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Effects of increasing standardized ileal digestible lysine:calorie ratio on the growth performance of growing-finishing pigs

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Effects of Increasing Standardized Ileal Digestible Lysine:Calorie Ratio on the Growth Performance of Growing-Finishing Pigs

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Summary

A total of 1,080 pigs (PIC TR4 × 1050) were used in four 28-d experiments to determine the lysine requirements of growing-finishing pigs reared in the new Kansas State University finishing barn. Low- and high-lysine corn-soybean meal-based diets with no added fat were formulated for each experiment by varying the amounts of corn, soybean meal, L-lysine HCl, DL-methionine, and L-threonine. Six lysine levels were evaluated in each experiment, with intermediate lysine levels obtained by blending the low- and high-lysine diets. There were 6 pens containing an equal number of barrows and gilts for each treatment, with 6 or 8 pigs per pen. Pens were blocked by initial count and BW. In Exp. 1, 252 pigs (initially 80.7 lb) were fed diets with standardized ileal digestible lysine:calorie (SID lys:cal) ratios of 2.09, 2.39, 2.69, 2.99, 3.29, or 3.59 g/Mcal ME. Increasing the SID lys:cal ratio improved (linear; $P < 0.04$) ADG and F/G. Optimum performance and income over feed cost (IOFC) was observed at 2.69 g SID lys/Mcal, or a dietary level of 1.01% total lysine and 0.90% SID lysine. In Exp. 2, 288 pigs (initially 122.9 lb) were fed diets with SID lys:cal ratios of 2.12, 2.35, 2.58, 2.81, 3.04, or 3.27 g/Mcal. Increasing the SID lys:cal ratio tended (quadratic; $P < 0.12$) to increase ADG and improved (linear; $P < 0.02$) F/G. Optimum performance and IOFC was observed at 2.35 g SID lys/Mcal, or a dietary level of 0.88% total and 0.78% SID lysine. In Exp. 3, 252 pigs (initially 177.2 lb) were fed diets with SID lys:cal ratios of 1.49, 1.79, 2.09, 2.39, 2.69, or 2.98 g/Mcal. Increasing the SID lys:cal ratio tended (linear; $P < 0.06$) to improve ADG and improved (linear; $P < 0.001$) F/G. Optimum performance and IOFC was observed at 2.09 g SID lys/Mcal, or a dietary level of 0.80% total and 0.70% SID lysine. In Exp. 4, 288 pigs (initially 224.3 lb) were fed the same SID lys:cal ratios as in Exp. 3. Increasing the SID lys:cal ratio decreased (linear; $P < 0.04$) ADFI, F/G, carcass yield, and IOFC. Despite a linear improvement in F/G, ADG did not improve above 1.79 g SID lys/Mcal, which resulted in the best IOFC. This requirement is equivalent to 0.69% total and 0.60% SID lysine. These experiments agree with previous recommendations for growing-finishing pigs of this genotype. For pigs weighing 80 to 143 lb, 123 to 190 lb, 177 to 235 lb, and 224 to 284 lb, growth performance and IOFC were optimal with SID lys:cal ratios of 2.69, 2.35, 2.09, and 1.79 g SID lys/Mcal ME (or 0.90%, 0.78%, 0.70% and 0.60% SID lysine) in corn-soybean meal diets without added fat.

Key words: income over feed cost, lysine

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Introduction

Lysine is the first limiting amino acid in corn-soybean meal-based swine diets. For this reason, more research has focused on identifying the life-cycle lysine requirements of swine than any other amino acid. Understanding the lysine requirements is essential for developing cost-effective nutrition programs. It is also important to have a basic understanding of the lysine requirements for pigs in their environment at a particular farm before attempting further dietary amino acid or energy research. These experiments are among the first to be carried out in the new growing-finishing research barn at the Kansas State University (K-State) Swine Teaching and Research Center.

Currently, amino acid requirements are often expressed on a standardized ileal digestible (SID) basis to account for differences in digestibility across commonly used feed-stuffs. This improves our ability to formulate diets that meet pigs' amino acid requirements with a variety of ingredients. The SID lysine requirement is often expressed as a ratio of SID lysine to the ME content of the diet because the ME density of the diet can influence intake, growth rate, and efficiency of gain. Identifying the lysine requirements in these terms has resulted in improvements in growth performance and the ability to manage feed costs and has reduced the environmental impact of swine production.

With the continued progress in swine genetics to improve the efficiency of pork production and other desirable characteristics, periodic reevaluation of lysine requirements is necessary. Also, the development of highly efficacious, commercial vaccines for the prevention of porcine circovirus type 2 (PCV2) has resulted in remarkable improvements in the performance of growing pigs. Recent research at K-State (Shelton et al., 2008²) indicates that the lysine requirement for healthy, PCV2-vaccinated pigs may be higher than previous requirement estimates.

Therefore, the objective of these experiments was to determine the lysine requirements of high-health, PRRS-negative, PCV2-vaccinated, growing-finishing pigs in the new K-State growing-finishing research barn.

Procedures

Procedures used in these experiments were approved by the K-State Institutional Animal Care and Use Committee. These experiments were conducted in the new growing-finishing research barn at the K-State Swine Teaching and Research Center. The facility was a totally enclosed, environmentally controlled, mechanically ventilated barn. This facility had 2 identical rooms containing forty 8 × 10 ft pens with adjustable gates facing the alleyway. The adjustable gates allowed individual pen adjustments for pig space. Each pen was equipped with a Farmweld (Teutopolis, IL) dry, single-sided self-feeder with 2 eating spaces located in the fence line and a cup waterer. Pens were located over a completely slatted concrete floor with a 4-ft pit underneath for manure storage. The facility was also equipped with 12 feed storage bins and a computerized feeding system (FeedPro; Feedlogic Corp., Willmar, MN) that delivered, recorded, and blended diets as specified. The equipment provided pigs with ad libitum access to their dietary treatment and water.

² Shelton et al., Swine Day 2008, Report of Progress 1001, pp. 82-97.

A total of 252 (initially 80.7 lb), 288 (initially 122.9 lb), 252 (initially 177.2 lb), and 288 (initially 224.3 lb) pigs (PIC TR4 × 1050) were used in Exp. 1, 2, 3, and 4, respectively. All pigs had been vaccinated previously with 2 doses of a commercial PCV2 vaccine according to label recommendations and as prescribed by the farm veterinarian. There were 36 pens containing either 6 or 8 pigs per pen in each experiment, depending on the block and the number of available barrows and gilts within each group. Pens containing 8 pigs were provided 8 × 10 ft of space, and pens containing 6 pigs were provided 8 × 8 ft of space. In all of the pens, half of the pigs were gilts (3 or 4), and the other half were barrows (3 or 4).

In each experiment, pens were allotted by initial count and weight to 1 of the 6 dietary treatments in a randomized complete block design with 6 pens per treatment. Pen weights and feed disappearance were measured throughout each of the four 28-d experiments. Average daily gain, ADFI, F/G, average weight, daily SID lysine intake, SID lysine intake per pound of gain, value of live gain per pig (using \$44.53/cwt live), feed cost per pound of gain, feed cost per pig, and income over feed cost (IOFC) were determined in each experiment. In Exp. 4, all pigs were harvested at the conclusion of the feeding period, and carcass data were collected to evaluate carcass characteristics. Economic comparisons within each experiment were based on the same prices applied across all experiments. However, the values of live gain per pig estimates in Exp. 4 were adjusted using the carcass base price (\$57.83/cwt) and collected yield data.

Diets used in these experiments were corn-soybean meal based (Table 1). Low- and high-lysine diets with no added fat were formulated for each experiment by varying amounts of corn, soybean meal, L-lysine HCl, DL-methionine, and L-threonine. Within each experiment, the low- and high-lysine diets were blended to achieve the desired intermediate lysine concentrations and maintain acceptable amino acid patterns on an SID basis. The 6 treatments within each experiment were achieved using 100:0, 80:20, 60:40, 40:60, 20:80, and 0:100 blends of the 2 diets. The diets were formulated to meet all other nutritional requirements recommended by NRC (1998³). In Exp. 1, the calculated SID lysine:calorie ratios used were 2.09, 2.39, 2.69, 2.99, 3.29, and 3.59 g/Mcal ME. Corresponding total and SID lysine concentrations were 0.79%, 0.90%, 1.01%, 1.11%, 1.22%, and 1.33% and 0.70%, 0.80%, 0.90%, 1.00%, 1.10%, and 1.20%, respectively. In Exp. 2, the calculated SID lysine:calorie ratios used were 2.12, 2.35, 2.58, 2.81, 3.04, and 3.27 g/Mcal ME. Corresponding total and SID lysine concentrations were 0.80%, 0.88%, 0.96%, 1.05%, 1.13%, and 1.22% and 0.71%, 0.78%, 0.86%, 0.93%, 1.01%, and 1.09%, respectively. For both Exp. 3 and 4, the calculated SID lysine:calorie ratios used were 1.49, 1.79, 2.09, 2.39, 2.69, and 2.98 g/Mcal ME. Corresponding total and SID lysine concentrations were 0.58%, 0.69%, 0.80%, 0.90%, 1.01%, and 1.12% and 0.50%, 0.60%, 0.70%, 0.80%, 0.90%, and 1.00%, respectively. During the experiments, diet samples were collected from the feeders to verify that the desired total amino acid values were achieved. Also in each of the experiments, 8 lb/ton of FeO was included as a red marker in either the low- or high-lysine diet. This provided a visual aid to validate delivery of the appropriate blend to the assigned feeders.

At the conclusion of each experiment, data were analyzed for linear and quadratic effects of increasing SID lysine:calorie ratios using the PROC MIXED procedure of

³ NRC. 1998. Nutrient Requirements of Swine. 10th ed. Natl. Acad. Press, Washington, DC.

SAS (SAS Institute Inc., Cary, NC). Pen was the experimental unit used in all data analyses.

Results

For each experiment, analyzed concentrations of amino acids for the feed samples collected were similar to the calculated total values (within the acceptable limits for analytical variation).

In Exp. 1 (80 to 143 lb BW), ADG and F/G improved (linear; $P < 0.04$, Table 2) with increasing SID lysine:calorie ratio, with the greatest improvements through 2.69 g SID lysine/Mcal ME. As expected, daily SID lysine intake was increased (linear; $P < 0.001$) with increasing dietary lysine. Lysine intake per pound of gain also increased (linear; $P < 0.001$) with increasing dietary lysine. Approximately 9.5 g SID lysine per pound of gain was required for optimal performance. The value of live gain per pig increased (linear; $P < 0.04$) with increasing SID lysine:calorie ratio and was maximized at 2.69 g SID lysine/Mcal ME. Feed cost per pound of gain and feed cost per pig were increased (linear; $P < 0.001$) with increasing SID lysine:calorie ratios. Therefore, IOFC was reduced (linear; $P < 0.001$) with increasing SID lysine:calorie ratios, with the greatest IOFC observed for pigs fed 2.69 g SID lysine/Mcal ME. These data illustrate that both the biologic and economic responses were optimized at an SID lysine:calorie ratio of 2.69 g SID lysine/Mcal ME. Using a typical corn and soybean meal diet without added fat, this is equivalent to a total lysine content of 1.01%, or an SID content of 0.90%.

In Exp. 2 (123 to 190 lb BW), although not significant, ADG numerically increased (quadratic; $P < 0.12$, Table 3) with increasing SID lysine:calorie ratio from 2.12 to 2.35, where it appeared to plateau, and became numerically lowest at the highest lysine level (3.27 g SID lysine/Mcal ME). Average daily feed intake decreased (linear; $P < 0.001$) when the ratio exceeded 2.35 g SID lysine/Mcal ME. Feed efficiency was improved (linear; $P < 0.02$) with increasing SID lysine:calorie ratio. Despite the linear response, the greatest incremental improvement in F/G occurred when the SID lysine:calorie ratio was increased from 2.12 to 2.35. Together these responses indicate that the requirement was around 2.35 g SID lysine/Mcal ME. Daily SID lysine intake and SID lysine intake per pound of gain increased (linear; $P < 0.001$) with increasing SID lysine. Optimal performance was observed at approximately 9.8 g SID lysine per pound of gain. Although not significant, the value of live gain per pig increased (quadratic; $P < 0.12$) with increasing SID lysine:calorie ratio and was numerically the greatest at 2.35 g SID lysine/Mcal ME. Feed cost per pound of gain and feed cost per pig increased (linear; $P < 0.001$) with increasing SID lysine:calorie ratio. These responses resulted in a reduction (linear; $P < 0.001$) in IOFC with increasing SID lysine:calorie ratio, with the greatest IOFC observed for pigs fed 2.35 g SID lysine/Mcal ME. Biologic and economic responses were optimized at a SID lysine:calorie ratio of 2.35 g SID lysine/Mcal ME. This is equivalent to a total lysine content of 0.88% in a corn and soybean meal diet without added fat, or 0.78% on an SID basis.

In Exp. 3 (177 to 235 lb BW), ADG tended (linear; $P < 0.06$, Table 4) to increase with increasing SID lysine:calorie ratio and achieved the maximum at 2.09 g SID lysine/Mcal ME. Feed efficiency was improved (linear; $P < 0.001$) with increasing SID

lysine:calorie ratio; however, the greatest incremental improvement in F/G occurred when the SID lysine:calorie ratio was increased from 1.79 to 2.09. These responses suggest a requirement of 2.09 g SID lysine/Mcal ME. As in the previous experiments, daily SID lysine intake and SID lysine intake per pound of gain increased (linear; $P < 0.001$) with increasing SID lysine. Optimal performance was observed at approximately 9.8 g SID lysine per pound of gain. The value of live gain per pig also tended (linear; $P < 0.06$) to increase with increasing SID lysine:calorie ratio and was greatest at 2.09 g SID lysine/Mcal ME. Feed cost per pound of gain and feed cost per pig increased (linear; $P < 0.001$) with increasing SID lysine:calorie ratio. These responses resulted in a reduction (linear; $P < 0.03$) in IOFC with increasing SID lysine:calorie ratio, with the greatest IOFC observed for pigs fed 2.09 g SID lysine/Mcal ME. These data illustrate that both the biologic and economic responses were optimized at a SID lysine:calorie ratio of 2.09 g SID lysine/Mcal ME. In a corn and soybean meal diet without added fat, this is equivalent to a total lysine content of approximately 0.80%, or an SID content of 0.70%.

In Exp. 4 (224 to 284 lb BW), although not significant, ADG numerically increased (linear; $P < 0.13$, Table 5) with increasing SID lysine:calorie ratio from 1.49 to 1.79, where it appeared to plateau. Average daily feed intake decreased (linear; $P < 0.04$) when the ratio exceeded 1.79 g SID lysine/Mcal ME. Feed efficiency was improved (linear; $P < 0.001$) with increasing SID lysine:calorie ratio, and the best F/G was observed at 2.69 g SID lysine/Mcal ME. However, the greatest incremental improvement in F/G occurred when the SID lysine:calorie ratio was increased from 1.49 to 1.79. There were no differences observed in HCW or the various measurements of carcass lean and fat content. However, carcass yield decreased (linear; $P < 0.02$) with increasing SID lysine:calorie ratio, and the greatest incremental decrease occurred when the SID lysine:calorie ratio was increased from 1.79 to 2.09. Together these responses indicate that the requirement is around 1.79 g SID lysine/Mcal ME. As expected, the daily SID lysine intake and SID lysine intake per pound of gain increased (linear; $P < 0.001$) with increasing SID lysine. Optimal performance was observed at approximately 9.3 g SID lysine per pound of gain. Although not significant, the value of live gain per pig increased (quadratic; $P < 0.10$) with increasing SID lysine:calorie ratio and was numerically the greatest at 1.79 g SID lysine/Mcal ME. Feed cost per pound of gain and feed cost per pig increased (linear; $P < 0.001$) with increasing SID lysine:calorie ratio. These responses resulted in a reduction (linear; $P < 0.001$) in IOFC with increasing SID lysine:calorie ratio, with the greatest IOFC observed for pigs fed 1.79 g SID lysine/Mcal ME. These data illustrate that both the biologic and economic responses were optimized at a SID lysine:calorie ratio of 1.79 g SID lysine/Mcal ME. This is equivalent to a total lysine content of 0.69% in a corn and soybean meal diet without added fat, or 0.60% on an SID basis.

Discussion

When the lysine requirements for growing-finishing pigs are expressed using SID lysine:calorie ratios, the results obtained in these experiments are very similar to the latest recommendations for pigs of this genotype reported by the genetic supplier (Figure 1, PIC nutrient specifications, May 2008). These ratios also agree with current K-State recommendations developed from previous research on growing-finishing pigs

of this genotype (Main et al., 2002⁴). The utility of expressing the lysine requirement using these ratios is further supported by the differences in dietary energy densities used by different researchers. Main et al. (2002) used diets containing 6% choice white grease, whereas diets used in the current experiments did not contain added fat.

Research reported last year by Shelton et al. (2008) suggested that the required SID lysine:calorie ratios are higher than previously reported. They observed that ratios of at least 3.16, 2.58, and 2.55 g SID lysine/Mcal ME were necessary to achieve optimal performance and economic return for 85- to 140-lb, 120- to 180-lb, and 185- to 245-lb gilts, respectively. These ratios are considerably higher than the recent PIC and K-State (Main et al., 2002) recommendations previously described, and it has been suggested that improvements in growth (primarily the rate of protein deposition) from genetic progress and/or PCV2 vaccination have increased the requirement. However, pigs in the current experiments were also vaccinated for PCV2 and had much greater ADG and ADFI than pigs in all the previously mentioned experiments. Yet the estimated requirements from the current experiments are similar to the PIC recommendations and findings of Main et al. (2002) when reported as SID lysine:calorie ratios.

Another potential explanation for some of the differences in estimated SID lysine:calorie requirements is the potential differences between the calculated and realized energy values obtained in the various experiments. Reductions in grain particle size improve the digestibility of energy and other nutrients. The studies conducted by Shelton et al. (2008) were conducted in the same facilities and used the same genotype as Main et al.'s (2002) studies. The feed for their experiments also originated from the same mill. However, the targeted particle size at this mill was 700 to 750 microns in 2002 (similar to the targeted corn particle size of 700 microns in the current experiments) but was reduced to 400 to 450 microns in 2008 to help cope with rising feed costs and tightening margins. A 300-micron reduction in the corn particle size could result in a significant change in the "realized" ME concentration. Shelton et al. (2008) did not report any adjustment in the energy value for the corn in their diets, but it is possible that the ME value for corn was underestimated. An adjusted energy value to account for differences in grain particle size might have resulted in slightly lower estimates of SID lysine:calorie ratios.

Although there appear to be differences between recent lysine requirement estimates when expressed as SID lysine:calorie ratios, the apparent differences in the SID lysine requirements are less if the growth responses observed are used to express the requirements in terms of grams of SID lysine intake per pound of gain (Figure 2). When the estimated requirements from Main et al. (2002), Shelton et al. (2008), and the current experiments are expressed as grams of SID lysine intake per pound of gain, the requirements appear to be roughly 9 to 10 g of SID lysine per pound of gain throughout the growing-finishing period. A comparison of the responses on this basis may be useful in accounting for some of the differences in ADFI, potential genetic improvements in relative F/G, and/or differences in dietary energy density across studies.

In summary, these data demonstrate that growing-finishing pigs require approximately 9.5 g of SID lysine per pound of gain from 80 to 284 lb BW. Although these data agree

⁴ Main et al., Swine Day 2002, Report of Progress 897, pp. 135-150.

with currently recommended SID lysine:calorie ratios, the research reported by Shelton et al. (2008) indicates that the SID lysine requirements may be higher when expressed in these terms. However, requirement estimates for SID lysine greater than those reported here need further validation. As demonstrated in these studies, over-fortifying diets with amino acids can be costly. Growth performance and IOFC may be optimized with SID lysine:calorie ratios of 2.69, 2.35, 2.09, and 1.79 g SID lysine/Mcal ME for pigs weighing 80 to 143 lb, 123 to 190 lb, 177 to 235 lb, and 224 to 284 lb, respectively. Corresponding recommendations for typical corn and soybean meal diets without added fat are 1.01%, 0.88%, 0.80%, and 0.70% total lysine, or 0.90%, 0.78%, 0.70%, and 0.60% SID lysine, respectively.

Table 1. Diet composition¹

Ingredient, %	Lysine level:	Exp. 1		Exp. 2		Exp. 3 and 4	
		Low	High	Low	High	Low	High
Corn		82.06	66.82	82.37	66.76	87.31	70.81
Soybean meal (46.5% CP)		15.18	30.48	15.64	30.86	10.40	27.17
Monocalcium P (21% P)		0.60	0.55	0.30	0.20	0.35	0.30
Limestone		0.85	0.85	0.80	0.83	0.85	0.85
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.13	0.13	0.13	0.13	0.10	0.10
Trace mineral premix		0.13	0.13	0.13	0.13	0.10	0.10
L-lysine HCl		0.15	0.30	0.15	0.15	0.05	0.15
DL-methionine		---	0.13	---	0.03	---	0.04
L-threonine		0.02	0.13	---	0.03	---	0.04
Phytase 600		0.13	0.13	0.13	0.13	0.09	0.09
FeO ²		0.40	---	---	0.40	0.40	---
Total		100.00	100.00	100.00	100.00	100.00	100.00
Cost, \$/lb ³		0.099	0.120	0.099	0.117	0.092	0.113

Calculated analysis

Standardized ileal digestible (SID) amino acids

Lysine, %	0.70	1.20	0.71	1.09	0.50	1.00
Isoleucine:lysine, %	71	62	71	69	83	69
Leucine:lysine, %	178	134	177	148	228	153
Methionine:lysine, %	31	34	31	29	40	31
Met & Cys:lysine, %	64	60	64	57	82	60
Threonine:lysine, %	65	65	63	62	75	65
Tryptophan:lysine, %	19	18	19	20	21	19
Valine:lysine, %	83	70	83	77	101	78
CP, %	14.2	20.3	14.4	20.2	12.3	18.9
Total lysine, %	0.79	1.33	0.80	1.22	0.58	1.12
ME, kcal/lb	1,510	1,516	1,521	1,519	1,521	1,520
SID lysine:ME, g/Mcal	2.09	3.59	2.12	3.27	1.49	2.98
Ca, %	0.51	0.55	0.44	0.48	0.45	0.49
P, %	0.46	0.51	0.40	0.44	0.39	0.45
Available P, % ⁴	0.30	0.30	0.23	0.23	0.23	0.23

¹ The low- and high-lysine diets in each experiment were blended in proportions of 100:0, 80:20, 60:40, 40:60, 20:80, and 0:100 using the Feedlogic system, which provided 6 equally spaced concentrations of lysine for treatments.

² Iron oxide was included in one of the diets in each experiment to provide a red marker for diet identification and for visual verification of the blended, intermediate treatments in each experiment.

³ Diet costs were based on corn at \$4.00/bu and 46.5% soybean meal at \$380/ton.

⁴ Included approximately 0.10% to 0.12% P release from added phytase.

Table 2. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 80- to 143-lb pigs (Exp. 1)¹

SID lysine, %:		0.70	0.80	0.90	1.00	1.10	1.20	Probability, <i>P</i> <	
Item	SID lysine, g/Mcal ME:	2.09	2.39	2.69	2.99	3.29	3.59	SEM	Linear Quadratic
Initial wt, lb		80.5	80.6	80.7	80.8	80.9	80.5	2.4	--- ² ---
ADG, lb		2.16	2.19	2.28	2.25	2.26	2.26	0.03	0.04 ---
ADFI, lb		5.35	5.32	5.30	5.34	5.25	5.18	0.11	--- ---
F/G		2.47	2.43	2.32	2.38	2.32	2.29	0.04	0.001 ---
Ending wt, lb		141.1	141.9	144.6	143.6	144.3	143.8	2.9	--- ---
Daily SID lysine intake, g		16.98	19.29	21.62	24.22	26.19	28.19	0.46	0.001 ---
SID lysine intake/lb gain, g		7.85	8.81	9.47	10.80	11.57	12.48	0.17	0.001 ---
Value of gain/pig (live), \$ ³		26.98	27.30	28.45	27.99	28.23	28.17	0.43	0.04 ---
Feed cost/lb gain, \$ ⁴		0.24	0.25	0.25	0.27	0.27	0.28	0.01	0.001 ---
Feed cost/pig, \$		14.77	15.33	15.91	16.69	17.05	17.45	0.33	0.001 ---
IOFC, \$/pig ⁵		12.21	11.97	12.53	11.30	11.18	10.72	0.34	0.001 ---

¹ A total of 252 pigs (PIC TR4 × 1050) were housed with 3 replications of 6 pigs per pen and 3 replications of 8 pigs per pen in a 28-d experiment.² Probability, *P* > 0.13.³ Based on a live price of \$44.53/cwt.⁴ Diet costs were based on corn at \$4.00/bu and 46.5% soybean meal at \$380/ton.⁵ Income over feed cost = value of gain/pig - feed cost/pig.**Table 3. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 123- to 190-lb pigs (Exp. 2)¹**

SID lysine, %:		0.71	0.78	0.86	0.93	1.01	1.09	Probability, <i>P</i> <	
Item	SID lysine, g/Mcal ME:	2.12	2.35	2.58	2.81	3.04	3.27	SEM	Linear Quadratic
Initial wt, lb		122.6	122.7	123.0	123.2	123.2	122.9	2.0	--- ² ---
ADG, lb		2.36	2.43	2.43	2.40	2.41	2.35	0.04	--- 0.12
ADFI, lb		6.71	6.72	6.65	6.61	6.47	6.39	0.08	0.001 ---
F/G		2.85	2.76	2.74	2.76	2.69	2.72	0.04	0.02 ---
Ending wt, lb		188.7	190.8	190.9	190.3	190.7	188.7	2.6	--- ---
Daily SID lysine intake, g		21.61	23.77	25.96	27.90	29.65	31.60	0.27	0.001 ---
SID lysine intake/lb gain, g		9.19	9.78	10.71	11.64	12.31	13.47	0.16	0.001 ---
Value of gain/pig (live), \$ ³		29.40	30.32	30.25	29.91	30.03	29.28	0.45	--- 0.12
Feed cost/lb gain, \$ ⁴		0.28	0.28	0.29	0.30	0.31	0.32	0.01	0.001 ---
Feed cost/pig, \$		18.56	19.28	19.78	20.34	20.57	20.98	0.21	0.001 ---
IOFC, \$/pig ⁵		10.84	11.04	10.47	9.57	9.46	8.30	0.41	0.001 ---

¹ A total of 288 pigs (PIC TR4 × 1050) were housed with 6 replications of 8 pigs per pen in a 28-d experiment.² Probability, *P* > 0.13.³ Based on a live price of \$44.53/cwt.⁴ Diet costs were based on corn at \$4.00/bu and 46.5% soybean meal at \$380/ton.⁵ Income over feed cost = value of gain/pig - feed cost/pig.

Table 4. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 177- to 235-lb pigs (Exp. 3)¹

SID lysine, %:		0.50	0.60	0.70	0.80	0.90	1.00	Probability, <i>P</i> <	
Item	SID lysine, g/Mcal ME:	1.49	1.79	2.09	2.39	2.69	2.98	SEM	Linear Quadratic
Initial wt, lb		177.0	176.9	176.9	177.1	178.0	177.0	2.7	--- ² ---
ADG, lb		1.96	1.98	2.14	2.07	2.02	2.14	0.06	0.06 ---
ADFI, lb		6.58	6.49	6.64	6.68	6.24	6.45	0.16	--- ---
F/G		3.36	3.29	3.10	3.23	3.10	3.02	0.05	0.001 ---
Ending wt, lb		232.0	232.4	236.9	235.1	235.2	236.8	3.4	--- ---
Daily SID lysine intake, g		14.92	17.68	21.08	24.23	25.51	29.25	0.57	0.001 ---
SID lysine intake/lb gain, g		7.62	8.94	9.84	11.71	12.66	13.69	0.17	0.001 ---
Value of gain/pig (live), \$ ³		24.46	24.70	26.72	25.82	25.23	26.63	0.78	0.06 ---
Feed cost/lb gain, \$ ⁴		0.33	0.34	0.33	0.35	0.35	0.35	0.01	0.001 ---
Feed cost/pig, \$		18.20	18.63	19.73	20.53	19.88	21.17	0.49	0.001 ---
IOFC, \$/pig ⁵		6.26	6.07	6.99	5.28	5.30	5.47	0.45	0.03 ---

¹ A total of 252 pigs (PIC TR4 × 1050) were housed with 3 replications of 6 pigs per pen and 3 replications of 8 pigs per pen in a 28-d experiment.² Probability, *P* > 0.13.³ Based on a live price of \$44.53/cwt.⁴ Diet costs were based on corn at \$4.00/bu and 46.5% soybean meal at \$380/ton.⁵ Income over feed cost = value of gain/pig - feed cost/pig.**Table 5. Effects of standardized ileal digestible (SID) lysine:calorie ratio on 224- to 284-lb pigs (Exp. 4)¹**

SID lysine, %:		0.50	0.60	0.70	0.80	0.90	1.00	Probability, <i>P</i> <	
Item	SID lysine, g/Mcal ME:	1.49	1.79	2.09	2.39	2.69	2.98	SE	Linear Quadratic
Initial wt, lb		224.3	224.3	224.2	224.2	224.4	224.4	2.7	--- ² ---
ADG, lb		2.11	2.22	2.22	2.24	2.24	2.22	0.05	0.13 ---
ADFI, lb		7.44	7.58	7.47	7.41	7.29	7.26	0.13	0.04 ---
F/G		3.53	3.41	3.36	3.30	3.21	3.28	0.05	0.001 ---
Ending wt, lb		281.4	284.3	284.2	284.8	284.8	284.3	3.4	--- ---
Daily SID lysine intake, g		16.88	20.62	23.72	26.88	29.41	32.94	0.50	0.001 ---
SID lysine intake/lb gain, g		8.00	9.28	10.67	11.99	13.12	14.86	0.17	0.001 ---
HCW, lb		208.7	210.4	208.7	209.7	208.5	208.9	2.3	--- ---
Yield, %		74.2	74.0	73.4	73.6	73.2	73.5	0.2	0.02 ---
Backfat depth, in.		0.96	0.90	0.87	0.93	0.91	0.92	0.03	--- ---
Loin depth, in.		2.43	2.54	2.43	2.49	2.45	2.44	0.04	--- ---
NPPC fat-free lean, %		48.4	49.5	49.8	49.0	49.2	49.1	0.5	--- ---
Carcass base price, \$/cwt		57.83							
Total revenue/carcass, \$		118.28	121.03	119.99	120.07	119.92	119.77	1.68	--- ---
Value of gain/pig (live), \$ ³		23.97	25.55	25.35	25.52	25.49	25.23	0.53	--- 0.10
Feed cost/lb gain, \$ ⁴		0.32	0.33	0.34	0.35	0.35	0.37	0.01	0.001 ---
Feed cost/pig, \$		18.46	19.67	20.25	20.93	21.18	22.19	0.38	0.001 ---
IOFC, \$/pig ⁵		5.51	5.88	5.11	4.59	4.31	3.05	0.46	0.001 ---

¹ A total of 288 pigs (PIC TR4 × 1050) were housed with 6 replications of 8 pigs per pen in a 28-d experiment.² Probability, *P* > 0.13.³ Determined from the carcass base price × the yield × total live gain during the experiment.⁴ Diet costs were based on corn at \$4.00/bu and 46.5% soybean meal at \$380/ton.⁵ Income over feed cost = value of live gain/pig - feed cost/pig.

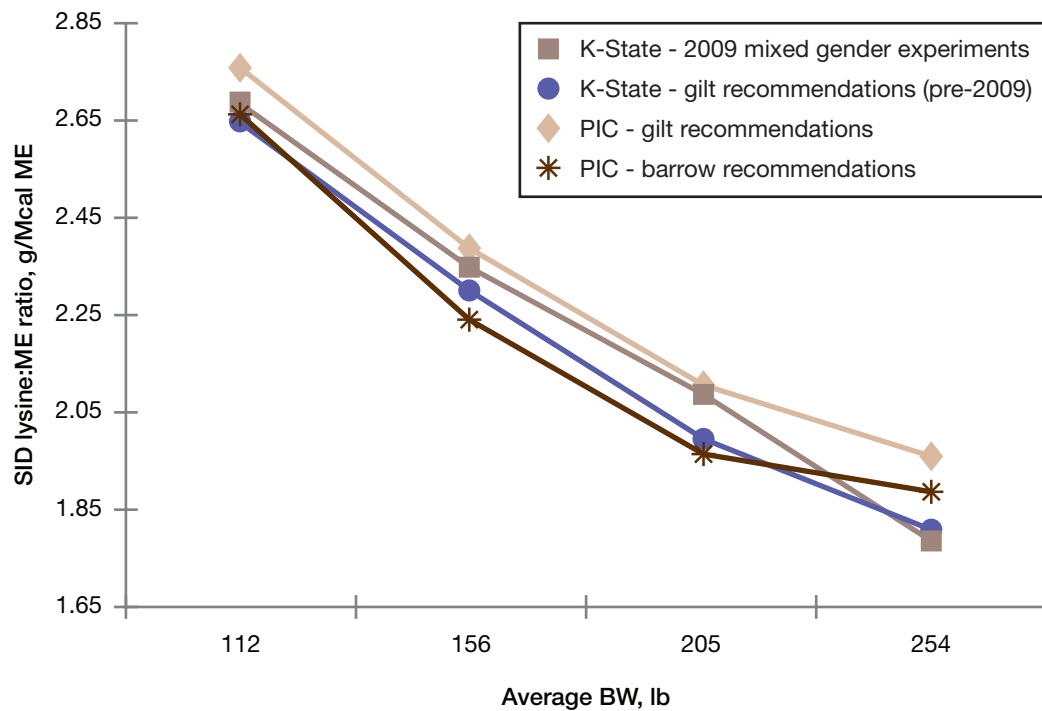


Figure 1. Recommended SID lysine:calorie ratios for growing-finishing pigs.

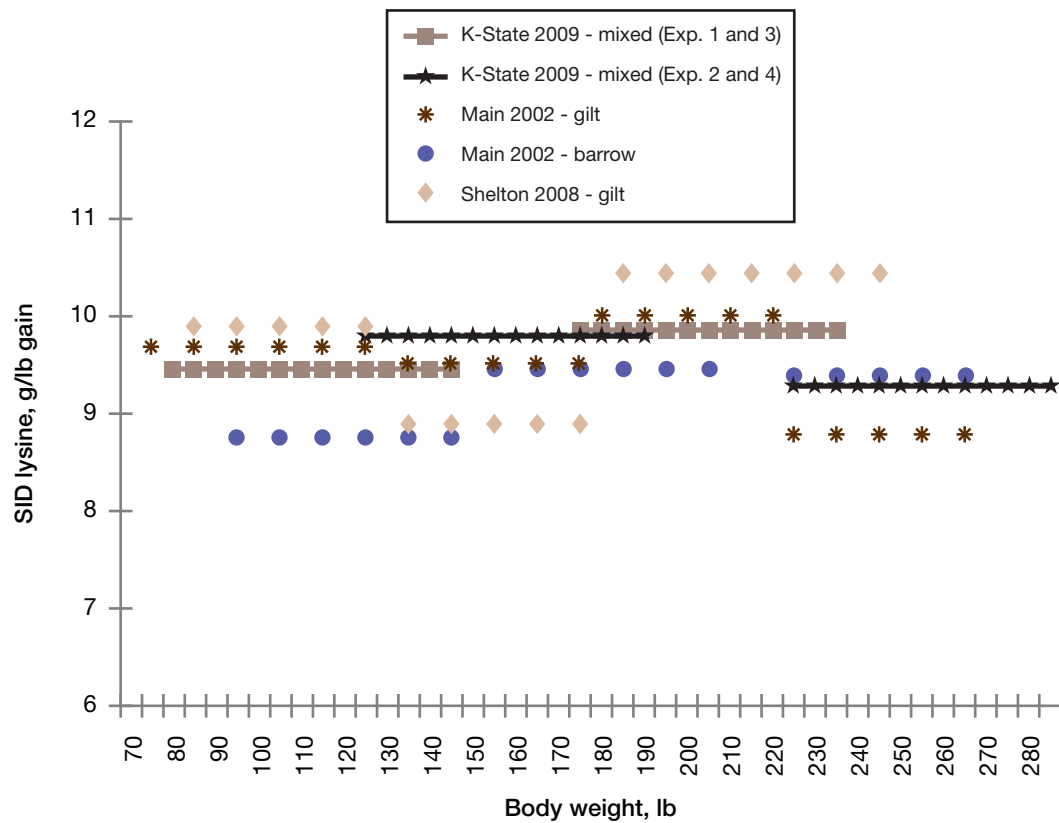


Figure 2. Observed intakes of SID lysine per pound of gain at the recommended levels of SID lysine across experiments.

Length of line indicates body weight range of pigs in each experiment.