Effects of Nutrition During Gilt Development on Lifetime Productivity of Sows of Two Prolific Maternal Lines: Growth and Puberty Characteristics of Rep 1 Gilts

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Summary

This report is an annual update of an ongoing experiment initiated in 2005 to investigate effects of energy restriction during gilt development on reproduction through four parities. Gilts of two genetic lines expected to differ in rate of growth are used and are developed with either ad libitum access to feed or are restricted in energy to 75% of ad libitum amounts from approximately 120 days of age to breeding. Semen of the same sires, an industry maternal line, was used to produce gilts of both lines, but their dams were from two uniquely different populations. Dams of one line were an industry Large White x Landrace (LW x LR) cross and dams of the other line were from a Nebraska line (Line 45) selected 23 generations for increased ovulation rate, uterine capacity, and litter size (L45X). Both lines are expected to be prolific, but L45X females are expected to be extra prolific, being earlier maturing and having larger litters; whereas LW x LR gilts are expected to have greater rates of lean growth. The experiment is being conducted in three replications with 160 gilts per replication. Replication 1 gilts completed the gilt development phase in summer of 2005 and were mated for December 2005 litters. Replication 2 gilts were born in May 2005 and are currently in the gilt development phase. Replication 3 gilts will be born in November 2005. The project will terminate when Replication 3 females wean their fourth parity litters. This report summarizes growth rate, backfat and longissimus muscle deposition, and age at puberty in Replication 1 gilts. Lines differed in growth rate, LW x LR cross gilts grew faster than L45X gilts, but at the same weights, lines had similar backfat and longissimus muscle area. L45X gilts were younger at puberty. Restricting intake during the gilt development period affected both lines similarly, reducing growth rate and backfat deposition, but did not affect longissimus muscle deposition. The objectives of the experiment are being accomplished and will answer the question of whether energy restriction during gilt development, and thus less backfat at breeding, affects lifetime productivity.

Introduction

Annual death losses in many sow herds average 10 to 12%, and losses as high as 18% have been recorded. Death losses and involuntary culling result in annual sow replacement rates of 45 to 55%. Because lower sow culling rates would have important economic benefits for pig producers, the Animal Science Committee of the National Pork Board has identified sow longevity/mortality as an industry priority for 2006.

Many variables contribute to herd-to-herd variation in sow mortality including housing systems, management practices associated with gilt development, sow management practices, and possibly use of different genetic lines. At the University of Nebraska–Lincoln (UNL), we are focusing on two of these components: nutritional regimens during gilt development and prolific lines that differ in rate of lean growth.

Two gilt development practices prevail in the industry. One is to provide gilts ad libitum access to feed for maximum growth rate until 230 to 250 lb; thereafter gilts are limit fed until flushing/breeding at 280 to 300 lb. Another practice is to maintain gilts with ad libitum access to feed right up to breeding. In both cases, it is commonplace to mate gilts at their second or third post-pubertal estrus and mate them again for subsequent litters within five to 10 days of weaning after a 15 to 23-day lactation period.

Optimum gilt development regimens, however, may depend on the prolificacy of the line and on its rate of lean growth. We initiated an experiment to address the effects of different nutritional regimens during gilt development on sow reproduction and longevity. The initial report of the design of the experiment is in the 2005 Nebraska Swine Report. The experiment was designed to determine whether gilt nutritional development strategies affect longevity and lifetime productivity of prolific gilts that differ in rate of lean growth. Sow longevity was defined as production through four parities. The time between when females are mated to produce project gilts until gilts wean their fourth litter is just over two years. The project is being conducted in three replicates at approximately four-month intervals; therefore, the entire experiment will take approximately three years to complete. Replication 1 gilts completed the development phase during the summer of 2005 and were mated during September of 2005. This report presents the feed intake, growth rate, and puberty data for Replication 1 gilts.

Materials and Methods

Production of Replication 1 gilts

Litters from which Replication 1 gilts were selected were born during the last week of December 2004 and the first week of January 2005. Their dams were from two distinctly different maternal lines (see below) that were inseminated during a two-week period in September of 2004 with semen from boars of an unrelated industry maternal line (L_M). Project gilts were selected randomly when pigs were 56 days of age.

Gilt Population I (LW x LR): Population 1 gilts were the progeny of L_M boars and females of the Large White-Landrace female population that is used routinely in the UNL swine nutrition research program. It is maintained using artificial insemination in a rotation cross between the industry Large White (LW) and Landrace (LR) lines. These females are designated as industry LW x LR cross. A total of 20 litters of this cross were produced; 80 LW x LR gilts, averaging four per litter, were selected for Replication 1.

Gilt Population II (L45X): Population 2 gilts were progeny of the same L_M boars that sired LW X LR gilts and females of the Nebraska line (Line 45) that has been selected 23 generations for increased litter size. This population is designated L45X. Selection over the generations in the Nebraska line included combinations of ovulation rate, uterine capacity, and litter size at birth. During the last six generations, Line 45 also was selected for increased growth rate, decreased backfat, and increased longissimus muscle area. A total of 45 L45X litters were produced; 80 gilts, two from each of 40 litters, were selected for Replication 1.

All litters were sired by a total of nine L_M boars. Thus, the 160 gilts selected for Replication 1 represented nine half-sib families that contained both LW x LR and L45X gilts.

Management of gilts

At birth, pigs from litters the gilts were born in were crossfostered both within and between sows of the two populations to reduce variation in number of pigs nursed by dams. Litters averaged 13.3 days of age at weaning (range 11 to 16 days). At weaning, pigs were placed in a nursery with 30 pigs per pen where they remained until approximately 56 days of age. Standard nursery diets and management were used.

At an average of 56.2 days of age (range of 48 to 61 days), gilts were weighed and placed in pens of 10 head per pen by population, age, and litter in a modified-open-front, curtain-sided building (MOF). All pens were identical with 1/3 slatted and 2/3 solid surface, providing approximately 8.5 sq ft per gilt. Gilts of LW x LR and L45X populations were assigned to alternate pens and littermates were assigned to different pens (e.g., Pens 1 and 3 contained littermates, Pens 2 and 4 contained littermates, etc.) Within each of these pairs of pens within populations, one pen was randomly assigned to Treatment 1 (see below), the other received Treatment 2, resulting in four pens per population x treatment class.

Treatments. Gilts received the same diet and management from when they were placed in the MOF until an average age of 123 days. During that time, they had ad libitum access to a standard corn-soybean meal diet. A three-phase feeding regimen was used. Phase 1 diet contained 1.15% lysine and was fed from 56 days of age to 80 lb, Phase 2 diet contained 1.0% lysine and was fed from 80 lb to mean weight of 130 lb, Phase 3 diet contained .9% lysine and was fed until gilts were 123 days of age when they were placed on experimental dietary regimens.

Treatment 1 was a feeding regimen in which gilts were provided ad libitum access to feed in a self-feeder during the entire period from 123 days of age until they were moved to the breeding barn approximately one week before breeding commenced. The diet was corn-soybean meal-based and formulated to contain 0.70% lysine, 0.70% Ca, and 0.60% P. All other nutrients met or exceeded requirements for developing gilts outlined in the UNL/SDSU Swine Nutrition Guide (2000).

Gilts on Treatment 2 received a daily allotment of feed by weight that was 75% of that consumed by gilts on Treatment 1. The diet was formulated similar to the diet described for Treatment 1 except that it was fortified to contain 0.93% lysine, 1.0% Ca, and 0.8% P. All trace minerals, except Se, and vitamins were also increased to compensate for reduced feed intake. Daily intake of all nutrients except energy was expected to be similar for gilts on both diets. The daily allotment was adjusted at two-week intervals and was based on average daily feed intake of gilts of the same population with ad libitum access to feed.

Beginning at 56 days of age, gilts were weighed at two-week intervals, feed delivered to each pen during that interval was recorded, and beginning and ending feeder weights were recorded. Average daily feed intake (ADFI) for pens of gilts with ad libitum access to feed (T1 and T2 before 123 days of age, T1 after 123 days of age) in each pen during each

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two-week period, and the mid-weight (MW) of gilts in that pen (mean beginning weight + mean final weight)/2) were calculated. After each weigh-day, quadratic regression of ADFI on MW was calculated separately for LW x LR and L45X gilts. Beginning at 123 days of age, predicted MW of gilts in each pen on Treatment 2 during the next two-week period was calculated from past growth and used in the regression equation to calculate the expected average feed intake for the pen if ad libitum access to feed was permitted. The average daily allotment for gilts in that pen during the next period was set at 75% of that value. The allotment of feed was placed on the solid flooring daily in two feedings, one-half at approximately 8:00 a.m. and one-half in late afternoon.

Traits. Pigs averaged 56.2 days at the beginning of the trial and 235 days when last weights were recorded. Fourteen weights per pig and 13 pen feed intake values were recorded. When pigs were placed on treatment at 123 days of age, ultrasound scans of backfat (BF) and longissimus muscle area (LMA) at the 10th rib also were recorded. There were nine BF and LMA records per pig.

Beginning when mean age of pigs in each pen was 140 days, heat-checking to determine age at puberty commenced. It was accomplished by moving pigs from each pen to an adjacent building where they were exposed to a boar and observed for the standing response indicative of estrus. The day of first observed estrus was considered to be age at puberty. Heat checking continued until the end of the trial or until all gilts in the pen had been observed in estrus at least twice. Length of estrus, the number of consecutive days they remained in estrus, and the intervals between estrous periods were recorded. Gilts were moved to the breeding facility at approximately 240 days of age.

Table 1. Numbers of gilts starting the trial, numbers removed because they were unthrifty, numbers expressing their pubertal estrus, and mean age at puberty for gilts in each group.

Population	Nutritional regimen	No. at 56 days of age	No. removed 56 to 123 days (unthrifty)	No. removed 123 to 236 days (unthrifty)	No. expressing pubertal estrus	Mean age at puberty
LW X LR	Ad libitum	40	0	0	38	173.2
	Restricted	40	0	0	34	167.5
L45X	Ad libitum	40	3	1	35	161.1
	Restricted	40	2	0	37	167.3
Population						*
Population *treatment						*

LW X LR = Cross of commercial L_M boars with UNL Large White-Landrace females.
L45X = Cross of L_M boars with females of the Nebraska prolific line.
*$P < 0.05$.

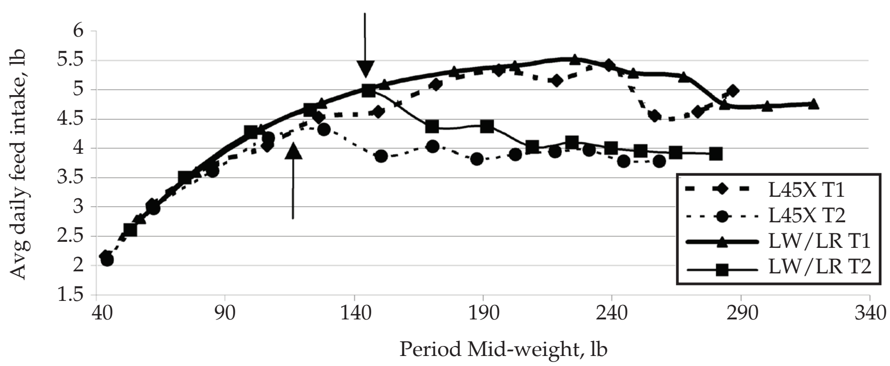

Figure 1. Average daily feed intake plotted against mid-weight per two-week period for LwxLR (solid lines) and L45X (dashed lines) gilts developed with ad libitum intake (T1 = bold lines) or 75% of ad libitum intake (T2 = plain lines) from 120 days of age.

Analyses: Feed intake, weight, backfat, longissimus muscle area, and puberty data of Replication 1 gilts are reported. Regressions of feed intake on MW over the entire feeding period were compared between LW X LR and L45X. No other feed intake comparisons were made because feed intake for gilts on Treatment 2 was controlled.

Age at puberty was analyzed with a model including population, dietary treatment, their interaction, and the random effect of litter as the error variance. Other variables were analyzed with regression methods. Weight was regressed on age in a model including fixed effects of population, dietary treatment, and their interaction and linear and quadratic regressions on age and interactions of regression coefficients with fixed effects. Litter was included as a random effect and repeated measures on each pig were accounted for. Similar analyses were performed for backfat and longissimus muscle area, except that these variables were regressed on weight.

Results

Table 1 contains the numbers of unthrifty gilts that were removed from the trial, the numbers for which a pubertal estrus was recorded, and the mean age at puberty for gilts in each group. Six unthrifty L45X gilts were removed from the trial before breeding age, five of them were removed before

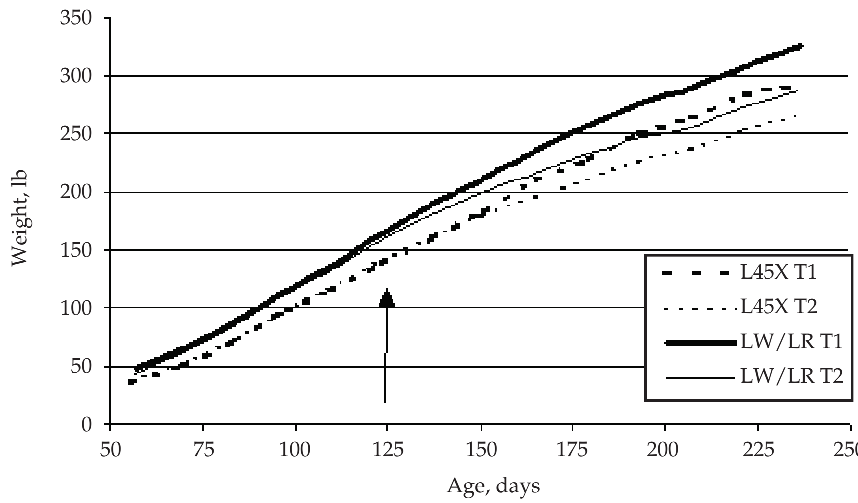

Figure 2. Regressions of weight on age for LW x LR (solid lines) and L45X (dashed lines) gilts developed on ad libitum access to feed (T1 = bold lines) or 75% of ad libitum (T2 = standard lines) from 120 days of age.

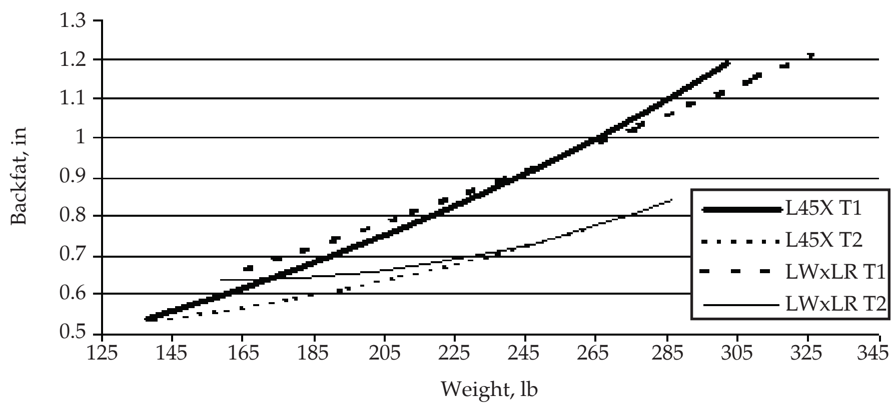

Figure 3. Regressions of backfat on weight for LW x LR (solid lines) and L45X (dashed lines) cross gilts developed with ad libitum intake (T1 = bold lines) or 75% of ad libitum intake (plain lines) from 123 days of age.

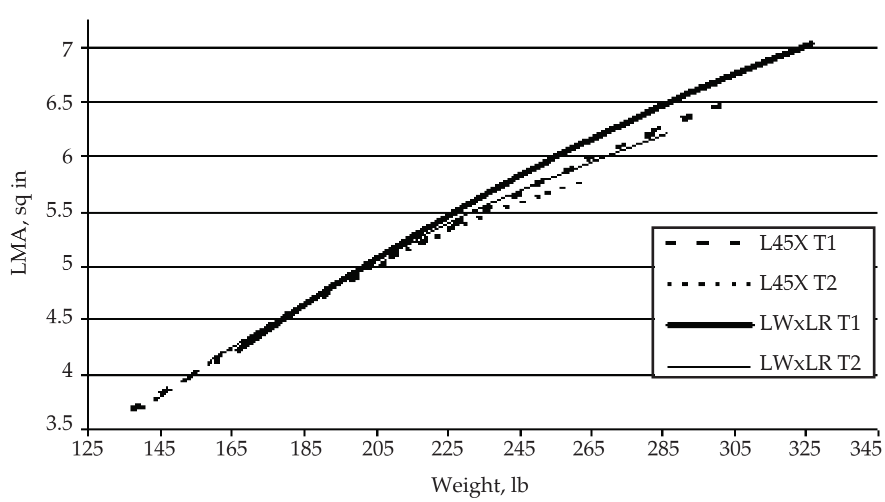

Figure 4. Regressions of longissimus muscle area on weigh for LwxLR (solid lines) and L45X (dashed lines) gilts developed with ad libitum intake (T1 = bold lines) or 75% of ad libitum intake (T2 = plain lines) from 123 days of age.

123 days of age when nutritional treatments began. Of the remaining gilts, 72 of 80 LW X LR gilts and 72 of 74 L45X gilts were observed in estrus. Overall, L45X gilts were 6.1 days younger at puberty than LW x LR gilts ($P < 0.05$); nutritional regimen did not affect age at puberty. However, a population x treatment interaction existed ($P < 0.05$) as LW X LR gilts developed on restricted feed intake were 5.7 days younger at puberty than those developed with ad libitum access to feed, whereas L45X gilts developed on ad libitum access to feed were 6.2 days younger than those on restricted intake.

Figure 1 illustrates average daily feed intake plotted against mid-weight during each 14-day period. Feed intake for LW X LR and L45X gilts with ad libitum access to feed was similar, increasing in a curvilinear fashion from average intake of approximately 2.2 lb per day when gilts weighed 43 lb and increasing to a maximum of approximately 5.6 lb per day when gilts weighed 230 to 240 lb. Hot weather during July and August may have contributed to the decline in intake after 240 lb. Because of more rapid growth (Figure 2), LW X LR gilts were heavier than L45X gilts when feed restriction was imposed (indicated by arrows in Figure 1) and remained heavier during each subsequent period.

The experiment was designed so that predicted feed intake of restricted-fed gilts was 75% of the intake of gilts with ad libitum access to feed. However, they actually consumed somewhat more, averaging 80% for LW X LR gilts and 78% for L45X gilts over the entire period of feed restriction.

The plot of weight against age (Figure 2) illustrates growth rate for gilts in each population by treatment class. Population, nutritional treatment, and interaction all affected growth rate ($P < 0.05$). LW X LR gilts grew faster than L45X

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gilts, were heavier at all ages, and the difference increased with age. Dietary treatment suppressed rate of growth so that at breeding age, gilts on restricted intake weighed 88% (LW X LR) and 90% (L45X) as much as their littermates with ad libitum access to feed.

Figures 3 and 4 illustrate the increase in 10th rib backfat thickness and longissimus muscle area relative to body weight for gilts of each class. Backfat per unit of live weight was similar at all weights for LW X LR and L45X gilts, and restricting intake reduced backfat ($P < 0.05$) similarly in gilts of both populations. At 235 days of age, backfat of gilts on the restricted-intake regimen was 70% (LW X LR) and 65% (L45X) of that of their littermates with ad libitum access to feed. Longissimus muscle area relative to body weight, however, was similar for gilts of both populations and was not affected significantly by nutritional regimen.

Discussion

Growth rates and backfat and longissimus muscle development for LW x LR and L45X gilts with ad libitum access to feed are consistent with previous data for these populations. At the same weights, gilts of the two populations have similar backfat and longissimus muscle; but LW x LR gilts grow faster and, therefore, have greater rates of lean growth. The objective in designing the nutritional regimens was to provide a diet with restricted energy but that provided similar daily amounts of lysine, vitamins and minerals so that rate of fat deposition would be decreased with little or no reduction in rate of muscle deposition. Figures 3 and 4 illustrate that this objective was accomplished.

The main project objective is to evaluate the long-term effects of these gilt development regimens on productivity through four parities. Replication 1 gilts were mated in September of 2005. Their breeding performance and their litter productivity will be reported in the 2007 Nebraska Swine Report. Replication 2 gilts were born in May of 2005, and available data on them will be included in that report.

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