Nebraska Swine Reports Animal Science Department

January 1999

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Summary and Implications

Normal diets and diets with 50 percent greater amounts of protein, vitamins and certain minerals were fed during the gilt development period through lactation to gilts of lines that differed in litter size. The lines had been developed with 10 generations of genetic selection that resulted in a difference between the prolific line and a randomly selected control line of 2.9 fully formed pigs at birth in first parity sows. However, the large litter size line also had greater numbers of stillborn pigs, smaller pigs at birth and greater pre-weaning mortality. The purpose of the experiment was to determine whether these losses in the prolific line could be reduced by feeding diets with greater density of all nutrients except energy during the period of gilt development through completion of the first lactation. The diet fed during gilt development and gestation did not affect total number of pigs born per litter or the number born alive. However, there was an increase of .9 pigs born alive (P=.07) in litters of the selected line when the high nutrient diet was provided. The increase in number born alive in the selected line was not significant at the .05 probability level customarily used for significance, but is close enough to indicate nutrient requirements for maximum productivity is greater for prolific gilts than for gilts with average litter sizes. The development/gestation feeding regimen did not affect pig birth weights, so the greater number of live pigs in litters of prolific sows was not due to heavier pigs. Litter sizes were standardized at birth so variation in number born would not affect litter weaning traits. There was no difference in number weaned due to line, development/gestation diet or lactation diet. However, pig weaning weights were 95 pounds greater (P<.050) when the dam had received the high-nutrient diet during gestation. The carryover effect of the high-nutrient gestation diet was to significantly increase feed intake during lactation, which probably increased milk production and caused heavier pig weaning weights. In addition, weaning weights of pigs were .57 pounds greater (P<.05) when nursed by sows fed the high-nutrient diet during lactation, even though the sows did not consume more lactation feed than sows fed the normal diet. There were no interactions among lines and diets for traits measured at weaning. Genetic selection can increase litter size. Very prolific females may have greater nutrient requirements for maximum reproductive performance than sows with average litter sizes. Pig weaning weights can be increased by feeding more nutrient-dense diets from the gilt development period through the first lactation.

Introduction

Increasing litter size weaned improves the economic efficiency of pork production. However, as litter size at birth is increased through genetic selection, the number of stillborn and mummified piglets also increases and pig birth weights decrease. Low birth weights are a major cause of pig deaths within the first three days postpartum. Because of this, increased litter size at birth may not increase numbers weaned per litter.

In part, differences between large and small fetuses within litter at late gestation may be due to nutrient intakes during gestation. Nutrient concentrations in gestation diets designed for females with average litter sizes may be inadequate for lines with large litter sizes. However, in studies investigating the effects of nutrition on reproduction in which the amount or concentration of only one nutrient in gestation or lactation diets was increased, there was little increase in either numbers born or numbers weaned per litter. Therefore, if nutrition is a limiting factor to prenatal and postnatal survival in large litters, the smaller fetuses in large litters probably do not suffer from the lack of only one nutrient, but from a combination of several nutrients.

The objective of this study was to determine responses in sow and litter traits of a line selected to be prolific and a control line to diets with increased levels of nutrients fed during gestation and lactation.

Material and Methods

For the study, 2 16 Landrace-Large White crossbred gilts from the eleventh generation of three genetic lines were used. One line had been selected on an index of ovulation rate and embryonic survival, another on testes weight and the third was a randomly selected control. Because selection for testis size did not change litter size compared to the control line, the testes line was included to give additional numbers to the control line. Although the testes size and control lines did not differ in litter size, the testis size line had greater growth rate from weaning to 230 pounds and was fatter. Thus, gilts were considered as representing three lines in experimental design and data analyses. The average litter size

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born in the tenth generation was 12.6 pigs for the index line and 9.5 pigs for the control and testes lines.

Females were randomly assigned to two gestation and two lactation diets in a 3x2x2 factorial design. The diets were a high-nutrient gestation and a high-nutrient lactation diet and the normal gestation and lactation diets fed at the University of Nebraska swine unit. All nutrients, except salt and selenium, were increased by approximately 50 percent in the high-nutrient gestation and lactation diets (Table 1). Dietary energy density was not increased, as observations show gilts on the normal diet maintained good condition throughout gestation, so energy was not thought to be a limiting factor. Also, other studies showed increasing the amount of energy fed during certain periods of gestation could decrease litter size at birth. Previous studies at Nebraska indicated excessive energy intake during gestation significantly reduced feed intake during lactation. Different nutrient levels in diets were obtained by varying the amounts of corn, soybean meal (44 percent CP), dicalcium phosphate and a mineral/vitamin premix.

Gestation diets were fed for a minimum of 30 days before breeding and throughout gestation. Gilts were group-fed with 10 gilts per pen during development and breeding. An average of 4.5 pounds of feed per gilt per day was fed during development and an average of 6 pounds of feed per gilt per day was fed during the breeding period until mating. After mating, gilts were fed 4.5 pounds per day. During gestation, gilts were fed individually 4.5 pounds of feed per day until 85 days of gestation and 8 pounds per day thereafter. Gilts were individually fed twice per day during lactation and were provided all the feed they would consume.

Gilt weight and backfat thickness were measured at breeding, farrowing and weaning. Litter size and individual pig weights were recorded at birth and weaning. Cross-fostering within and between lines was used within two days of birth to standardize litter sizes to approximately 10 pigs per gilt. Pigs were weaned at approximately 28 days. Feed intake for each gilt was also recorded during lactation.

Table 1. Nutrient composition of gestation and lactation diets (as-fed basis)[a,b,c]

Nutrient	GC	GH	LC	LH
ME, kcal/lb[a]	1408	1379	1546	1517
CP,%[a]	11.6	18.1	13.6	21.0
Lysine, %	.51	1.00	.66	1.22
Calcium, %	.90	1.24	.91	1.24
Phosphorous, %	.85	.97	.87	.98
Zinc, ppm	110.2	165.3	110.2	165.3
Iron, ppm	110.2	165.3	110.2	165.3
Copper, ppm	11.02	16.53	11.02	16.53
Iodine, ppm	.22	.33	.22	.33
Manganese, ppm	22.05	33.07	22.05	33.07
Sulfur, ppm	66.14	102.5	66.14	102.5
Aluminum, ppm	2.57	3.82	2.57	3.82
Selenium, ppm	.30	.30	.30	.30
Vitamin A, IU/lb	2500	3750	2500	3750
Vitamin E, IU/lb	12.50	18.75	12.50	18.75
Folic acid, ppm	2.20	3.31	2.20	3.31
Riboflavin, ppm	5.51	8.27	5.51	8.27
Pantothenic Acid, ppm	22.05	33.07	22.05	33.07
Vitamin B_{12}, ppm	.02	.03	.02	.03
Choline, ppm	551.2	826.7	551.2	826.7
Biotin, ppm	.11	.17	.11	.17
Vitamin D_3, IU/lb	250	375	250	375
Vitamin K, ppm of menadione	3.31	4.96	3.31	4.96
Niacin, ppm	33.07	49.60	33.07	49.60
Ethoxyquin, ppm	1000	1500	1000	1500

[a]ME = metabolizable energy and CP = crude protein.
[b]GC = normal gestation diet, H = high-nutrient gestation diet, LC = normal lactation diet and LH = high-nutrient lactation diet.
[c]Values for trace minerals and vitamins represent added quantities to the diet.

Table 2. Mean values for litter traits[a] and gilt traits[b] measured at breeding and farrowing.

Diet[c]	Line[d]	N	FULLYF	NBA	MUMM	BWT, lb	BFBR, in	WTBR, lb	BFFAR, in	WTFAR, lb
GC	C	32	10.8	9.7	.25	2.51	0.99	263.9	1.14	378.1
	I	61	11.5	9.6	.54	2.36	1.02	270.7	1.23	382.7
	T	18	8.9	8.3	.61	2.71	1.08	272.3	1.30	399.9
GH	C	30	9.5	9.1	.13	2.60	0.95	261.5	1.15	379.0
	I	58	11.9	10.5	.72	2.31	0.99	268.1	1.15	384.0
	T	17	8.1	7.6	.24	2.62	1.01	256.0	1.22	375.2
Diet GH - Diet GC			-.6 NS	-.1 NS	-.1 NS	-.02 NS	-.05	-7.1 NS	-.05 *	-7.5 NS

[a]FULLYF = number of fully-formed piglets born, NBA = number of piglets born alive, MUMM = number of mummified fetuses and BWT = individual birth weight.
[b]BFBR = average backfat at breeding, WTBR = gilt weight at breeding, BFFAR = average backfat at farrowing and WTFAR = gilt weight at farrowing.
[c]GC = control diet fed during development and gestation and GH = high-nutrient diet fed during development and gestation.
[d]C = control line, I = index line and T= testes line.
*P<.05

Table 3. Mean values for litter traits[a] and gilt traits[b] measured at weaning.

Diet[c]	Line[d]	N	NW	WNWT, lb	BFWN, in	WTWN, lb	FDINTK, lb
GC LC	C	15	9.2	12.21	0.89	273.1	165.3
	I	25	8.1	12.79	0.94	281.3	180.1
	T	11	8.1	11.93	1.09	294.1	164.2
GC LH	C	12	8.8	13.60	0.94	313.9	201.7
	I	26	8.6	13.27	0.94	313.9	194.4
	T	6	8.7	11.20	1.04	295.0	116.4
GH LC	C	12	8.5	13.07	1.02	313.5	196.7
	I	27	8.4	12.92	0.90	300.5	212.5
	T	6	8.8	13.23	1.14	308.0	225.5
GH LH	C	14	8.9	14.79	0.84	310.0	222.0
	I	22	8.9	12.96	0.87	304.5	207.2
	T	10	8.3	13.78	1.01	320.3	203.5
Diet GH - Diet GC			.1 NS	.95 **	-.01 NS	14.3 NS	41.0 **
Diet LH - Diet LC			.2 NS	.57 **	-.06 NS	14.6 NS	.2 NS

[a]NW = number of pigs weaned and WNWT = individual piglet weaning weight.
[b]BFWN = average backfat at weaning, WTWN = gilt weight at weaning and FDINTK = amount of feed consumed during lactation.
[c]GC = control diet fed during development and gestation, GH = high-nutrient diet fed during development and gestation, LC = control diet fed during lactation and LH = high-nutrient diet fed during lactation.
[d]C = control line, I = index line and T = testes line.
**P<.01

Statistical analyses were conducted to estimate effects of gestation and lactation diets, and interaction of diets with each other and with genetic lines.

Results

Number of fully-formed piglets born, number of piglets born alive and number of mummified fetuses were not significantly affected by gestation diet (Table 2). These traits were significantly different between lines, but line x diet interactions were not significant. The index line had the largest litters and number of mummified fetuses. Index line gilts receiving the high-nutrient gestation diet had .9 more live piglets born (P=.07), whereas the high-nutrient diet did not significantly increase number of pigs born alive in the control and testes size lines. This line x diet interaction approached significance (P=.12). The number of stillborn piglets was reduced in the index line by a 50 percent increase in dietary nutrient density. This response in litter size occurred only in the index line. Because the probability value for significance was .07, there is not strong evidence that the nutritional needs for maximum litter size of gilts of the prolific and control lines are different. However, the data are consistent with the hypothesis that the nutritional needs of the highly prolific gilts were not met with the control diet and that increasing the amount of nutrients fed during development and gestation has the potential to increase litter size in highly prolific females.

Individual pig birth weights were not significantly affected by gestation diet (Table 2). However, lines differed (P<.05) as index line piglets were smallest at birth whereas testes line piglets were largest. There was a statistically significant line x diet interaction on individual pig birth weights. But the interaction was the opposite of what was expected and does not explain the increased number of live pigs at birth in litters by index gilts when they were fed the high-nutrient gestation diet. Control line piglets from mothers fed the high-nutrient diet during gestation were .09 pounds heavier than control line piglets from mothers fed the control diet during gestation. However, the high-nutrient diet fed during gestation decreased individual birth weights in the index line by .05 pounds and by .09 pounds in the testes size line.

Number of pigs weaned was not significantly affected by gestation diet, lactation diet or line (Table 3), and interactions between diets and lines were not significant. Individual weaning weights were increased by .95 pounds (P<.05) when pigs were nursed by gilts fed the high-nutrient diet during development and gestation, suggesting a carry-over effect of gestation diets on milk production and pig growth during the lactation period (Table 3). This increase in weaning weight likely occurred because of greater milk production caused by greater feed intake during lactation. Regardless of the diet fed during lactation, gilts fed the high-nutrient diet during development/gestation consumed more feed during lactation. The high-nutrient lactation diet also increased weaning weights by .57 pounds (P<.05). Pig weaning weights also differed significantly among lines. Control line females weaned the heaviest pigs, whereas testes line females weaned the lightest pigs. Increasing levels of nutrients fed during gestation had the effect of increasing pig weaning weights in the control line by 1.04 pounds and by 1.90 pounds in the testes size, but did not affect weaning weights in the prolific line. This interaction was significant. High levels of nutrients fed during lactation increased pig weaning weights in all lines, but pig weaning weights were increased more in the control line (1.54 pounds) than the testes line (.37 pounds) and index line (.26 pounds). Again, this interaction was significant. The effect on pig weaning weights of increasing nutrient density of lactation diets may be different for gilts of prolific lines and those with more average litter sizes.

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