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Lean Growth and Overall Performance of Pigs During the Finisher Phase as Affected by Lean Growth Potential Determined During the Grower Phase and Dietary Protein Level During the Finisher Phase

J.N. Tembei
South Dakota State University

G.W. Libal
South Dakota State University

D.N. Peters
South Dakota State University

Lean growth and overall performance of pigs during the finisher phase as affected by lean growth potential determined during the grower phase and dietary protein level during the finisher phase

J.N. Tembei, G.W. Libal, C.R. Hamilton, and D.N. Peters
Department of Animal and Range Sciences

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Selection for decreased backfat thickness and faster rate of gain has resulted in pigs with increased potential for lean gain. Although energy intake is the limiting factor for lean growth during the grower period, the underlying limiting factor to support increased protein accretion during the finishing stage seems to be lysine intake. At the finishing phase, pigs consume enough feed per day to meet their energy requirements, but protein is the most limiting nutrient. Genetics and sex influence growth performance and protein accretion in finishing pigs. Pigs from different genetic populations have different protein requirements and these differences have been associated with differences in the rate of lean gain. It is logical to assume that these differences in lean growth potential and protein requirements exist within each contemporary population as well. Pigs with potential for fast rate of lean gain utilize feed more efficiently because they are producing carcasses with more muscle and less fat. Consequently, they require a higher concentration of dietary protein (amino acids) to achieve their genetic potential for lean growth. The objectives of this study were (1) to determine the efficacy of selecting pigs for lean growth potential during the grower phase to predict lean growth for these selected pigs during the finisher phase and (2) to evaluate the effect of level of dietary protein on the lean growth and carcass characteristics of these selected genotypes between 60 and 100 kg live weight.

(Key Words: Lean growth, Pigs, Grower/finisher, Protein level.)

Experimental Procedure

Grower Phase (Selection Stage) Two trials were conducted utilizing 124 and 96 contemporary pigs from two farrowing groups. Pigs were fed from an average initial body weight of 23 kg (Trial 1) and 28 kg (Trial 2) to an average individual or pen weight of 50 kg. Pigs were blocked by weight and penned by sex. All pigs were fed the same corn soybean meal diet (Table 1) that was fortified with vitamins and minerals during the grower phase. Real-time ultrasound was used to take readings on each pig at the end of the grower phase for 10th rib fat and longissimus muscle area. The grower phase period ended when pigs attained an average final body weight of 50 kg. Lean gain per day (LGPD) with 5% fat was computed using the NPPC (1991) equation in order to sort pigs into high (HLG) and low (LLG) lean gain types. Only pigs at least one standard deviation from the mean LGPD were selected as either HLG or LLG. Blood samples were collected from each pig in Trial 2 at the end of the grower phase for plasma urea nitrogen (PUN) analysis. A group of pigs was selected from the midpoint as medium lean gain (MLG) in Trial 2.

Finisher Phase (Evaluation Stage). Twenty and 48 pigs with average initial weights of 63 kg and 58 kg composed the outcome groups sorted from the grower phase on the basis of lean growth for Trials 1 and 2, respectively. They were allotted by weight to the finisher phase in a 2 x 2 x 2 or a 3 x 2 x 2 factorial arrangement of treatments within a randomized block design. There were two lean gain types, two genders, and two dietary protein levels in Trial 1 and three lean gain types, two genders, and two dietary protein levels in Trial 2. The corn soybean meal diets provided either 15% or 13% protein for barrows and either 17% or 15% protein for gilts (Table 1). Within genotypes, pigs were penned and fed by gender.

Pig weight and feed disappearance were recorded at 14-day intervals for the entire period the pigs were on test to determine average daily gain, average daily feed intake, and gain/feed. Pigs were taken off test on an individual pig basis and on a pen basis for Trials 1 and 2, respectively, on the weekly weigh

TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS (%)

	Grower	Finisher[a]		
			Barrows HP	
Ingredient	All pigs	Barrows LP	Gilts LP	Gilts HP
Corn	69.83	84.40	78.89	73.37
Soybean meal, 44%	27.34	13.17	18.77	24.38
Dicalcium phosphate	1.22	.96	.85	.73
Limestone	.86	.72	.74	.77
Salt	.25	.25	.25	.25
Premix[b]	.50	.50	.50	.50
Total	100.0	100.0	100.0	100.0
Calculated nutrient content, %				
Protein	18.00	13.00	15.00	17.00
Lysine	.97	.59	.74	.89
Calcium	.70	.55	.55	.55
Phosphorus	.60	.50	.50	.50

[a]LP = low protein, HP = high protein.

[b]Provided per kg of complete diet: 100 mg Zn, 75 mg Fe, 7.5 mg Cu, 25 mg Mn, 175 :g I, 1300 :g Se, 16.5 IU vitamin E, 3.3 mg riboflavin, 17.6 mg niacin, 13.2 :g vitamin B_{12}, 2.2 mg vitamin K_3, 13.2 mg pantothenic acid, 3960 IU vitamin A, and 396 IU vitamin D_3.

day that an individual or pen average body weight reached at least 100 kg.

To obtain PUN levels (Trial 2 only), feed was withdrawn at 4 p.m. on the day that a final body weight of 100 kg was attained. Pigs were fed at 9 a.m. the next day and blood samples obtained 5 to 6 hours later. Blood samples were collected from each pig, plasma harvested and preserved by freezing. Plasma urea nitrogen analysis was performed to evaluate the rate of amino acid utilization.

Pigs were slaughtered at 100 to 110 kg average body weight. Carcasses were weighed at slaughter to record hot carcass weight (HCW). At 24 hours postmortem, longissimus muscle area (LEA) and 10th rib fat (FAT) were collected from the left and right sides, a mean value calculated and recorded. Hot carcass weight, LEA, FAT, initial pig weight, and days on test were used to compute LGPD with 5% fat using the NPPC (1991) equation.

Results

Grower Phase (Selection Stage) Twenty pigs (10 HLG and 10 LLG) and 48 pigs (16 HLG, 16 LLG, and 16 MLG) were selected from the group of grower pigs evaluated in Trials 1 and 2, respectively. Means for initial and final weights, number of days on test, and pig performance at the end of the grower phase are presented in Tables 2 and 3 for Trials 1 and 2, respectively. Pigs were selected for lean gain within gender.

Trial 1. Lean gain per day ranged from a low of .19 to a high of .38 kg/day for barrows (mean = .29) and a low of .19 to a high of .40 kg/day for gilts (mean = .31). Barrows selected for LLG had LGPD of less than .25 kg and those selected as HLG had LGPD greater than .33 kg. Gilts selected for LLG had LGPD of less than .27 kg and those selected as HLG had LGPD greater than .35 kg. For the grower phase, mean LGPD was .30 kg for all pigs. Mean lean gains for selected pigs were .22 kg/day and .35 kg/day for LLG and HLG barrows and .24 kg/day and .37 kg/day for LLG and HLG gilts, respectively.

Trial 2. Lean gain per day ranged from a low of .09 to a high of .35 kg/day for barrows (mean = .22) and a low of .12 to a high of .40 kg/day for gilts (mean = .26). Barrows selected for LLG had LGPD of less than .18 kg and those selected as HLG had LGPD greater than .28 kg. Gilts selected for LLG had LGPD of less than .19 kg and those selected as HLG had LGPD greater than .30 kg. For the grower phase mean LGPD was .24 kg for all pigs. Mean lean gain for selected pigs was .16, .23, and .30 kg/day for LLG, MLG, and HLG barrows

TABLE 2. MEANS FOR PIG PERFORMANCE, ULTRASOUND MEASUREMENTS & LEAN GAIN CALCULATIONS (GROWER PHASE, SELECTION STAGE, TRIAL 1)

		Selected for lean gain type[a]				
		Barrows		Gilts		
Item	All pigs	Low	High	Low	High	SD
Number of pigs	124	6	4	4	6	
Initial wt, kg	22.87	20.92	24.25	19.88	29.63	3.76
Final wt, kg	51.47	47.88	52.31	49.38	56.00	4.03
Days on test	40.80	48.83	32.50	48.25	30.17	3.23
Avg daily gain, kg	.71	.55	.87	.61	.88	.07
10th rib fat, cm	.89	.95	.83	1.05	.92	.14
Longissimus area, cm^2	15.18	11.71	13.56	13.48	16.86	2.04
Lean gain, kg/day	**.30**	**.22**	**.35**	**.24**	**.37**	**.02**

[a]Selected pigs for high and low lean gain type within a sex were at least one standard deviation above or below the mean for lean gain per day.

TABLE 3. MEANS FOR PIG PERFORMANCE, ULTRASOUND MEASUREMENTS AND LEAN GAIN CALCULATIONS (GROWTH PHASE, SELECTION STAGE, TRIAL 2)

		Selected for lean gain type[a]						
		Barrows			Gilts			
Item	All pigs	Low	Med	High	Low	Med	High	SE
Number of pigs	96	8	8	8	8	8	8	
Initial wt, kg	27.70	28.63	29.06	27.44	27.44	28.06	27.38	.76
Final wt, kg	51.03	49.50	53.81	52.25	44.50	51.88	53.25	.93
Days on test	32.50	32.50	32.50	32.50	32.50	32.50	32.50	.94
Avg daily gain, kg	.72	.65	.76	.82	.52	.73	.80	.02
10th rib fat, cm	1.63	2.01	1.80	1.55	1.50	1.53	1.34	.08
Longissimus area, cm^2	14.94	13.03	14.97	17.32	12.64	14.44	17.91	.45
Lean gain, kg/day	**.24**	**.16**	**.23**	**.30**	**.16**	**.25**	**.32**	**.01**

[a]Selected pigs for high and low lean gain type within a sex were at least one standard deviation above or below the mean for lean gain per day. Medium lean gain pigs were those closest to the mean value.

and .16, .25, and .32 kg/day for LLG, MLG, and HLG gilts, respectively.

Finisher Phase (Evaluation Stage) Trial 1. Least squares means for the main effects for pig performance during the finisher phase for Trial 1 are shown in Table 4. Pigs selected for HLG had greater (P<.05) average daily gain and less (P<.10) FAT than pigs selected for LLG. Lean gain selection had no effect (P>.10) on LGPD or other carcass measurements. Barrows gained faster (P<.05) than gilts. There were no gender differences (P>.10) for LGPD and other carcass characteristics. Feed intake data were not obtained during the finisher phase for Trial 1. Pigs fed HP gained faster (P<.10) than those fed LP. However, the level of protein in the diet had no effect (P>.10) on other pig performance. There were no (P>.10) interactions between lean gain type and protein level or between lean gain type and pig gender for pig performance. Protein by gender interactions were not significant (P>.10) for gain, LGPD, and carcass characteristics. There were no three-way interactions among lean gain type, protein, and gender (P>.10).

Trial 2: Lean Gain Type. Results are presented in Table 5 for the main effects of selected lean gain type, gender, and dietary protein level. High lean gain and MLG pigs had significantly greater (P<.001) LGPD than LLG

pigs. However, there was no difference (P>.10) between HLG and MLG pigs. Medium lean gain type pigs consumed more (P<.10) feed per day than pigs from the LLG type. High lean gain pigs were intermediate in feed consumption. Longissimus muscle area was greater (P<.001) for the HLG than MLG or LLG and greater.

TABLE 4. LEAST SQUARES MEANS FOR MAIN EFFECTS OF LEAN GAIN FACTORS (FINISHING PHASE, EVALUATION STAGE, TRIAL 1)

	Lean gain type			Gender			Protein level			
Item	Low	High	P	Barrows	Gilts	P	Low	High	P	SD
Avg daily gain, kg	.97	1.11	*	1.11	.97	*	.99	1.09	+	.08
10th rib fat, cm	2.16	1.81	+	2.10	1.87	ns	1.97	36.31	ns	.38
Longissimus area, cm^2	34.78	37.12	ns	34.76	37.13	ns	35.59		ns	4.16
Hot carcass wt, kg	73.52	72.50	ns	73.41	72.61	ns	72.50	73.52	ns	3.60
Lean gain, kg/day	**.32**	**.35**	**ns**	**.34**	**.35**	**ns**	**.32**	**.35**	**ns**	**.05**

P = probability associated with main effect within a row, ns P>.10, + P<.10, * P<.05.

TABLE 5. LEAST SQUARES MEANS FOR MAIN EFFECTS OF LEAN GAIN FACTORS (FINISHING PHASE, EVALUATION STAGE, TRIAL 2)

	Lean gain type				
Item	Low	Med	High	P	SE
Avg daily gain, kg	.83	.86	.87	ns	.02
Daily feed intake, kg	3.04	3.39	3.15	+	.07
Gain/feed	.28	.27	.28	ns	.01
10th rib fat, cm	2.09	2.04	1.85	ns	.09
Longissimus area, cm^2	32.84	35.59	38.14	***	.72
Hot carcass wt, kg	73.27	74.86	73.82	ns	.96
Plasma urea nitrogen, mg/dL	15.16	16.45	15.21	ns	.62
Lean gain, kg/day	**.28**	**.31**	**.33**	***	**.01**

	Gender			Protein level			
	Barrows	Gilts	P	Low	High	P	SE
Avg daily gain, kg	.91	.80	***	.84	.87	ns	.01
Daily feed intake, kg	3.48	2.90	***	3.15	3.24	ns	.06
Gain/feed	.27	.29	*	.27	.28	ns	.01
10th rib fat, cm	2.27	1.71	***	1.97	2.01	ns	.08
Longissimus area, cm^2	33.77	37.27	***	34.72	36.32	+	.59
Hot carcass wt, kg	74.56	73.40	ns	73.35	74.61	ns	.79
Plasma urea nitrogen, mg/dL	15.46	15.75	ns	13.51	17.70	***	.51
Lean gain, kg/day	**.31**	**.31**	**ns**	**.29**	**.32**	**ns**	**.01**

P = probability associated with main effect within row, ns P>.10, + P<.10, * P<.05, *** P<.001.

(P<.001) for MLG than LLG. Lean gain type had no effect (P>.10) on PUN.

Trial 2: Protein Level and Pig Gender. Pigs fed HP had greater LEA (P<.10) and higher levels of PUN (P<.001) than pigs fed LP. The level of protein in the diet had no effect (P>.10) on other pig performance. Barrows consumed more (P<.001) feed, gained faster (P<.001), had greater FAT (P<.001), lower gain/feed (P<.05), and smaller LEA (P<.001) than gilts. Pig gender did not affect LGPD or PUN (P>.10). There was no (P>.10) interaction between lean gain type and protein level in the diet or between lean gain type and pig gender. However, there were several protein level by gender interactions. Barrows fed either HP or LP gained faster (P<.05) than gilts fed LP. Gilts fed HP had greater LGPD (P<.05) and higher gain/feed

(P<.001) than gilts fed LP and barrows fed either protein level.

Summary

Two trials were conducted utilizing 124 and 96 pigs from contemporary farrowing groups fed from an average initial weight of 23 kg (Trial 1) and 28 kg (Trial 2) to an average individual or pen weight of 50 kg. Lean gain per day with 5% fat was computed using the NPPC (1991) equation utilizing weight gain and real-time ultrasound measurements. Pigs were then sorted into high (HLG) and low (LLG) lean gain types with selected individuals at least one standard deviation from the mean LGPD. In Trial 1, LGPD ranged from a low of .19 to a high of .38 kg/day for barrows and a low of .19 to a high of .40 kg/day for gilts. Barrows selected for LLG and HLG had a mean LGPD of .22 and .35 kg and gilts selected for LLG and HLG had a mean LGPD of .24 and .37 kg. In Trial 2, LGPD ranged from a low of .09 to a high of .35 for barrows and a low of .12 to a high of .40 kg/day for gilts. Barrows selected for LLG, MLG, and HLG had means for LGPD of .16, .23, and .30 kg, respectively, and gilts selected for LLG, MLG, and HLG had means for LGPD of .16, .25, and .32 kg, respectively.

Twenty (10 HLG and 10 LLG) and 48 pigs (16 HLG, 16 MLG, and 16 LLG) were selected for their lean gain potential in the grower phase for Trials 1 and 2, respectively. During the finisher stage, they were fed corn soybean meal diets providing either HP or LP to an average weight of 100 kg. In Trial 1, HLG pigs gained faster and had less FAT than LLG pigs. However, LGPD and carcass characteristics were not affected by the selected lean gain type. Pigs fed HP gained faster than those fed LP, but the level of protein in the diet had no effect on other pig performance. Barrows gained faster than gilts. However, LGPD and carcass characteristics did not differ. HLG and MLG pigs had higher LGPD than LLG pigs and HLG pigs had larger LEA than MLG or LLG pigs in Trial 2. MLG pigs consumed more feed than either HLG or LLG pigs. Other performance was unaffected by the selected lean gain type. Pigs fed HP had higher LGPD, larger LEA, and higher PUN. Barrows exhibited faster gain, more feed consumption, lower gain/feed, greater FAT, and smaller LEA than gilts. Pig gender did not affect LGPD, HCW, and PUN. Barrows fed either protein level gained faster than gilts. Gilts fed HP had greater LGPD and gain/feed than gilts fed LP.

Implications

The selecting of pigs for lean growth on the basis of gain and carcass characteristics at 50 kg (utilizing the 1991 NPPC formula) was marginally successful. Considering that only pigs at least one standard deviation away from the mean within each sex were evaluated, it is doubtful that whole groups of pigs from a contemporary group could be successfully sorted by lean growth potential to feed them accordingly. Of interest is the fact that barrows and gilts were identical in their lean growth and that differences in gain were related to feed intake that resulted in differences in fat deposition. Improvements in 10th rib fat and LGPD due to protein levels above those that provide maximum gain for either barrows or gilts are not detectable utilizing carcass measurements and the NPPC (1991) formula for lean growth.