EFFECTS OF INCREASING STANDARDIZED ILEAL DIGESTIBLE LYSINE:CALORIE RATIO ON GILTS GROWN IN A COMMERCIAL FINISHING ENVIRONMENT[1,2]

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Summary

A total of 2,165 commercial gilts (PIC 337 × 1050) were used in two 4-wk studies to determine the lysine requirement for growing and finishing gilts. All diets were corn-soybean meal based and contained 0.15% L-lysine HCl and 3% added fat. Desired lysine levels were achieved by altering the corn and soybean meal level in the diet. Each experiment consisted of 6 treatments with 7 pens per treatment and 24 to 27 pigs per pen. In Exp. 1, 1,085 gilts (initially 84.2 lb) were used with standardized ileal digestible (SID) lysine:calorie ratios of 2.01, 2.30, 2.58, 2.87, 3.16, and 3.45 g/Mcal. Both ADG and F/G improved (quadratic, $P < 0.003$) with increasing SID lysine:calorie ratio, with the greatest improvement in performance through 3.16 g SID lysine/Mcal ME and a smaller increase to the highest SID lysine:calorie level. Daily SID lysine intake increased (linear, $P < 0.001$) and SID lysine intake per pound of gain increased (quadratic, $P < 0.001$) as expected with increasing dietary lysine. Income over feed costs (IOFC) and feed cost per pound of gain also followed a similar pattern (quadratic, $P < 0.001$). In Exp. 2, 1,080 gilts (initially 185.3 lb) were used with SID lysine:calorie ratios of 1.55, 1.75, 1.95, 2.05, 2.35, and 2.55 g/Mcal. As SID lysine:calorie ratio increased, ADG, F/G, daily SID lysine intake, SID lysine intake per pound of gain, IOFC, and feed cost per pound of gain improved (linear, $P < 0.001$) through the highest lysine:calorie level of 2.55 g/Mcal. These studies indicate that feeding higher levels of lysine than previously thought to be optimal offers significant economic and biologic improvements in growing and finishing gilts. More research is needed to validate the ideal SID lysine:calorie ratio for today's evolving genetics.

Key words: gilt, income over feed costs, lysine

Introduction

Lysine is the first limiting amino acid in corn-soybean meal-based swine diets. Therefore, understanding lysine requirements for growing and finishing pigs is essential in developing cost-effective diets. It is common to express the lysine requirement in terms of standardized illeal digestible (SID) lysine percentage or as a ratio of SID lysine to the ME level in a diet. Using the ratio, nutritionists can formulate diets for a variety of feeding

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situations with different dietary energy densities. Continuous evaluation of the lysine requirements is necessary with today's increasingly high-lean genotypes. Recent research has shown an increased growth rate in pigs vaccinated with commercial porcine circo virus type 2 (PCV2) vaccine. With enhanced growth rates in vaccinated pigs and evolving genetic lines, the lysine requirement may have increased from requirements established 6 yr ago. Therefore, the objective of this trial was to observe the growth and economic effects of feeding increasing dietary lysine levels to gilts in a commercial finishing environment.

Procedures

A total of 1,085 (initially 84.2 lb) and 1,080 (initially 185.3 lb) gilts were used in Exp. 1 and 2 for 28 and 29 d, respectively. The gilts were vaccinated with 2 doses of a commercial PCV2 vaccine while in the nursery. There were 24 to 27 pigs per pen in each experiment; average number of pigs per pen was initially the same across treatments within each study. The study was conducted at a commercial research facility in southwest Minnesota, and similar genetics (PIC 337 × 1050) were used in each experiment.

All diets were corn-soybean meal based with 0.15% added L-lysine HCl. Amounts of soybean and corn were changed to achieve the desired lysine concentration in the diet. All diets contained 3% added fat (choice white grease). Diets were formulated to meet all other requirements recommended by NRC (1998). In Exp. 1, the SID lysine:calorie ratios for the experimental diets were 2.01, 2.30, 2.58, 2.87, 3.16, and 3.45 g/Mcal (Table 1). In Exp. 2, the SID lysine:calorie ratios were 1.55, 1.75, 1.95, 2.05, 2.35, and 2.55 g/Mcal (Table 2). During the trials, diet samples were collected and analyzed to validate the calculated amino acid values (Tables 3 and 4).

In each experiment, pens of pigs were allotted to 1 of the 6 dietary treatments in a completely randomized design with 7 pens per treatment. Pig weights (by pen) and feed disappearance were measured throughout the trials. Average daily gain, ADFI, F/G, daily SID lysine intake, SID lysine intake per pound of gain, feed cost per pound of gain, and income over feed costs (IOFC) were determined in each trial. Income over feed costs was calculated by assessing a value to the weight gain per pig (at $60/cwt) during the trial and subtracting the feed costs per pig. All data were then analyzed for linear and quadratic effects of increasing SID lysine:calorie ratios, with pen being the experimental unit in all analyses.

Results and Discussion

In Exp. 1 (85- to 140-lb gilts), ADG and F/G improved (quadratic, $P < 0.003$, Table 5) with increasing SID lysine:calorie ratios, with the greatest improvement through 3.16 g lysine/Mcal ME with a small improvement through the highest ratio of 3.45 g SID lysine/Mcal ME. Although the magnitude of response was relatively small, ADFI decreased (linear, $P < 0.04$) with increasing SID lysine:calorie ratio. As expected, daily SID lysine intake increased (linear, $P < 0.001$) with increasing dietary lysine. Lysine intake per pound of gain increased (quadratic, $P < 0.001$) with increasing dietary lysine. It appears that approximately 10 g SID lysine was required per pound of gain for optimal performance. Feed cost per pound of gain decreased (quadratic, $P < 0.001$) with increasing SID lysine:calorie ratios; the most economical value was reached at 3.16 g SID lysine/Mcal ME. Income over feed costs increased (quadratic, $P < 0.001$) with increasing SID lysine:calorie ratio, with the greatest return achieved at the highest ratio. This data illustrates that economical and biological responses were maximized at the SID lysine:calorie ratios of 3.16 to 3.45 g SID lysine/Mcal ME.

In Exp. 2 (185- to 245-lb gilts), ADG and F/G improved (linear, $P < 0.001$, Table 6) with increasing SID lysine:calorie ratio. Feed intake was not ($P > 0.80$) affected by increasing dietary lysine. Daily SID lysine intake and SID lysine intake per pound of gain increased (linear, $P < 0.001$) with increasing SID lysine. Feed cost per pound of gain decreased (linear, $P < 0.001$) with increasing SID lysine:calorie ratio. These decreased costs were driven by the improvements in F/G. Income over feed costs increased (linear, $P < 0.001$) from $13.84/pig at 1.55 g SID lysine/Mcal ME to $17.94/pig at 2.55 g SID lysine/Mcal ME. The improvements in gain and F/G with increasing SID dietary lysine allowed for the improvements in IOFC. These data show that the most advantageous SID lysine:calorie ratio was the highest level tested (2.55 g SID lysine/Mcal ME).

The results from these trials indicate that 10 to 11 g of SID lysine per pound of gain were required in these trials for the optimal response. This is about 1 to 2 g higher than reported in previous trials (Main et al., 2002 Swine Day Report of Progress, p. 135). Figures 1 to 4 show data from Main et al. (2002) compared with results from our trials. These graphs indicate that growth performance achieved at the lower lysine levels in the current trials was similar to the performance achieved by pigs in the earlier research. In the Main et al. (2002) study, as lysine levels increased, growth performance reached a plateau, whereas growth performance continued to increase in the current trials. Both studies were conducted in the same research facility with the same genetic lines. The main differences are that 6 yr of genetic progress have occurred between the experiments and the pigs in the current research trials were vaccinated for PCV2. Research has demonstrated that pigs vaccinated for PCV2 have improved ADG and F/G compared with nonvaccinates. This suggests a greater capacity for protein deposition; thus, it is not surprising that these pigs may have a higher lysine requirement than nonvaccinates.

Kansas State University recommendations developed on the basis of previous research suggest using approximately 2.65 g SID lysine/Mcal ME for 85- to 140-lb gilts and 1.95 g SID lysine/Mcal ME for 185- to 245-lb gilts. As the data from these experiments demonstrate, because of the high growth performance potential, there are significant advantages in feeding higher levels of dietary lysine. As genetic advancement and improved health status occur, more research is needed to validate the optimal SID lysine:calorie ratio to maximize biological and economic responses.

Table 1. Composition of diets, Exp. 1 (as-fed basis)[1]

	SID[2] lysine:ME, g/Mcal					
	2.01	2.3	2.58	2.87	3.16	3.45
	SID lysine, %					
Item, %	0.70	0.80	0.90	1.00	1.10	1.20
Corn	79.41	75.43	71.46	67.48	63.51	59.53
Soybean meal (46.5% CP)	15.49	19.47	23.44	27.42	31.39	35.37
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00
Monocalcium P (21% P)	0.50	0.50	0.50	0.50	0.50	0.50
Limestone	0.90	0.90	0.90	0.90	0.90	0.90
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Copper sulfate	0.03	0.03	0.03	0.03	0.03	0.03
Vitamin premix	0.08	0.08	0.08	0.08	0.08	0.08
Trace mineral premix	0.08	0.08	0.08	0.08	0.08	0.08
Lysine HCl	0.15	0.15	0.15	0.15	0.15	0.15
Natuphos classic[3]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100	100	100	100	100	100
Calculated analysis						
SID amino acids, %						
Lysine	0.7	0.8	0.9	1.0	1.1	1.2
Isoleucine:lysine	70	70	69	69	69	69
Leucine:lysine	175	165	157	151	146	141
Methionine:lysine	31	29	28	27	26	26
Met & Cys:lysine	64	60	58	56	54	53
Threonine:lysine	63	62	61	60	60	59
Tryptophan:lysine	19	19	19	19	20	20
Valine:lysine	83	81	79	78	77	76
ME, kcal/lb	1,581	1,580	1,579	1,579	1,578	1,577
Total lysine, %	0.79	0.90	1.01	1.12	1.23	1.34
CP, %	14.1	15.6	17.1	18.6	20.1	21.7
Ca, %	0.51	0.52	0.54	0.55	0.56	0.57
P, %	0.43	0.45	0.47	0.48	0.50	0.52
Available P, %[4]	0.24	0.24	0.25	0.25	0.26	0.26
Diet cost, $/ton[5]	232.50	239.32	246.13	252.95	259.76	266.58

[1] A total of 1,085 gilts (PIC 337 × 1050) were housed at approximately 27 pigs per pen and 7 replications per treatment in a 28-d trial.
[2] Standardized ileal digestible.
[3] Provided per pound of diet: 136 units of phytase.
[4] Phytase provided 0.08% available P to the diet.
[5] Diet costs were based on corn at $5.00/bu and 46.5% soybean meal at $350/ton.

Table 2. Composition of diets, Exp. 2 (as-fed basis)[1]

	SID[2] lysine:ME, g/Mcal					
	1.55	1.75	1.95	2.15	2.35	2.55
	SID lysine, %					
Item, %	0.54	0.61	0.68	0.75	0.82	0.89
Corn	85.84	83.07	80.31	77.54	74.77	72.00
Soybean meal (46.5% CP)	9.12	11.91	14.69	17.47	20.25	23.03
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00
Monocalcium P (21% P)	0.58	0.56	0.55	0.53	0.52	0.50
Limestone	0.85	0.85	0.85	0.85	0.85	0.85
Salt	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.05	0.05	0.05	0.05	0.05	0.05
Trace mineral premix	0.05	0.05	0.05	0.05	0.05	0.05
Lysine HCl	0.15	0.15	0.15	0.15	0.15	0.15
L-Threonine	---	---	---	---	0.005	0.010
Optiphos 2000[3]	0.01	0.01	0.01	0.01	0.01	0.01
Total	100	100	100	100	100	100
Calculated analysis						
SID amino acids, %						
Lysine	0.54	0.61	0.68	0.75	0.82	0.89
Isoleucine:lysine	71	71	70	70	70	69
Leucine:lysine	200	188	178	170	164	158
Methionine:lysine	35	33	31	30	29	28
Met & Cys:lysine	71	68	64	62	60	58
Threonine:lysine	65	64	63	62	62	62
Tryptophan:lysine	18	18	19	19	19	19
Valine:lysine	88	85	83	82	80	79
ME, kcal/lb	1,583	1,583	1,582	1,582	1,582	1,582
Total lysine, %	0.62	0.69	0.77	0.85	0.92	1.00
CP, %	11.70	12.70	13.80	14.90	15.90	17.00
Ca, %	0.49	0.49	0.50	0.50	0.51	0.52
P, %	0.42	0.43	0.44	0.45	0.46	0.47
Available P, %[4]	0.22	0.22	0.22	0.22	0.22	0.22
Diet cost, $/ton[5]	220.51	225.18	229.86	234.53	239.32	244.11

[1] A total of 1,080 gilts (PIC 337 × 1050) were housed at approximately 27 pigs per pen and 7 replications per treatment in a 29-d trial.
[2] Standardized ileal digestible.
[3] Provided per pound of diet: 91 units of phytase.
[4] Phytase provided 0.05% available P to the diet.
[5] Diet costs were based on corn at $5.00/bu and 46.5% soybean meal at $350/ton.

Table 3. Chemical composition of diets (Exp. 1)[1]

	SID[2] lysine:ME, g/Mcal					
	2.01	2.30	2.58	2.87	3.16	3.45
	SID lysine, %					
Item, %[3]	0.7	0.8	0.9	1.0	1.1	1.2
CP	13.57 (14.10)	14.64 (15.61)	16.07 (17.12)	16.80 (18.63)	19.05 (20.14)	19.37 (21.65)
Lysine	0.78 (0.79)	0.86 (0.90)	0.99 (1.01)	1.06 (1.12)	1.14 (1.23)	1.24 (1.34)
Threonine	0.50 (0.52)	0.54 (0.51)	0.60 (0.50)	0.62 (0.50)	0.71 (0.49)	0.77 (0.49)
Methionine	0.22 (0.24)	0.23 (0.23)	0.25 (0.22)	0.28 (0.21)	0.27 (0.20)	0.29 (0.20)
Met+Cys	0.45 (0.50)	0.47 (0.48)	0.52 (0.46)	0.55 (0.44)	0.57 (0.43)	0.60 (0.42)
Isoleucine	0.54 (0.56)	0.59 (0.55)	0.67 (0.55)	0.71 (0.55)	0.81 (0.55)	0.84 (0.55)
Leucine	1.31 (1.35)	1.36 (1.28)	1.48 (1.23)	1.54 (1.18)	1.68 (1.14)	1.74 (1.11)
Valine	0.63 (0.66)	0.68 (0.65)	0.76 (0.63)	0.80 (0.63)	0.87 (0.62)	0.91 (0.61)
Tryptophan	0.14 (0.15)	0.15 (0.15)	0.18 (0.15)	0.20 (0.15)	0.22 (0.16)	0.23 (0.16)

[1] A total of 1,085 gilts (PIC 337 × 1050) were housed with approximately 27 pigs per pen and 7 replications per treatment in a 28-d trial.

[2] Standardized ileal digestible.

[3] Analyzed values for protein and amino acids are shown with calculated values located in parentheses.

Table 4. Chemical composition of diets (Exp. 2)[1]

	SID[2] lysine:ME, g/Mcal					
	1.55	1.75	1.95	2.15	2.35	2.55
	SID lysine, %					
Item, %[3]	0.54	0.61	0.68	0.75	0.82	0.89
CP	10.93 (11.68)	14.97 (12.74)	13.17 (13.80)	15.86 (14.86)	15.21 (15.92)	15.94 (16.98)
Lysine	0.62 (0.62)	0.92 (0.69)	0.79 (0.77)	0.99 (0.85)	0.93 (0.92)	1.07 (1.00)
Threonine	0.42 (0.42)	0.60 (0.46)	0.51 (0.50)	0.64 (0.55)	0.58 (0.60)	0.64 (0.64)
Methionine	0.19 (0.21)	0.27 (0.22)	0.22 (0.23)	0.28 (0.25)	0.24 (0.26)	0.27 (0.28)
Met+Cys	0.40 (0.44)	0.51 (0.47)	0.45 (0.50)	0.55 (0.53)	0.50 (0.55)	0.54 (0.58)
Isoleucine	0.42 (0.44)	0.59 (0.49)	0.54 (0.54)	0.65 (0.59)	0.63 (0.65)	0.71 (0.70)
Leucine	1.11 (1.18)	1.42 (1.26)	1.29 (1.33)	1.49 (1.41)	1.41 (1.48)	1.58 (1.56)
Valine	0.48 (0.54)	0.67 (0.59)	0.60 (0.65)	0.78 (0.70)	0.71 (0.75)	0.80 (0.80)
Tryptophan	0.12 (0.11)	0.17 (0.13)	0.16 (0.14)	0.17 (0.16)	0.17 (0.18)	0.17 (0.19)

[1] A total of 1,080 gilts (PIC 337 × 1050) were housed with approximately 27 pigs per pen and 7 replications per treatment in a 29-d trial.
[2] Standardized ileal digestible.
[3] Analyzed values for protein and amino acids are shown with calculated values located in parentheses.

Table 5. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 85- to 140-lb gilts (Exp. 1)[1]

	SID lysine:ME, g/Mcal								
	2.01	2.30	2.58	2.87	3.16	3.45		Probability, *P* <	
	SID lysine, %								
	0.7	0.8	0.9	1.0	1.1	1.2	SE	Linear	Quadratic
Initial weight, lb	84.2	84.0	84.2	84.3	84.4	84.2	2.19	0.94	0.98
ADG, lb	1.81	1.91	2.04	2.09	2.13	2.15	0.024	0.001	0.003
ADFI, lb	4.34	4.30	4.29	4.24	4.21	4.20	0.057	0.04	0.93
F/G	2.39	2.25	2.10	2.03	1.98	1.96	0.014	0.001	0.001
Final weight, lb	135.0	137.5	141.4	142.7	143.9	144.3	2.58	0.004	0.38
Daily SID lysine intake, g	13.79	15.62	17.54	19.24	21.02	22.87	0.250	0.001	0.85
SID Lysine intake/lb gain, g	7.60	8.17	8.59	9.22	9.89	10.66	0.060	0.001	0.001
Feed cost/lb gain, $[2]	0.278	0.269	0.259	0.257	0.257	0.261	0.002	0.001	0.001
IOFC, $/head[2,3]	16.35	17.72	19.50	20.02	20.39	20.39	0.257	0.001	0.001

[1] A total of 1,085 gilts (PIC 337 × 1050) were housed with approximately 27 pigs per pen and 7 replications per treatment in a 28-d trial.

[2] Feed costs were based on corn at $5.00/bu and 46.5% soybean meal at $350/ton.

[3] Income over feed costs = value of gain on a $60/live cwt weight basis - feed costs during trial period.

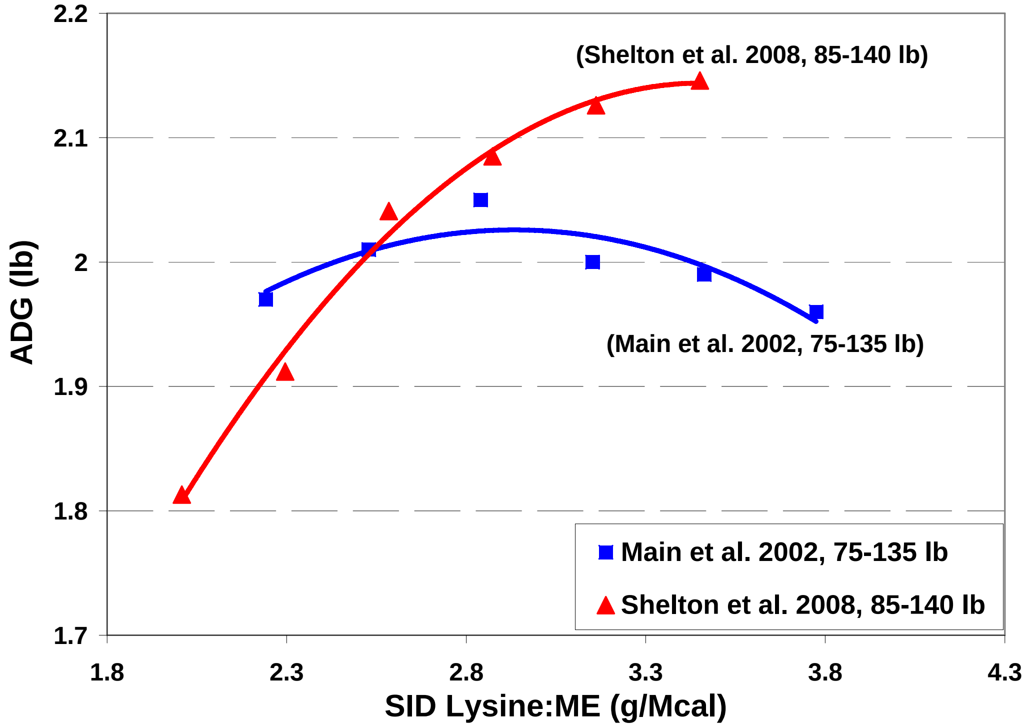

Figure 1. Comparison of standardized ileal digestible (SID) lysine:calorie ratio on ADG for 2 gilt studies.

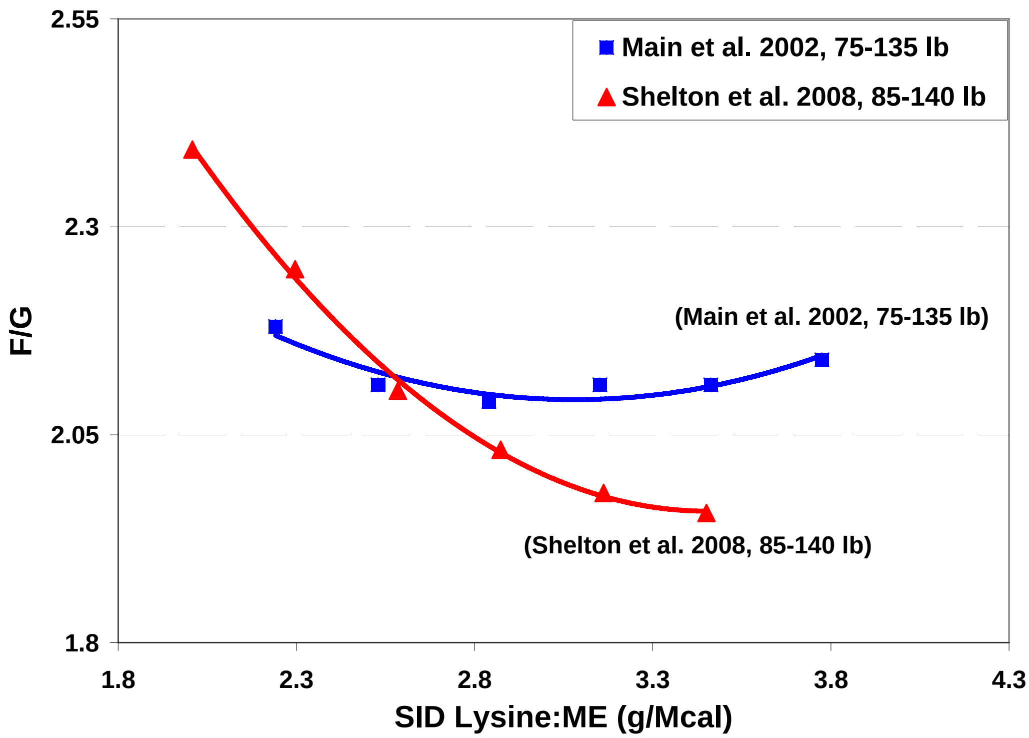

Figure 2. Comparison of standardized ileal digestible (SID) lysine:calorie ratio on F/G for 2 gilt studies.

Table 6. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 185- to 245-lb gilts (Exp. 2)[1]

	SID lysine:ME, g/Mcal								
	1.55	1.75	1.95	2.15	2.35	2.55			
	SID lysine, %							Probability, *P* <	
	0.54	0.61	0.68	0.75	0.82	0.89	SE	Linear	Quadratic
Initial weight, lb	185.4	185.3	185.4	185.2	185.3	185.3	2.79	0.98	0.98
ADG, lb	1.82	1.92	1.93	2.05	2.08	2.17	0.032	0.001	0.90
ADFI, lb	5.59	5.68	5.55	5.58	5.60	5.60	0.067	0.81	0.87
F/G	3.07	2.96	2.90	2.71	2.69	2.58	0.036	0.001	0.64
Final weight, lb	238.3	241.2	241.7	244.7	246	248.2	3.08	0.02	0.99
Daily SID lysine intake, g	13.69	15.75	17.15	19.02	20.85	22.62	0.233	0.001	0.91
SID lysine intake/lb gain, g	7.53	8.21	8.91	9.28	10.01	10.43	0.110	0.001	0.26
Feed cost/lb gain, $[2]	0.339	0.334	0.332	0.32	0.322	0.315	0.004	0.001	0.87
IOFC, $/head[2,3]	13.84	14.91	15.11	16.7	16.93	17.94	0.463	0.001	0.97

[1] A total of 1,080 gilts (PIC 337 × 1050) were housed at approximately 27 pigs per pen and 7 replications per treatment in a 29-d trial.
[2] Feed costs were based on corn at $5.00/bu and 46.5% soybean meal at $350/ton.
[3] Income over feed costs = value of gain on a $60/live cwt weight basis - feed costs during trial period.

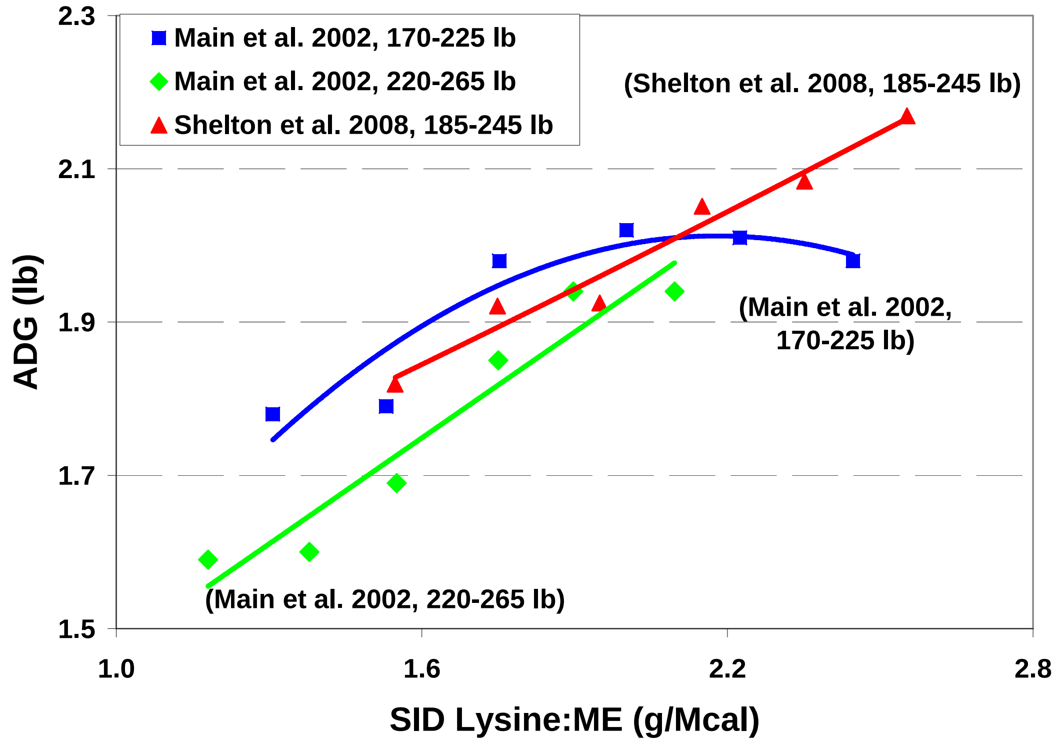

Figure 3. Comparison of standardized ileal digestible (SID) lysine:calorie ratio on ADG for 3 gilt studies.

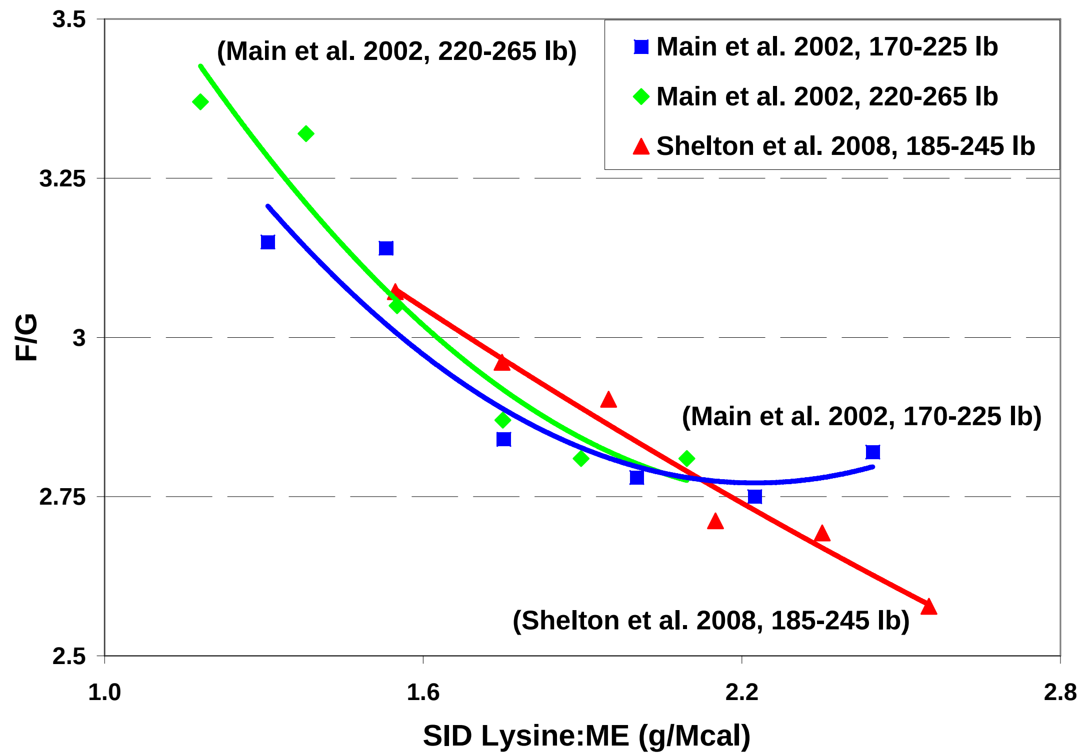

Figure 4. Comparison of standardized ileal digestible (SID) lysine:calorie ratio on F/G for 3 gilt studies.