (P<.05) less fat accretion than T2 gilts.

A line by diet interaction (P<.05) was found for ADG measured between 120 and 180 d (Figure 1). Line 4 gilts did not show as great a response to T3 as did gilts from the other four lines. Additionally, line 1 gilts did not exhibit as great a response for T1 and T2 as did gilts from the other four lines. TLI gilts significantly (P<.05) outperformed NTLI gilts for ADG between 120 and 180 d. TLI gilts had a higher ADG between 180 and 300 d and 120 and 300 d as well, but the difference was not significantly different (Figure 2).

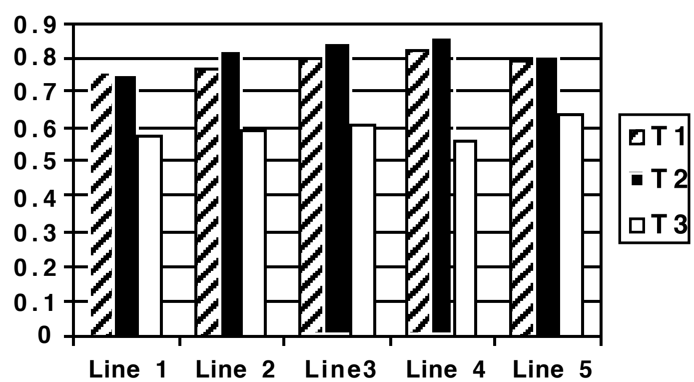

Figure 1. Line by diet interaction effects for average daily gain measured between 120 and 180 d of age.

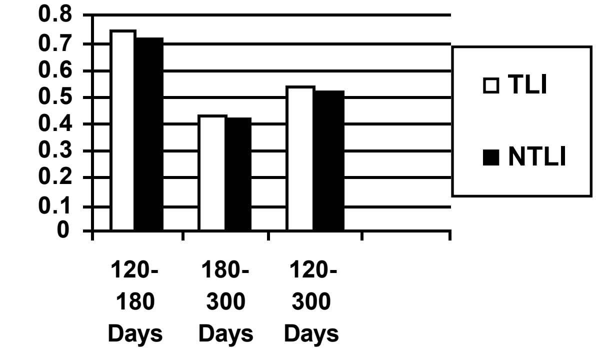

Figure 2. Average daily gain for gilts with TLI, terminal line influence, or NTLI, no terminal line influence, measured between 120 and 180 d, 180 and 300 d, and 120 and 300 d.

TLI gilts deposited significantly ($P<.05$) less fat than NTLI gilts between 180 and 300 d and 120 and 300 d. Although not significantly different, TLI pigs deposited less fat between 120 and 180 d as well (Figure 3).

TLI gilts had significantly ($P<.05$) greater LMAR for all three periods (Figure 4).

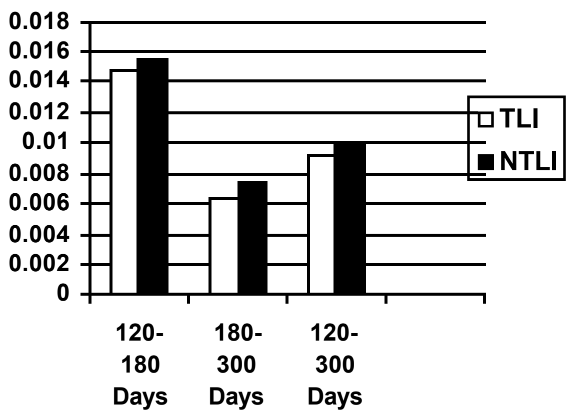

Figure 3. Rate of backfat accretion for gilts with TLI, terminal line influence, or NTLI, no terminal line influence, measured between 120 and 180 d, 180 and 300 d, and 120 and 300 d.

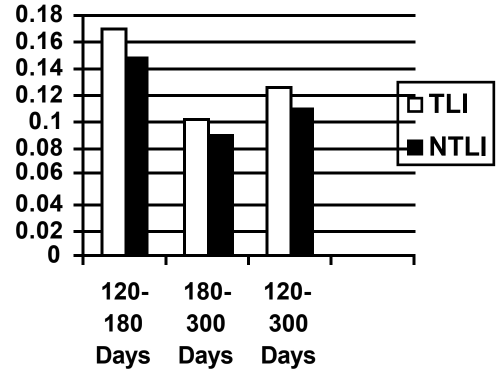

Figure 4. Rate of loin muscle deposition for gilts with TLI, terminal line influence, or NTLI, no terminal line influence, measured between 120 and 180 d, 180 and 300 d, and 120 and 300 d.

Conclusions

Gilts in T3 grew significantly ($P<.05$) slower than T1 and T2 gilts; however, T3 gilts did exhibit compensatory gain between 180 and 300 d. Gilts in T2 had significantly ($P<.05$) higher rates of fat accretion. A significant ($P<.05$) genetic line by diet interaction was observed for ADG between 120 and 180 d. Also, gilts with terminal line influence had significantly ($P<.05$) lower BFR and higher LMAR than gilts with no terminal line influence. A gilt's genetic potential for lean growth, therefore, should be considered before implementing any nutritional regime.

References

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Table 2. Total and residual correlations[1] between composition traits.[2]

Variable	1	2	3	4	5	6
1 BF1	1.00	0.02	0.54*	-0.09	0.50*	-0.09
2 LMA1	-0.33*	1.00	-0.07	0.54*	-0.15*	0.41*
3 BF2	0.60*	-0.32*	1.00	-0.12*	0.61*	-0.12*
4 LMA2	-0.23*	0.51*	-0.32*	1.00	-0.20*	0.60*
5 BF3	0.47*	-0.26*	0.62*	-0.23*	1.00	-0.15*
6 LMA3	-0.15*	0.44*	-0.21*	0.50*	-0.16*	1.00

[1] Pearson correlations above the diagonal, residual correlation below the diagonal.
[2] BF=10th rib backfat, LMA=loin muscle area, 1=measurements taken at 120 days of age, 2=measurements taken at 180 days of age, 3=measurements taken at 300 days of age.
* P<0.01.

Table 3. Least squares means and standard errors by line for performance traits.[1]

Line	BF1	LMA1	BF2	LMA2	BF3	LMA3
Line 1	0.499±.009[b]	3.53±.04[c]	0.840±.017[a]	4.95±.05[d]	1.207±.024[b]	6.50±.07[d]
Line 2	0.536±.009[c]	3.70±.04[b]	0.952±.017[a]	5.13±.05[c]	1.267±.024[b]	6.88±.07[c]
Line 3	0.554±.009[c]	3.92±.04[a]	0.905±.017[a]	5.81±.05[a]	1.238±.024[b]	7.81±.07[a]
Line 4	0.551±.009[c]	3.82±.04[a]	0.964±.017[a]	5.18±.05[c]	1.256±.024[b]	6.98±.07[c]
Line 5	0.464±.009[a]	3.91±.04[a]	0.777±.017[a]	5.61±.05[b]	1.022±.024[aa]	7.35±.07[b]

[1] BF=10th rib backfat, LMA=loin muscle area, 1=measurements taken at 120 days of age, 2=measurements taken at 180 days of age, 3=measurements taken at 300 days of age.
Means with the same letter are not significantly different (P<0.05).
[a, b, c] Pdiff (6) used for significance testing.

Table 4. Least squares means and standard errors by treatment for performance changes between 120 and 180 days of age.[1]

Treatment[2]	ADG, lb/d	BFR, in./d	LMAR, in.^{2}/d
T1	1.732±.015[b]	0.006492±.000168[b]	0.02702±.00057[a]
T2	1.794±.015[a]	0.008012±.000171[a]	0.02649±.00058[a]
T3	1.300±.015[c]	0.003230±.000172[c]	0.02195±.00059[b]

[1] ADG=average daily gain, BFR=backfat rate of accretion, LMA=loin muscle area deposition rate
[2] T1=*ad libitum* high protein diet, T2=*ad libitum* low protein diet, T3=restricted intake (4 lb/d) high protein diet.
Means with the same letter are not significantly different (P<0.05).
[a, b, c] Pdiff (6) used for significance testing.

Table 5. Least squares means and standard errors by treatment for performance changes between 180 and 300 days of age.[1]

Treatment[2]	ADG, lb./d	BFR, in./d	LMAR, in.^{2}/d
T1	0.873±.016[b]	0.002286±.000125[a]	0.01483±.00043[a]
T2	0.882±.016[b]	0.002012±.000129[a]	0.01510±.00044[a]
T3	1.042±.018[a]	0.003656±.000140[b]	0.01531±.00048[a]

[1] ADG=average daily gain, BFR=backfat rate of accretion, LMA=loin muscle area deposition rate.
[2] T1=*ad libitum* high protein diet, T2=*ad libitum* low protein diet, T3=restricted intake (4 lb/d) high protein diet.
Means with the same letter are not significantly different (P<0.05).
[a, b, c] Pdiff (6) used for significance testing.

Table 6. Least squares means and standard errors by treatment for performance changes between 120 and 300 days of age.[1]

Treatment[2]	ADG, lb/d	BFR, in./d	LMAR, in.^{2}/d
T1	1.170±.011[a]	0.003690±.000089[a]	0.018886±.000270[a]
T2	1.199±.011[a]	0.004053±.000091[b]	0.018767±.000275[a]
T3	1.133±.011[b]	0.003579±.000092[a]	0.018094±.000277[a]

[1] ADG=average daily gain, BFR=backfat rate of accretion, LMA=loin muscle area deposition rate.
[2] T1=*ad libitum* high protein diet, T2=*ad libitum* low protein diet, T3=restricted intake (4 lb/d) high protein diet.
Means with the same letter are not significantly different (P<0.05).
[a, b, c] Pdiff (6) used for significance testing.