# Effects of standardized ileal digestible lysine level on growth performance and economic return for 18 to 128 kg Duroc-sired pigs

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## LAY SUMMARY

Lysine is typically the first limiting amino acid in corn-soybean meal-based swine diets, and as such, having an accurate estimate of lysine requirements for various genotypes is vitally important to optimize both growth performance and economic return. The focus of this research was to determine the standardized ileal digestible (SID) lysine requirement estimates of Duroc-sired pigs throughout the growing-finishing period. A series of five experiments were conducted where pigs were fed increasing levels of SID lysine at various weight ranges between 18 and 128 kg. Using the results of each individual experiment we were able to develop equations to predict the Lys:calorie ratio required to maximize both growth performance and economic return. These equations can be utilized by swine production systems to optimize feeding programs for this genotype of pigs.

## TEASER TEXT

The prediction equations developed from the results of this research may be used as a baseline to develop feeding programs for Duroc-sired pigs throughout the growing-finishing period.

**ABSTRACT:** The recent shift of the U.S. swine industry towards improved pork quality, such as color, marbling, and firmness has led to increased use of Duroc-sired pigs in the marketplace. Our objective was to determine the standardized ileal digestible (SID) Lys requirement estimates for Duroc-sired (600 × 241, DNA, Columbus NE) pigs from 18 to 128 kg BW. We conducted a series of experiments using corn-soybean meal-based diets with pigs allotted to 6 or 7 treatments in randomized complete block designs. In all experiments an equal number of barrows and gilts were used within a pen. In Exp. 1, 300 pigs (initially 18.4 ± 0.50 kg) were used with 5 pigs per pen and 10 pens per treatment with 6 SID Lys levels from 1.00 to 1.50%. Increasing SID Lys increased (linear, $P < 0.040$) final BW, ADG, G:F, and Lys intake/kg of gain, and decreased (linear, $P = 0.012$) ADFI. In Exp. 2, 608 pigs (initially 36.3 ± 0.91 kg) were used with 7 to 9 pigs per pen and 12 pens per treatment with 6 SID Lys levels from 0.80 to 1.20%. Increasing SID Lys increased (linear, $P \leq 0.036$) ADG, G:F, and Lys intake/kg of gain. In Exp. 3, 700 pigs (initially 53.2 ± 0.86 kg) were used with 8 to 10 pigs per pen and 12 pens per treatment with 6 SID Lys levels from 0.65 to 1.00%. Increasing SID Lys increased (linear, $P < 0.001$) final BW, ADG, and Lys intake/kg of gain, decreased (quadratic, $P = 0.004$) ADFI, and improved (quadratic, $P < 0.001$) G:F. In Exp. 4, 616 pigs (initially 76.4 ± 1.25 kg) were used with 8 to 10 pigs per pen and 5, 6, or 11 pens per treatment with 7 SID Lys levels from 0.58 to 1.00%. Increasing SID Lys increased (linear, $P \leq 0.022$) ADG, Lys intake/kg of gain, and G:F. In Exp. 5, 679 pigs (initially 103.8 ± 1.32 kg) were used with 8 to 10 pigs per pen and 11 or 12 pens per treatment with 6 SID Lys levels from 0.43 to 0.78%. Increasing SID Lys increased (linear, $P \leq 0.043$) final BW, ADG, and Lys intake/kg of gain, and improved (quadratic, $P \leq 0.032$) G:F. Using results from all experiments, the quadratic equation of Lys:calorie ratio, g of SID Lys/Mcal of NE = $0.0002611 \times BW^2 - 0.0711037 \times BW + 7.284$ was developed to reflect the requirement for maximal growth performance from 18 to 128 kg BW. Maximal income over feed cost (IOFC) is best described by the quadratic equation: Lys:calorie ratio, g of SID Lys/Mcal of NE = $0.0001558 \times BW^2 - 0.04030769 \times BW + 5.410$. These data provide updated SID Lys estimates for Duroc-sired grow-finish pigs.

**Key Words:** Amino acid, economics, growth, grow-finish pig, lysine

**List of abbreviations**

ADFI, average daily feed intake

ADG, average daily gain

BW, body weight

CP, crude protein

DM, dry matter

G:F, gain-to-feed

RCBD, randomized complete block design

SID, standardized ileal digestibility

STTD, standard total tract digestibility

## INTRODUCTION

Improvements in modern swine genetics have resulted in an increased potential for growth performance and protein accretion, which may cause a shift in dietary nutrient requirements. As a result, it is important to continuously analyze and reassess dietary nutrient requirements (O'Connell et al., 2006). Lysine is typically the first limiting amino acid in corn-soybean meal-based swine diets, and as such an accurate estimation of Lys requirements is crucial to maximize lean growth while optimizing feed cost in growing-finishing pigs. Numerous factors have an impact on Lys requirements, such as genetics, environmental conditions, sex, and pig body weight (Campbell and Taverner, 1988). Genetic suppliers provide estimates for amino acid requirements; however, validating these levels is necessary to optimize growth performance and economic returns (De La Llata et al., 2001; Main et al., 2008, Shelton et al., 2011). Additionally, it is important to have an appreciation for the biological and economic implications of feeding below, at, or above biological requirements throughout the grower-finishing period when developing feeding regimens (Main et al., 2008).

Recently, the U. S. swine industry has shifted towards an emphasis for improved pork quality (color, marbling, and firmness), which has led to increased usage of Duroc-sired pigs in the marketplace. Suzuki et al. (2003) observed that Duroc-sired pigs had excellent growth rates and intramuscular fat content. Moreover, Soto et al. (2019) observed that Duroc-sired late finishing pigs had 6% greater overall feed intake compared with Pietrain-influence sired pigs reported by Gonçalves et al. (2017). Therefore, the objective of these experiments was to determine the standardized ileal digestible (SID) Lys estimates for Duroc-sired finishing pigs from 18 to 128 kg with the intent of developing a SID Lys requirement estimate curve for this genotype.

## MATERIALS AND METHODS

### *General*

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in these experiments. All experiments were conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facilities were totally enclosed and environmentally regulated. In Exp. 1, each pen (1.21 × 1.21-m) was equipped with a 4-hole, dry self-feeder, and a nipple waterer. Pens were located over a metal tri-bar floor with a 1.21-m pit underneath for manure storage. In Exp. 2, 3, 4, and 5, each pen was equipped with a 2-hole dry, single-sided feeder (Farmweld, Teutopolis, IL) and a 1-cup waterer, and adjustable gates to allow 0.74 $m^2$ per pig. Pens were located over a completely slatted concrete floor with a 1.21-m pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wimar, MN) was used to deliver and record daily feed additions to each individual pen. Pigs were provided *ad libitum* access to water and feed in meal form throughout the experiments. Complete diets were manufactured at Hubbard Feeds, Beloit, KS for each experiment. All experimental diets were corn-soybean meal-based. Ingredient nutrient composition and SID AA coefficients were derived from NRC (2012), except for NE of soybean meal which was set at 100% that of corn (Cemin et al., 2020). In Exp. 1, six individual diets were manufactured (Table 1). In Exp. 2, 3, 4, and 5, two diets were formulated to 0.80 and 1.20, 0.65 and 1.00, 0.58 and 1.00, and 0.43 and 0.78% SID Lys, respectively. These dietary treatments were blended via a robotic feeding system to establish the range of SID Lys levels in each experiment (Tables 2 and 3).

In each experiment, Duroc-sired pigs (600× 241, DNA, Columbus NE) were used to estimate the SID Lys requirement. Barrows and gilts were penned together with gender equalized by pen or block for each experiment. For all experiments, ratios of other AAs to Lys were maintained well above requirement estimates to ensure that Lys was the first-limiting AA. Although the increase in dietary Lys was brought about by increasing the ratio of soybean meal to corn which also increased the CP content of the diet, Lys was the first limiting AA. This formulation strategy was used to make the results more translational to application, as SID Lys is typically increased within the industry by increasing both soybean mean and L-Lys HCl. Previous research by Yen et al. (2005), Main et al. (2008), and many others have employed a similar diet formulation strategy in determining Lys requirements of finishing pigs. In all experiments, pens of pigs were weighed, and feed disappearance was recorded approximately every 7 d to determine ADG, ADFI, and G:F in all experiments.

***Experiment 1***

A total of 300 pigs (initially 18.4 ± 0.50 kg to approximately 40 kg) were used in a 24-d study. There were 5 mixed-gender pigs per pen at a floor space of 0.30 $m^2$ per pig. Pens of pigs were allotted by BW and randomly assigned to 1 of 6 dietary treatments with 10 replications per treatment in a randomized complete block design (RCBD). Dietary treatments were corn-soybean meal based and formulated to 1.00, 1.10, 1.20, 1.30, 1.40, or 1.50% SID Lys containing 0.25, 0.30, 0.35, 0.40, 0.45, and 0.50% L-Lys HCl, respectively, with other feed-grade AAs added as necessary to maintain ratios relative to Lys (Table 1).

***Experiment 2***

A total of 608 pigs (initially 36.3 ± 0.91 kg to approximately 54 kg) were used in two consecutive groups of approximately 300 pigs with the group 1 study lasting 14-d and group 2 lasting 21-d. There were 7 to 9 mixed gender pigs per pen at a floor space of 0.74 $m^2$ per pig. Pigs were allotted by BW and randomly assigned to 1 of 6 dietary treatments in a RCBD. The dietary treatments included 6 SID Lys concentrations (0.80, 0.88, 0.96, 1.04, 1.12 and 1.20%), with 12 replications per treatment.

***Experiment 3***

A total of 700 pigs (initially 53.2 ± 0.86 kg to approximately 75 kg) were used in two consecutive groups of approximately 350 pigs. Each study lasted 21-d. There were 8 to 10 pigs per pen with similar numbers of barrows and gilts in each pen. Pens of pigs were allotted by BW and randomly assigned to 1 of 6 dietary treatments in a RCBD. The dietary treatments included 6 SID Lys concentrations (0.65, 0.72, 0.79, 0.86, 0.93, and 1.00%), with 12 replications per treatment.

***Experiment 4***

A total of 616 pigs (initially 76.4 ± 1.25 kg to approximately 106 kg) were used in two consecutive groups of approximately 300 pigs. Each study lasted 21-d. There were 8 to 10 mixed gender pigs per pen with similar numbers of barrows and gilts placed in each pen. Pens of pigs were allotted by BW and randomly assigned to 1 of 7 dietary treatments in a RCBD. The dietary treatments included 7 SID Lys concentrations (0.58, 0.65, 0.72, 0.79, 0.86, 0.92, and 1.00%), with 11 replications for the 0.65, 0.72, 0.79, 0.86, and 0.92% SID Lys treatments; 6 replications for the 0.58% SID Lys treatment; and 5 replications for the 1.00% SID Lys treatment.

***Experiment 5***

A total of 679 pigs (initially 103.8 ± 1.32 kg to approximately 128 kg) were used in two consecutive groups of approximately 330 pigs. Each study lasted 21- and 28-d. There were 8 to 10 mixed gender pigs per pen with similar numbers of barrows and gilts placed in each pen. Pens of pigs were allotted by BW and randomly assigned to 1 of 6 dietary treatments in a RCBD. The dietary treatments included 6 SID Lys concentrations (0.43, 0.50, 0.57, 0.64, 0.71, and 0.78%), with 12 replications for the 0.43, 0.50, 0.57, 0.71, and 0.78% SID Lys treatments, and 11 replications for the 0.64% SID Lys treatment.

***Chemical analysis***

A sample of each diet in Exp. 1 and from the lowest and highest SID Lys, % diets in Exp. 2, 3, 4, and 5 was submitted for AA profile (Tables 4 and 5). In experiment 1, representative diet samples were obtained from every third bag of feed. In experiments 2, 3, 4, and 5, diet samples were taken from 6 feeders per dietary treatment 3 d after the beginning of each trial. Diet samples were stored at -20°C until they were homogenized, subsampled, and submitted for analysis of AA profile (method 994.12; AOAC International, 2012) conducted by Ajinomoto Animal Nutrition North America, Inc. (Eddyville, IA). Results of laboratory analysis indicated total nutrient profiles were consistent with expected diet formulation values.

***Economic analysis***

For the economic analysis, feed cost/pig, feed cost/kg gain, revenue per pig, and IOFC were calculated for high- and low-priced diets. High-priced diet costs were determined using the following ingredient prices: corn = $6.00/bushel ($236/tonne); soybean meal = $440/tonne; L-Lys at $1.76/kg; DL-Met at $5.51/kg; L-Thr at $2.65/kg; L-Trp at $11.02/kg; and L-Val at $8.82/kg. Low-priced diet costs were determined using the following ingredient prices: corn = $3.00/bushel ($118/tonne); soybean meal = $330/tonne; L-Lys at $1.43/kg; DL-Met at $3.75/kg; L-Thr at $1.87/kg; L-Trp at $6.61/kg; and L-Val at $5.51/kg. Feed cost/pig was determined by total feed intake × diet cost ($/kg). Feed cost/kg of gain was calculated using feed cost/pig divided by total gain. Revenue per pig was determined for both a high- and a low-price by total gain × $1.46/kg live gain, or total gain × $0.99/kg live gain, respectively. Income over feed cost was calculated using revenue/pig – feed cost/pig.

***Statistical analysis***

Data were analyzed as a RCBD for a one-way ANOVA using the lmer function from the lme4 package in R Studio (Version 3.5.2, R Core Team; Vienna, Austria) with pen serving as the experimental unit, pen average BW as blocking factor, and treatment as fixed effect. Dose response curves were evaluated using linear (LM), quadratic polynomial (QP), and broken-line linear (BLL) models. For each response variable, the best-fitting model was selected using the Bayesian Information Criterion (BIC). A decrease in BIC greater than 2.0 among models for a particular response criterion was considered an improved fit. Results were considered significant with $P \leq 0.05$ and were considered marginally significant with $P \leq 0.10$. The predicted requirement for maximum growth performance and economic return found from dose response curves in each study were used to develop regression equations to predict the overall Lys:calorie ratio required for maximum growth performance and economic return. In Experiments 1, 2 and 3, the lowest breakpoint suggested by the dose response models (ADG or G:F) was selected. In Experiment 4, the midpoint between the two suggested breakpoints was used. In Experiment 5, the highest breakpoint suggested by the dose response models was selected. The suggested requirement for maximum growth performance from each experiment was used to develop the regression equation. For economic return, the highest breakpoint suggested by the dose response models was used to develop the regression equation. These curves describe the Lys:calorie ratio that best met biological requirements for growth performance and optimized IOFC in this series of trials (Figure 1)

## RESULTS

### *Experiment 1*

In 18- to 40-kg pigs, increasing SID Lys increased d 24 BW (linear, $P \leq 0.04$; Table 6). Overall ADG increased with increasing SID Lys (linear, $P = 0.003$). Pigs fed increasing SID Lys had decreased (linear, $P = 0.012$) ADFI from d 0 to 24. An improvement for overall G:F (linear, $P < 0.001$) was observed with increasing SID Lys. Daily SID Lys intake and Lys intake per kg of gain increased (linear, $P < 0.001$) with increasing SID Lys. For economic analysis, feed cost and feed cost per kg of gain increased (linear, $P < 0.001$), while total revenue tended to decrease (linear, $P = 0.074$) with increasing SID Lys at both high and low ingredient pig prices. At high ingredient and pig prices, there was no evidence of significant difference ($P > 0.10$) for IOFC. However, at low ingredient and pig prices, increasing SID Lys decreased (linear, $P = 0.048$) IOFC, with pigs fed diets containing 1.10% SID Lys having the greatest numeric IOFC.

Dose response curves were evaluated for overall growth performance, and when modeling ADG, the LM and QP models resulted in a comparable fit. The QP model equation was: ADG = -0.282148 × (SID Lys, %)$^2$ + 0.797053 × (SID Lys, %) + 0.339, with maximum ADG estimated at 1.41% SID Lys (Supplemental Figure 1A). For the LM, maximum ADG was predicted above 1.50% SID Lys. For G:F, the LM resulted in the best fit, and predicted maximum feed efficiency above 1.50% SID Lys (Supplemental Figure 1B).

When modelling IOFC at high ingredient and pig prices, the LM model resulted in the best fit and predicted the SID Lys requirement to achieve maximum IOFC was at less than 1.00% (Supplemental Figure 1C). Meanwhile, at low ingredient and pig prices, the LM and BLL models had a similar fit to maximize IOFC. The LM estimated maximum IOFC at less than 1.00% SID Lys, while the BLL model predicted similar IOFC from 1.00 to 1.12% SID Lys with a reduction in IOFC when SID Lys increased past 1.12% (Supplemental Figure 1D).

***Experiment 2***

In 36- to 54-kg pigs, increasing SID Lys did not significantly affect ($P > 0.10$) final BW (Table 7). However, ADG increased (linear, $P = 0.036$) with increasing SID Lys, while there was no observed difference ($P > 0.10$) in ADFI. As a result, increasing SID Lys increased (linear, $P < 0.001$) G:F. Daily SID Lys intake and Lys intake per kg of gain increased (linear, $P < 0.001$) with increasing SID Lys.

For economic analysis, feed cost and feed cost per kg of gain increased (linear, *P* < 0.002), and revenue tended to increase (linear, *P* = 0.060) with increasing SID Lys at both high and low ingredient and pig prices. At high ingredient and pig prices, there was no evidence of difference (*P* > 0.10) for IOFC. However, at low ingredient and pig prices, increasing SID Lys tended to decrease (linear, *P* = 0.097) IOFC, with pigs fed diets containing 0.88 or 0.96% SID Lys having the greatest numeric IOFC.

Dose response curves for overall growth performance revealed that LMs were the best fit for ADG and G:F, with the SID Lys requirement to maximize ADG and G:F predicted above 1.20% (Supplemental Figure 2A and 2B). At both high and low ingredient and pig prices, LMs resulted in the best fit for IOFC, with maximum IOFC estimated at less than 0.80% SID Lys (Supplemental Figure 2C and 2D).

***Experiment 3***

In 53- to 75-kg pigs, increasing SID Lys increased (linear, *P* < 0.001) final BW (Table 8). Average daily gain increased (linear, *P* < 0.001) with increasing SID Lys while for ADFI, there was a quadratic (*P* = 0.004) decrease with increasing SID Lys. A linear and quadratic (*P* < 0.001) response was observed for overall G:F with increasing SID Lys. Additionally, daily SID Lys intake and Lys intake per kg of gain increased (linear and quadratic, *P* < 0.003) with increasing SID Lys.

For economic analysis, feed cost increased (linear and quadratic, *P* < 0.023), while feed cost per kg of gain decreased (linear and quadratic, *P* < 0.012) with increasing SID Lys in both economic scenarios. Meanwhile, at both high and low ingredient and pig prices, increasing SID Lys increased linearly (*P* < 0.002) revenue and IOFC.

Dose response curves were evaluated for overall growth performance with the LM being the best fitting model for ADG, predicting maximum ADG above 1.00% SID Lys (Supplemental Figure 3A). The QP model resulted in the best fit to optimize feed efficiency.

The QP model equation was: G:F = -0.4830938 × (SID Lys, %)$^2$ + 0.9555893 × (SID Lys, %) – 0.027 with maximal G:F estimated at 0.99% SID Lys (Supplemental Figure 3B). When modelling IOFC at high ingredient and pig prices, the BLL model resulted in the best fit, predicting no further improvement in IOFC past 0.76% SID Lys (Supplemental Figure 3C). Meanwhile, at low ingredient and pig prices, the LM and QP models had a comparable fit. The LM predicted maximum IOFC above 1.00% SID Lys. The QP model equation was: IOFC = -14.5626 × (SID Lys, %)$^2$ + 26.6348 × (SID Lys, %) -0.085, with maximum IOFC estimated at 0.91% SID Lys.

***Experiment 4***

In 76- to 100-kg pigs, increasing SID Lys did not significantly affect ($P$ > 0.10) final BW (Table 9). Average daily gain increased (linear, $P$ = 0.022) with increasing SID Lys, while there was no observed difference ($P$ > 0.10) in ADFI. As a result, increasing SID Lys numerically increased (quadratic, $P$ < 0.10) G:F. with no improvement in G:F feeding beyond 0.86% SID Lys. Daily SID Lys intake and Lys intake per kg of gain increased (linear, $P$ < 0.001) with increasing SID Lys. For economic analysis, feed cost increased (linear, $P$ < 0.001), and feed cost per kg of gain increased (linear and quadratic, $P$ < 0.041) with increasing SID Lys in both pricing scenarios. Increasing SID Lys tended to increase (linear, $P$ = 0.051) revenue at both high and low ingredient and pig prices. For IOFC, increasing SID Lys did not have a significant effect ($P$ > 0.10) in either pricing scenario, however, pigs fed diets containing 0.65 or 0.72% SID Lys had the greatest numeric IOFC.

When modeling dose response curves for ADG, the BLL and LM models resulted in a comparable fit. The BLL model predicted no further improvement in ADG above 0.83% SID Lys, while the LM estimated maximum ADG above 1.00% (Supplemental Figure 4A). For G:F, the LM and QP models resulted in a comparable fit, with the LM predicting maximum G:F at greater that 1.00% SID Lys. The QP equation model was: G:F = -0.2244707 × (SID

Lys, %)$^2$ + 0.4156878 × (SID Lys, %) + 0.190, with 100% of maximum G:F estimated at 0.93% SID Lys (Supplemental Figure 4B). When modelling IOFC at high ingredient and pig prices, the QP was the best fitting model. The QP model equation was: IOFC = -17.3293 × (SID Lys, %)$^2$ + 27.0408 × (SID Lys, %) + 4.169, with maximum IOFC estimated at 0.78% SID Lys (Supplemental Figure 4C). However, at low ingredient and pig prices, the BLL and LM models resulted in a comparable fit. The BLL model predicted a reduction in IOFC when SID Lys increased past 0.76%, while the LM model estimated maximum IOFC at less than 0.58% SID Lys.

***Experiment 5***

In 103- to 128-kg pigs, increasing SID Lys increased (linear, $P$ = 0.025) final BW (Table 10). Average daily gain increased linearly ($P$ = 0.043) with increasing SID Lys, while there was no observed difference ($P$ > 0.10) in ADFI. As a result, increasing SID Lys increased (quadratic, $P$ < 0.032) G:F, with pigs fed diets containing 0.71% SID Lys having the greatest numeric G:F. Daily SID Lys intake and Lys intake per kilogram of gain increased (linear, $P$ < 0.001) with increasing SID Lys.

For economic analysis, at high ingredient and pig prices there was no significant difference between treatments for feed cost per pig ($P$ > 0.10). However, at low ingredient and pig prices, increasing SID Lys increased (linear, $P$ = 0.014) feed cost per pig. At high prices, increasing SID Lys had a quadratic effect ($P$ = 0.032) on feed cost per kg of gain. Meanwhile at low ingredient and pig prices, increasing SID Lys increased (linear, $P$ = 0.044) feed cost per kg of gain. In both economic scenarios, increasing SID Lys increased (linear, $P$ = 0.028) revenue. At high ingredient and pig prices, IOFC increased (linear and quadratic, $P$ < 0.020) with increasing SID Lys. Additionally, increasing SID Lys had a quadratic effect ($P$ = 0.004) on IOFC at low ingredient and pig prices, with pigs fed diets containing 0.71% SID Lys having the greatest numeric IOFC in each scenario.

When modelling dose response curves for ADG and G:F, BLL models resulted in the best fit. The BLL model for maximum ADG predicted no further improvement past 0.64% SID Lys (Supplemental Figure 5A). Meanwhile, the BLL model for maximum G:F estimated no further improvement above 0.59% SID Lys (Supplemental Figure 5B). When modelling IOFC at high or low ingredient and pig prices, the QP model resulted in the best fit. At high ingredient and pig prices the QP model equation was: IOFC = -42.6028 × (SID Lys, %)$^2$ + 54.9097 × (SID Lys, %) – 4.047, with maximum IOFC predicted at 0.64% SID Lys (Supplemental Figure 5C). Additionally, at low ingredient ant pig prices, the QP model equation was: IOFC = -25.9430 × (SID Lys, %)$^2$ + 32.4160 × (SID Lys, %) + 0.901, with maximum IOFC estimated at 0.62% SID Lys (Supplemental Figure 5D).

***Prediction Equations***

A summary of the optimum Lys:calorie ratio observed in each trial as well as the associated SID Lys intake per day and per kg of gain are provided in Table 11. These values were used to develop regression equations to predict the Lys:calorie ratio required for maximum growth performance and IOFC of 18- to 128-kg pigs (Figure 1). To maximize growth performance, the quadratic equation of Lys:calorie ratio, g of SID Lys/Mcal of NE = 0.0002611 × BW$^2$ – 0.0711037 × BW + 7.284 was developed. To optimize IOFC, the quadratic equation of Lys:calorie ratio, g of SID Lys/Mcal of NE = 0.0001558 × BW$^2$ - 0.04030769 × BW + 5.410 was developed.

## DISCUSSION

Essential AA requirements for growing-finishing pigs are commonly based on ratios to Lys. As a result, it is critical to have an accurate estimation of Lys requirements to maximize growth performance and optimize feed cost throughout the growing-finishing period (Soto et al., 2019). Moreover, continuous advancements in modern pig genetics have led to increased potential for growth performance and protein accretion, potentially leading to increased dietary nutrient requirements (O'Connell et al., 2006). Additionally, advancements in dose-response models have provided a strategy to estimate nutrient requirements more accurately (Gonçalves et al., 2016). This trend in genetic improvement, coupled with technological improvements to help optimize health status, environmental conditions, and management plans, has allowed for improvements in growth performance and carcass composition. Between 1980 and 2019, the average market weight of pigs has increased by 18 kg (National Pork Board, 2016; 2020). Coupled with this increased market weight, pigs have become more efficient. Between 1990 and 2019 average growth rate of wean-to-finish pigs increased from 0.58 to 0.80 kg/day, while feed intake per kg of gain decreased from 3.2 to 2.6 kg during that same time frame (PigChamp, 1990; National Pork Board, 2020). Similarly, this improved growth performance was observed in our study, as pigs grew at an average between 0.89 and 1.08 kg/day across our 5 experiments.

Estimations of dietary Lys requirements for growing-finishing pigs have changed considerably in the last 30 years. Cromwell et al. (1993) suggested that the total Lys requirement for barrows and gilts from 35 to 105 kg was 0.60 and 0.90%, respectively. Hahn et al. (1995) suggested a total Lys requirement for barrows and gilts weighing between 90 and 110 kg of 0.49 and 0.52%, respectively. More recently, in a meta-analysis with PIC (Hendersonville, TN) genetic lines, Gonçalves et al. (2017) suggested that the SID Lys requirement for barrows and gilts in predominantly Pietrain-sired pigs was 1.11 and 1.16% (25 to 50 kg), 0.91 and 0.94% (50- to 75-kg), 0.78 and 0.80% (75- to 100-kg), and 0.70 and 0.75% (100 to 135 kg), respectively. Soto et al. (2019) observed that late finishing pigs (102- to 128-kg) grown in the same facilities with similar genetic maternal and paternal lines as our study achieved maximum ADG and G:F at 0.62 and 0.63% SID Lys, respectively. In our study, the SID Lys estimate for maximum growth performance was 1.41 to 1.50%, at least 1.20%, 0.99 to 1.00%, 0.83 to 0.93%, and 0.59 to 0.64% for pigs weighing 18 to 40 kg, 36 to 54 kg, 53 to 75 kg, 76 to 100 kg, and 103 to 128 kg, respectively.

During the grower period (25 to 50 kg) we observed considerably higher estimates than those of Gonçalves et al. (2017). This difference may be a result of drastic differences in daily feed intake (2.31 kg/day in Gonçalves vs. 1.99 kg/day in current study). Pigs in our study may have required a considerably higher SID Lys percentage in the diet to meet a similar Lys intake per kg of gain. Similarly, in pigs weighing between 50 and 100 kg, we observed higher lysine requirements than those of Gonçalves et al. (2017). In late finishing (103 to 128 kg pigs), we observed a similar SID Lys requirement to those of Soto et al. (2019), which was considerably lower than those of Gonçalves et al. (2017). Variation in Lys requirements among studies could be attributable to differences in genetic capability for protein deposition, amino acid digestibility, or immune stress (Kendall et al., 2007). The present studies were conducted under a controlled, high-health research environment. Thus, Lys requirement estimates might change with different environmental conditions.

Lysine requirements are often expressed as a function of SID Lys required per kg of BW gain. Our estimated requirement ranged from approximately 22.6 to 23.3 g SID Lys/kg gain for 18 to 75 kg pigs and from 21.3 to 22.5 g SID Lys/kg gain for 76 to 128 kg pigs. In comparison, Shelton et al. (2011) and Main et al. (2008) observed a requirement ranging between 19.6 and 23.0 g SID Lys/kg gain in pigs weighing 35 to 110 kg. Additionally, Main et al. (2008) and Soto et al. (2019) observed a requirement ranging between 17.0 and 22.6 g SID Lys/kg gain in pigs weighing 100 to 130 kg. The increased requirement of SID Lys intake per kg of BW gain observed in our trials may be a result of pigs depositing a higher proportion of protein rather than lipids compared to previous research.

Economic analysis, as well as growth performance, is vital when developing nutritional programs. Income over feed cost accounts for the gross sale revenue and feed expense generated. Multiple studies have observed that nutrient requirements to maximize biological performance may align with optimal IOFC estimates (De La Llata et al., 2001; Main et al., 2008). In contrast, our results in Exp. 1, 2, 3, and 4 (18 to 100 kg pigs) suggest that the SID Lys requirement to optimize IOFC is considerably lower than the biological requirement for maximal growth performance. However, in Exp. 5 the SID Lys requirement for maximum IOFC and growth performance were more closely aligned (0.59 to 0.64%). These results would suggest that, in the economic scenarios considered in our analysis, there is no economic advantage to feed pigs to their maximum biological growth performance when they weigh less than 100 kg. However, in late-finishing pigs (103 to 128 kg) maximum economic performance is achieved at similar levels as maximum growth performance.

In conclusion, the SID Lys estimate for maximum IOFC and growth performance was determined for 5 different weight ranges from 18 to 128 kg. In addition, prediction equations were developed to describe the Lys:calorie ratio that best met biological requirements for growth performance and optimized IOFC. Therefore, this data can be used to formulate SID Lys diet levels for Duroc-sired pigs ranging in weight from 18 to 128 kg.

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## LITERATURE CITED

AOAC International. 2012. Official methods of analysis of AOAC Int. 19th ed. Gaithersburg (MD): Association of Official Analytical Chemists.

Campbell, R. G., M. R. Taverner. 1988. Genotype and sex effects on the relationship between energy intake and protein deposition in growing pigs. J. Anim. Sci. 66:676-686. doi:10.2527/jas1988.66367x

Cemin, Henrique S., Hayden E. Williams, Mike D. Tokach, Steve S. Dritz, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Kyle F. Coble, Brittany A. Carrender, and Mandy J. Gerhart. 2020. Estimate of the energy value of soybean meal relative to corn based on growth performance of nursery pigs. J. Anim. Sci. Biotech. 11:70- 79 https://jasbsci.biomedcentral.com/track/pdf/10.1186/s40104-020-00474-x

Cromwell, G. L., T. R. Cline, J. D. Crenshaw, T. D. Crenshaw, R. C. Ewan, C. R. Hamilton, A. J. Lewis, D. C. Mahan, E. R. Miller, and J. E. Pettigrew. 1993. The dietary protein and (or) lysine requirements of barrows and gilts. NCR-42 committee on swine nutrition. J. Anim. Sci. 74:93-102. doi:10.2527/1993.7181510x

De La Llata, M., S. S. Dritz, M. R. Langemeier, M. D. Tokach, R. D. Goodband, and J. L. Nelssen. 2001. Economics of increasing lysine:calorie ratio and adding dietary fat for growing-finishing pigs reared in a commercial environment. Swine Health Prod. 9:215-223.

Gonçalves, M. A., N. M. Bello, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, J. C. Woodworth, and R. D. Goodband. 2016. An update on modeling dose-response relationships: Accounting for correlated data structure and heterogeneous error variance in linear and nonlinear mixed models. J. Anim. Sci. 94:1940-1950. doi:10.252/jas.2015-0106

Gonçalves, M. A. D., U. Orlando, W. Cast, and M. Culberson. 2017. Standardized ileal digestible lysine requirements for finishing PIC pigs under commercial conditions: A meta-analysis. J. Anim. Sci. 95(E. Suppl. 2):E131-3132.

Hahn, J. D., R. R. Biehl, and D. H. Baker. 1995. Ideal digestible lysine level for early- and late- finishing swine. J. Anim. Sci. 73:773-784. doi:10.2527/1995.733773x

Kendall, D. C., A. M. Gaines, B. J. Kerr, and G. L. Allee. 2007. True ileal digestible tryptophan to lysine ratios in ninety- to one hundred twenty-five-kilogram barrows. J. Anim. Sci. 73:3000-3008. doi:10.2527/jas.2007-0013

Main, R. G., S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen. 2008. Determining an optimum lysine:calorie ratio for barrows and gilts in a commercial finishing facility. J. Anim. Sci. 86:2190-2207. doi:10.2527/jas.2007-0408

National Pork Board. 2016. Quick facts. National Pork Board, Des Moines, IA. Date accessed: Aug. 2, 2021. Retrieved from: https://porkgateway.org/wp-content/uploads/2015/07/quick-facts-book1.pdf

National Pork Board. 2020. Production Analysis Summary for U.S. Pork Industry: 2017-2019. National Pork Board, Des Moines, IA. Date accessed: Aug. 2, 2021. Retrieved from: https://library.pork.org/media/?mediaId=4D0CDE8D-9898-44F4-A2FB321F87DE331D

NRC. 2012. Nutrient requirements of swine: 11th revised edition. Natl. Acad. Press, Washington, DC.

O'Connell, M. K., P. B. Lynch, and J. O'Doherty. 2006. The effect of dietary lysine restriction during the grower phase and subsequent dietary lysine concentration during the realimentation phase on the performance, carcass characteristics and nitrogen balance of growing-finishing pigs. Livest. Sci. 101:1690179. doi:10.1016/j.livprodsci.2005.11.024

PigChamp. 1990. Grow-finish production values. Swine Graphics, Inc., Webster City, IA.

Shelton, N. W., M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey. 2011. Effects of increasing dietary standardized ileal digestible lysine for gilts grown in a commercial finishing environment. J. Anim. Sci. 89:3587-3595. doi:10.2527/jas.2010-3030

Soto, J. A., M. D. Tokach, S. S. Dritz, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and F. Wu. 2019. Optimal dietary standardized ileal digestible lysine and crude protein concentration for growth and carcass performance in finishing pigs weighing greater than 100 kg. J. Anim. Sci. 97:1701-1711. doi:10.1093/jas/skz052

Suzuki, K., T. Shibata, H. Kadowaki, H. Abe, and T. Toyoshima. 2003. Meat quality comparison of Berkshire, Duroc, and crossbred pigs by Berkshire and Duroc. Meat Sci. 64:35-42. doi:10.1016/S039-1740(02)00134-1

Yen, J. T., J. Klindt, B. J. Kerr, F. C. Buonomo. 2005. Lysine requirement of finishing pigs administered porcine somatotropin by sustained-release implant. J. Anim. Sci. 83:2789-2797. doi:10.2527/2005.83122789x

**Figure 1.** Optimal Lys:calorie ratio (g of Lys/Mcal of NE) prediction equations were developed for maximum growth performance and IOFC for 18 to 128 kg pigs using our interpretation of 5 trials conducted to determine the maximum SID Lys, % for Duroc-sired pigs (600 × 241, DNA) fed in a university research environment. Barrows and gilts were penned together with gender equalized by block. To maximize growth performance, the quadratic equation is Lys:calorie ratio, g of SID Lys/Mcal of NE = $0.0002611 \times BW^2 - 0.0711037 \times BW + 7.284$. To maximize IOFC, the quadratic equation is Lys:calorie ratio, g of SID Lys/Mcal of NE = $0.0001558 \times BW^2 - 0.04030769 \times BW + 5.410$.

**Table 1.** Diet composition in Exp. 1 (as-fed basis)[1]

| | SID Lys, % | | | | | |
|---|---|---|---|---|---|---|
| Item | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 |
| Ingredient, % | | | | | | |
| Corn | 69.40 | 66.55 | 63.67 | 60.81 | 57.93 | 55.13 |
| Soybean meal, 46.5% CP | 25.61 | 28.11 | 30.61 | 33.11 | 35.61 | 38.11 |
| Corn oil | 2.00 | 2.25 | 2.50 | 2.75 | 3.00 | 3.20 |
| Limestone | 1.00 | 1.00 | 0.98 | 0.98 | 0.95 | 0.95 |
| Monocalcium P, 21% P | 0.70 | 0.65 | 0.65 | 0.60 | 0.60 | 0.55 |
| Sodium chloride | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lys-HCl | 0.25 | 0.30 | 0.35 | 0.40 | 0.45 | 0.50 |
| DL-Met | 0.07 | 0.11 | 0.15 | 0.19 | 0.23 | 0.26 |
| L-Thr | 0.08 | 0.11 | 0.14 | 0.17 | 0.20 | 0.23 |
| L-Trp | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 |
| L-Val | 0.00 | 0.02 | 0.05 | 0.08 | 0.11 | 0.15 |
| Vitamin premix with phytase[2] | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Trace mineral premix[3] | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Calculated analysis[4] | | | | | | |
| SID AA, % | | | | | | |
| Lys, % | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 |
| Ile:Lys | 65 | 63 | 61 | 59 | 58 | 57 |
| Leu:Lys | 140 | 132 | 126 | 120 | 116 | 112 |
| Met:Lys | 32 | 34 | 35 | 36 | 37 | 37 |
| Met and Cys:Lys | 58 | 58 | 58 | 58 | 58 | 58 |
| Thr:Lys | 63 | 63 | 63 | 63 | 63 | 63 |
| Trp:Lys | 19.2 | 19.1 | 19.1 | 19.1 | 19.0 | 19.0 |
| Val:Lys | 71 | 70 | 70 | 70 | 70 | 70 |
| His:Lys | 43 | 41 | 40 | 39 | 38 | 37 |
| Total Lys, % | 1.13 | 1.23 | 1.34 | 1.45 | 1.55 | 1.65 |
| NE, kcal/kg | 2,553 | 2,553 | 2,553 | 2,553 | 2,553 | 2,553 |
| SID Lys:NE, g/Mcal | 3.92 | 4.31 | 4.70 | 5.09 | 5.48 | 5.88 |
| SID Lys:CP, % | 5.47 | 5.69 | 5.88 | 6.05 | 6.20 | 6.34 |
| CP, % | 18.3 | 19.3 | 20.4 | 21.5 | 22.6 | 23.7 |
| Ca, % | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |
| P, % | 0.51 | 0.51 | 0.52 | 0.52 | 0.53 | 0.53 |
| STTD P, % | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |

[1]Diets were fed from 18.4 to 40.2 kg BW.

[2]Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany NJ), provided 1248 phytase units (FYT/kg), for an estimated release of 0.12% STTD P. Provided per kilogram of premix: 1,653,465 IU Vitamin A, 661,386 IU Vitamin $D_3$, 17,637 IU Vitamin E, 1323 mg Vitamin K, 13 mg Vitamin $B_{12}$, 19,842 mg niacin, 11,023 mg pantothenic acid, 3,306 mg menadione.

[3]Provided per kilogram of premix: 11 g Cu, 0.2 g I, 73 g Fe, 22 g Mn, 0.2 g of Se, 73 g Zn.

[4]Ingrdient values and SID coefficients were derived from NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington D.C.

**Table 2.** Diet composition Exp. 2 and 3 (as-fed basis)

| | Exp. 2 | | Exp. 3 | |
|---|---|---|---|---|
| | SID Lys, %[1] | | SID Lys, %[2] | |
| Item | 0.80 | 1.20 | 0.65 | 1.00 |
| Ingredient, % | | | | |
| Corn | 78.62 | 64.75 | 83.12 | 71.87 |
| Soybean meal, 46.5% CP | 16.62 | 31.13 | 13.15 | 24.69 |
| Corn oil | 1.65 | 1.00 | 1.40 | 1.00 |
| Limestone | 1.00 | 0.98 | 0.80 | 0.78 |
| Monocalcium P, 21% P | 0.90 | 0.70 | 0.58 | 0.43 |
| Sodium chloride | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lys-HCl | 0.28 | 0.33 | 0.19 | 0.28 |
| DL-Met | 0.03 | 0.13 | 0.02 | 0.10 |
| L-Thr | 0.08 | 0.12 | 0.04 | 0.11 |
| L-Trp | 0.02 | 0.01 | 0.01 | 0.01 |
| L-Val | 0.01 | 0.06 | 0.01 | 0.05 |
| Vitamin premix with phytase[3] | 0.15 | 0.15 | 0.10 | 0.10 |
| Trace mineral premix[4] | 0.15 | 0.15 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 | 100 |
| Calculated analysis[5] | | | | |
| SID AA, % | | | | |
| Lys, % | 0.80 | 1.20 | 0.65 | 1.00 |
| Ile:Lys | 62 | 62 | 68 | 64 |
| Leu:Lys | 148 | 128 | 171 | 139 |
| Met:Lys | 31 | 34 | 33 | 35 |
| Met and Cys:Lys | 58 | 58 | 65 | 61 |
| Thr:Lys | 63 | 63 | 66 | 65 |
| Trp:Lys | 19 | 19 | 19 | 19 |
| Val:Lys | 72 | 72 | 80 | 75 |
| His:Lys | 44 | 41 | 49 | 43 |
| Total Lys, % | 0.91 | 1.34 | 0.75 | 1.13 |
| NE, kcal/kg | 2,698 | 2,698 | 2,698 | 2,703 |
| SID Lys:NE, g/Mcal | 2.96 | 4.45 | 2.41 | 3.70 |
| SID Lys:CP, % | 5.42 | 5.79 | 4.87 | 5.51 |
| CP, % | 14.8 | 20.7 | 13.4 | 18.1 |
| Ca, % | 0.67 | 0.67 | 0.51 | 0.51 |
| P, % | 0.52 | 0.54 | 0.43 | 0.45 |
| STTD P, % | 0.40 | 0.40 | 0.32 | 0.32 |

[1]Diets were fed from 36.3 to 54.2 kg BW. The two diets were blended to create intermediate treatment diets containing 0.88, 0.96, 1.04, and 1.12% SID Lys, respectively.

[2]Diets were fed from 53.2 to 74.2 kg BW. The two diets were blended to create intermediate treatment diets containing 0.72, 0.79, 0.86, and 0.93% SID Lys, respectively.

[3]Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany NJ), provided 748 or 500 phytase units (FYT/kg), for an estimated release of 0.10 or 0.09% STTD P, in Exp. 2 and 3, respectively. Provided per kilogram of premix: 1,653,465 IU Vitamin A, 661,386 IU Vitamin $D_3$, 17,637 IU Vitamin E, 1323 mg Vitamin K, 13 mg Vitamin $B_{12}$, 19,842 mg niacin, 11,023 mg pantothenic acid, 3,306 mg menadione.

[4]Provided per kilogram of premix: 11 g Cu, 0.2 g I, 73 g Fe, 22 g Mn, 0.2 g of Se, 73 g Zn.

[5]Ingrdient values and SID coefficients were derived from NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington D.C.

**Table 3.** Diet composition Exp. 4 and 5 (as-fed basis)

| | Exp. 4 | | Exp. 5 | |
|---|---|---|---|---|
| | SID Lys, %[1] | | SID Lys, %[2] | |
| Item | 0.58 | 1.00 | 0.43 | 0.78 |
| Ingredient, % | | | | |
| Corn | 85.26 | 71.87 | 87.36 | 81.71 |
| Soybean meal, 46.5% CP | 10.94 | 24.69 | 10.19 | 14.90 |
| Corn oil | 1.50 | 1.00 | 0.40 | 0.90 |
| Limestone | 0.80 | 0.78 | 0.80 | 0.80 |
| Monocalcium P, 21% P | 0.60 | 0.43 | 0.55 | 0.50 |
| Sodium chloride | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lys-HCl | 0.17 | 0.28 | --- | 0.30 |
| DL-Met | --- | 0.10 | --- | 0.05 |
| L-Thr | 0.03 | 0.11 | --- | 0.11 |
| L-Trp | --- | 0.01 | --- | 0.02 |
| L-Val | --- | 0.05 | --- | 0.02 |
| Vitamin premix with phytase[3] | 0.10 | 0.10 | 0.10 | 0.10 |
| Trace mineral premix[4] | 0.10 | 0.10 | 0.10 | 0.10 |
| Total | 100 | 100 | 100 | 100 |
| Calculated analysis[5] | | | | |
| SID AA, % | | | | |
| Lys, % | 0.58 | 1.00 | 0.43 | 0.78 |
| Ile:Lys | 70 | 64 | 92 | 60 |
| Leu:Lys | 183 | 139 | 245 | 148 |
| Met:Lys | 33 | 35 | 44 | 33 |
| Met and Cys:Lys | 67 | 61 | 89 | 60 |
| Thr:Lys | 66 | 65 | 81 | 66 |
| Trp:Lys | 18 | 19 | 24 | 19 |
| Val:Lys | 82 | 75 | 109 | 72 |
| His:Lys | 51 | 43 | 68 | 43 |
| Total Lys, % | 0.67 | 1.13 | 0.52 | 0.88 |
| NE, kcal/kg | 2,698 | 2,703 | 2,577 | 2,579 |
| SID Lys:NE, g/Mcal | 2.15 | 3.70 | 1.57 | 3.02 |
| SID Lys:CP, % | 4.67 | 5.51 | 3.57 | 5.47 |
| CP, % | 12.4 | 18.1 | 12.1 | 14.3 |
| Ca, % | 0.51 | 0.51 | 0.50 | 0.50 |
| P, % | 0.43 | 0.45 | 0.42 | 0.43 |
| STTD P, % | 0.32 | 0.32 | 0.31 | 0.31 |

[1]Diets were fed from 76.4 to 99.1 kg BW. The two diets were blended to create intermediate treatment diets containing 0.65, 0.72, 0.79, 0.86, and 0.93% SID Lys, respectively.

[2]Diets were fed from 103.8 to 127.3 kg BW. The two diets were blended to create intermediate treatment diets containing 0.50, 0.57, 0.64, and 0.71% SID Lys, respectively.

[3]Ronozyme Hiphos (GT) 2700 (DSM Nutritional Products, Inc, Parsippany NJ), provided 500 phytase units (FYT/kg), for an estimated release of 0.09% STTD P. Provided per kilogram of premix: 1,653,465 IU Vitamin A, 661,386 IU Vitamin $D_3$, 17,637 IU Vitamin E, 1323 mg

Vitamin K, 13 mg Vitamin $B_{12}$, 19,842 mg niacin, 11,023 mg pantothenic acid, 3,306 mg menadione.

[4]Provided per kilogram of premix: 11 g Cu, 0.2 g I, 73 g Fe, 22 g Mn, 0.2 g of Se, 73 g Zn.

[5]Ingrdient values and SID coefficients were derived from NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington D.C.

**Table 4.** Amino acid analysis of diets (Exp. 1; as-fed basis)[1]

| Item | SID Lys, % | | | | | |
|---|---|---|---|---|---|---|
| | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 |
| Amino acid analysis, %[2] | | | | | | |
| Lys | 1.16 | 1.30 | 1.34 | 1.48 | 1.52 | 1.64 |
| Ile | 0.74 | 0.81 | 0.76 | 0.87 | 0.90 | 0.95 |
| Met | 0.35 | 0.40 | 0.38 | 0.45 | 0.50 | 0.53 |
| Met + Cys | 0.64 | 0.71 | 0.70 | 0.80 | 0.83 | 0.89 |
| Thr | 0.79 | 0.88 | 0.90 | 1.02 | 1.05 | 1.11 |
| Trp | 0.24 | 0.25 | 0.28 | 0.31 | 0.31 | 0.33 |
| Val | 0.83 | 0.91 | 0.88 | 1.00 | 1.07 | 1.14 |
| His | 0.48 | 0.51 | 0.50 | 0.55 | 0.55 | 0.59 |
| Phe | 0.98 | 1.04 | 1.02 | 1.12 | 1.13 | 1.17 |

[1]Diet samples were taken from every 3rd bag of feed 7 d after the beginning of the trial and stored at -20°C. Values are reported on a total analyzed basis.

[2]Composite sample was submitted to Ajinomoto Heartland Inc. (Eddyville, IA) for amino acid analysis.

**Table 5.** Amino acid analysis of diets (Exp. 2, 3, 4, and 5; as-fed basis)[1]

| | Exp. 2 | | Exp. 3 | | Exp. 4 | | Exp. 5 | |
|---|---|---|---|---|---|---|---|---|
| | SID Lys, % | | SID Lys, % | | SID Lys, % | | SID Lys, % | |
| Item | 0.80 | 1.20 | 0.65 | 1.00 | 0.58 | 1.00 | 0.43 | 0.79 |
| Amino acid analysis, %[2] | | | | | | | | |
| Lys | 0.95 | 1.26 | 0.83 | 1.19 | 0.78 | 1.18 | 0.55 | 1.15 |
| Ile | 0.58 | 0.80 | 0.52 | 0.74 | 0.49 | 0.75 | 0.48 | 0.75 |
| Met | 0.25 | 0.41 | 0.22 | 0.35 | 0.19 | 0.33 | 0.23 | 0.34 |
| Met + Cys | 0.43 | 0.69 | 0.45 | 0.64 | 0.39 | 0.61 | 0.44 | 0.63 |
| Thr | 0.59 | 0.76 | 0.49 | 0.72 | 0.44 | 0.65 | 0.46 | 0.73 |
| Trp | 0.17 | 0.25 | 0.15 | 0.22 | 0.12 | 0.22 | 0.14 | 0.24 |
| Val | 0.69 | 0.93 | 0.64 | 0.87 | 0.59 | 0.87 | 0.61 | 0.86 |
| His | 0.43 | 0.56 | 0.40 | 0.53 | 0.39 | 0.53 | 0.31 | 0.47 |
| Phe | 0.81 | 1.05 | 0.74 | 0.98 | 0.68 | 1.01 | 0.62 | 0.94 |

[1]Diet samples were taken from 6 feeders 3 d after the beginning of the trial and stored at -20°C. Values are reported on a total analyzed basis.

[2]Composite sample was submitted to Ajinomoto Heartland Inc. (Eddyville, IA) for amino acid analysis.

**Table 6.** Effects of increasing SID Lys on growth performance of pigs weighing 18 to 40 kg (Exp. 1)[1]

| | SID Lys, % | | | | | | | *P* = | |
|---|---|---|---|---|---|---|---|---|---|
| Item | 1.00 | 1.10 | 1.20 | 1.30 | 1.40 | 1.50 | SEM | Linear | Quadratic |
| BW, kg | | | | | | | | | |
| d 0 | 18.4 | 18.5 | 18.4 | 18.4 | 18.4 | 18.4 | 0.50 | 0.918 | 0.863 |
| d 24 | 39.0 | 39.9 | 39.9 | 39.6 | 40.1 | 40.2 | 0.86 | 0.040 | 0.537 |
| Overall (d 0 to 24) | | | | | | | | | |
| ADG, g | 844 | 889 | 895 | 888 | 894 | 907 | 17.0 | 0.003 | 0.166 |
| ADFI, g | 1,477 | 1,468 | 1,472 | 1,429 | 1,445 | 1,411 | 31.2 | 0.012 | 0.676 |
| G:F, g/kg | 572 | 605 | 609 | 622 | 620 | 643 | 6.4 | < 0.001 | 0.212 |
| SID Lys g/d | 14.74 | 16.12 | 17.63 | 18.53 | 20.19 | 21.12 | 0.386 | < 0.001 | 0.470 |
| SID Lys g/kg gain | 17.46 | 18.15 | 19.69 | 20.87 | 22.59 | 23.28 | 0.218 | < 0.001 | 0.719 |
| Economics, $ | | | | | | | | | |
| High ingredient and pig prices[2] | | | | | | | | | |
| Feed cost/pig | 11.91 | 12.49 | 12.73 | 12.92 | 13.47 | 13.64 | 0.314 | < 0.001 | 0.702 |
| Feed cost/kg gain[3] | 0.583 | 0.573 | 0.592 | 0.602 | 0.628 | 0.625 | 0.0064 | < 0.001 | 0.272 |
| Total revenue/pig[4] | 29.82 | 31.85 | 31.37 | 31.33 | 31.32 | 31.83 | 0.689 | 0.074 | 0.265 |
| IOFC[5] | 17.91 | 19.36 | 18.64 | 18.41 | 17.85 | 18.20 | 0.429 | 0.304 | 0.169 |
| Low ingredient and pig prices[6] | | | | | | | | | |
| Feed cost/pig | 7.54 | 7.99 | 8.22 | 8.42 | 8.85 | 9.03 | 0.203 | < 0.001 | 0.673 |
| Feed cost/lb gain | 0.369 | 0.366 | 0.383 | 0.392 | 0.413 | 0.414 | 0.0019 | < 0.001 | 0.339 |
| Total revenue/pig[4] | 20.22 | 21.60 | 21.27 | 21.24 | 21.24 | 21.59 | 0.467 | 0.074 | 0.265 |
| IOFC | 12.68 | 13.61 | 13.05 | 12.82 | 12.38 | 12.56 | 0.300 | 0.048 | 0.181 |

[1]A total of 300 pigs (DNA 600 × 241; initially 18.4 ± 0.50 kg BW) were used with 5 pigs per pen and 10 replications per treatment. Each pen contained both barrows and gilts and gender equalized by block.
[2] For high priced diets, corn was valued at $6.00/bu ($235.71/tonne), soybean meal at $440/tonne, L-Lys at $1.76/kg, DL-Met at $5.51/kg, L-Thr at $2.65/kg, L-Trp at $11.02/kg, and L-Val at $8.82/kg.
[3] Feed cost/lb gain = (feed cost/pig) / total gain.

[4] Total revenue/pig = total gain/pig × gain value ($1.46/kg at high prices; $0.99/kg at low prices)
[5] Income over feed cost = total revenue/pig – feed cost/pig.
[6] For low priced diets, corn was valued at $3.00/bu ($117.86/tonne), soybean meal at $330/tonne, L-Lys at $1.43/kg, DL-Met at $3.75/kg, L-Thr at $1.87/kg, L-Trp at $6.61/kg, and L-Val at $5.51/kg.

**Table 7.** Effects of increasing SID Lys on growth performance of pigs weighing 36 to 54 kg (Exp. 2)[1]

| | SID Lys, % | | | | | | | *P* = | |
|---|---|---|---|---|---|---|---|---|---|
| Item | 0.80 | 0.88 | 0.96 | 1.04 | 1.12 | 1.20 | SEM | Linear | Quadratic |
| BW, kg | | | | | | | | | |
| Initial | 36.3 | 36.4 | 36.3 | 36.4 | 36.4 | 36.2 | 0.91 | 0.826 | 0.634 |
| Final | 53.9 | 54.0 | 54.2 | 54.3 | 54.2 | 54.4 | 0.93 | 0.316 | 0.806 |
| ADG, kg | 0.99 | 0.99 | 1.01 | 1.02 | 1.01 | 1.03 | 0.019 | 0.036 | 0.952 |
| ADFI, kg | 2.03 | 1.96 | 1.98 | 2.01 | 1.95 | 1.98 | 0.032 | 0.308 | 0.399 |
| G:F | 0.490 | 0.507 | 0.512 | 0.508 | 0.521 | 0.522 | 0.0108 | < 0.001 | 0.374 |
| SID Lys g/d | 16.20 | 17.24 | 18.98 | 20.89 | 21.83 | 23.82 | 0.336 | < 0.001 | 0.505 |
| SID Lys g/kg gain | 16.24 | 17.17 | 18.58 | 20.75 | 21.69 | 22.94 | 0.624 | < 0.001 | 0.963 |
| Economics, $ | | | | | | | | | |
| High ingredient and pig prices[2] | | | | | | | | | |
| Feed cost/pig | 11.03 | 10.92 | 11.27 | 11.56 | 11.67 | 11.99 | 0.646 | < 0.001 | 0.357 |
| Feed cost/kg gain[3] | 0.639 | 0.629 | 0.641 | 0.655 | 0.654 | 0.666 | 0.0141 | 0.002 | 0.424 |
| Total revenue/pig[4] | 25.61 | 25.75 | 26.13 | 26.114 | 26.24 | 26.56 | 1.865 | 0.060 | 0.949 |
| IOFC[5] | 14.58 | 14.83 | 14.86 | 14.58 | 14.57 | 14.57 | 1.235 | 0.669 | 0.624 |
| Low ingredient and pig prices[6] | | | | | | | | | |
| Feed cost/pig | 6.73 | 6.75 | 7.01 | 7.32 | 7.42 | 7.71 | 0.406 | < 0.001 | 0.373 |
| Feed cost/kg gain | 0.390 | 0.389 | 0.398 | 0.415 | 0.416 | 0.429 | 0.0088 | < 0.001 | 0.464 |
| Total revenue/pig[4] | 17.37 | 17.46 | 17.72 | 17.73 | 17.79 | 18.01 | 1.264 | 0.060 | 0.949 |
| IOFC | 10.64 | 10.71 | 10.71 | 10.41 | 10.37 | 10.29 | 0.876 | 0.097 | 0.659 |

[1]A total of 608 pigs (600 × 241, DNA; initially 36.3 ± 0.91 kg BW) were used in 2 groups with 7 to 9 pigs per pen and 12 replications per treatment. A total of 285 pigs (initially 38.9 ± 0.81 kg BW) were fed trial diets for a 14-day period for group 1, and 323 pigs (initially 34.1 ± 0.95 kg BW) were fed trial diets for a 21-day period for group 2. Each pen contained both barrows and gilts and gender equalized by block.

[2] For high priced diets, corn was valued at $6.00/bu ($235.71/tonne), soybean meal at $440/tonne, L-Lys at $1.76/kg, DL-Met at $5.51/kg, L-Thr at $2.65/kg, L-Trp at $11.02/kg, and L-Val at $8.82/kg.

[3] Feed cost/lb gain = (feed cost/pig) / total gain.

[4] Total revenue/pig = total gain/pig × gain value ($1.46/kg at high prices; $0.99/kg at low prices)
[5] Income over feed cost = total revenue/pig – feed cost/pig.
[6] For low priced diets, corn was valued at $3.00/bu ($117.86/tonne), soybean meal at $330/tonne, L-Lys at $1.43/kg, DL-Met at $3.75/kg, L-Thr at $1.87/kg, L-Trp at $6.61/kg, and L-Val at $5.51/kg.

**Table 8.** Effects of increasing SID Lys lysine on growth performance of pigs weighing 53 to 75 kg (Exp. 3)[1]

| | SID Lys, % | | | | | | | *P* = | |
|---|---|---|---|---|---|---|---|---|---|
| Item | 0.65 | 0.72 | 0.79 | 0.86 | 0.92 | 1.00 | SEM | Linear | Quadratic |
| BW, kg | | | | | | | | | |
| d 0 | 53.1 | 53.2 | 53.2 | 53.2 | 53.1 | 53.2 | 0.86 | 0.926 | 0.857 |
| d 21 | 72.9 | 73.4 | 74.1 | 74.2 | 74.7 | 75.7 | 1.03 | < 0.001 | 0.804 |
| Overall (d 0 to 21) | | | | | | | | | |
| ADG, kg | 0.94 | 0.96 | 1.00 | 1.01 | 1.03 | 1.06 | 0.017 | < 0.001 | 0.910 |
| ADFI, kg | 2.42 | 2.33 | 2.33 | 2.32 | 2.32 | 2.38 | 0.048 | 0.295 | 0.004 |
| G:F | 0.389 | 0.413 | 0.429 | 0.434 | 0.444 | 0.447 | 0.0050 | < 0.001 | 0.001 |
| SID Lys g/d | 15.79 | 16.78 | 18.37 | 19.97 | 21.56 | 23.94 | 0.396 | < 0.001 | 0.003 |
| SID Lys g/kg gain | 16.76 | 17.47 | 18.43 | 19.83 | 20.96 | 22.58 | 0.220 | < 0.001 | 0.002 |
| Economics, $ | | | | | | | | | |
| High ingredient prices[2] | | | | | | | | | |
| Feed cost/pig | 15.04 | 15.23 | 15.07 | 15.53 | 15.57 | 16.45 | 0.344 | < 0.001 | 0.023 |
| Feed cost/kg gain[3] | 0.760 | 0.733 | 0.720 | 0.727 | 0.721 | 0.738 | 0.0084 | 0.012 | < 0.001 |
| Total revenue/pig[4] | 28.89 | 30.31 | 30.54 | 31.20 | 31.53 | 32.59 | 0.568 | < 0.001 | 0.745 |
| IOFC[5] | 13.85 | 15.07 | 15.47 | 15.68 | 15.96 | 16.14 | 0.327 | < 0.001 | 0.064 |
| Low ingredient prices[6] | | | | | | | | | |
| Feed cost/pig | 8.64 | 8.78 | 8.83 | 9.23 | 9.34 | 10.05 | 0.203 | < 0.001 | 0.006 |
| Feed cost/kg gain | 0.437 | 0.422 | 0.422 | 0.432 | 0.432 | 0.451 | 0.0050 | 0.002 | < 0.001 |
| Total revenue/pig | 19.59 | 20.55 | 20.71 | 21.16 | 21.38 | 22.10 | 0.385 | < 0.001 | 0.745 |
| IOFC | 10.95 | 11.77 | 11.88 | 11.93 | 12.04 | 12.05 | 0.237 | 0.002 | 0.062 |

[1]A total of 700 pigs (DNA 600 × 241; initial BW of 53.2 ± 0.86 kg) were used with 8 to 10 pigs per pen and 12 replications per treatment and were fed trial diets for a 21-d period in two groups. Each pen contained both barrows and gilts and gender equalized by block.

[2] For high priced diets, corn was valued at $6.00/bu ($235.71/tonne), soybean meal at $440/tonne, L-Lys at $1.76/kg, DL-Met at $5.51/kg, L-Thr at $2.65/kg, L-Trp at $11.02/kg, and L-Val at $8.82/kg.
[3] Feed cost/lb gain = (feed cost/pig) / total gain.
[4] Total revenue/pig = total gain/pig × gain value ($1.46/kg at high prices; $0.99/kg at low prices)
[5] Income over feed cost = total revenue/pig – feed cost/pig.
[6] For low priced diets, corn was valued at $3.00/bu ($117.86/tonne), soybean meal at $330/tonne, L-Lys at $1.43/kg, DL-Met at $3.75/kg, L-Thr at $1.87/kg, L-Trp at $6.61/kg, and L-Val at $5.51/kg.

**Table 9.** Effects of increasing SID Lys on growth performance of pigs weighing 76 to 100 kg (Exp. 4)[1]

| | SID Lys, % | | | | | | | | *P* = | |
|---|---|---|---|---|---|---|---|---|---|---|
| Item | 0.58 | 0.65 | 0.72 | 0.79 | 0.86 | 0.92 | 1.00 | SEM | Linear | Quadratic |
| BW, kg | | | | | | | | | | |
| d 0 | 76.5 | 76.5 | 76.2 | 76.5 | 76.4 | 76.2 | 76.2 | 1.24 | 0.499 | 0.936 |
| d 21 | 98.4 | 99.0 | 98.7 | 99.3 | 99.4 | 99.3 | 99.3 | 1.37 | 0.290 | 0.538 |
| Overall (d 0 to 21) | | | | | | | | | | |
| ADG, kg | 1.04 | 1.06 | 1.07 | 1.09 | 1.09 | 1.10 | 1.10 | 0.026 | 0.022 | 0.488 |
| ADFI, kg | 2.94 | 2.92 | 2.89 | 2.88 | 2.86 | 2.89 | 2.88 | 0.067 | 0.357 | 0.423 |
| G:F | 0.355 | 0.365 | 0.371 | 0.378 | 0.383 | 0.380 | 0.382 | 0.0084 | < 0.001 | 0.097 |
| SID Lys g/d | 16.92 | 18.96 | 20.79 | 22.78 | 24.50 | 26.91 | 28.65 | 0.527 | < 0.001 | 0.874 |
| SID Lys g/kg gain | 16.30 | 17.82 | 19.43 | 20.96 | 22.52 | 24.54 | 26.15 | 0.472 | < 0.001 | 0.398 |
| Economics, $ | | | | | | | | | | |
| High ingredient and pig prices[2] | | | | | | | | | | |
| Feed cost/pig | 17.91 | 18.29 | 18.53 | 18.69 | 18.94 | 19.42 | 19.91 | 0.470 | < 0.001 | 0.527 |
| Feed cost/kg gain[3] | 0.824 | 0.810 | 0.815 | 0.819 | 0.826 | 0.844 | 0.864 | 0.0178 | 0.008 | 0.038 |
| Total revenue/pig[4] | 31.79 | 32.98 | 33.29 | 33.28 | 33.51 | 33.65 | 33.84 | 0.836 | 0.051 | 0.405 |
| IOFC[5] | 13.64 | 14.69 | 14.69 | 14.66 | 14.58 | 14.23 | 14.21 | 0.676 | 0.822 | 0.151 |
| Low ingredient and pig prices[6] | | | | | | | | | | |
| Feed cost/pig | 10.03 | 10.51 | 10.68 | 10.95 | 11.26 | 11.66 | 12.15 | 0.274 | < 0.001 | 0.486 |
| Feed cost/kg gain | 0.461 | 0.465 | 0.470 | 0.480 | 0.491 | 0.506 | 0.527 | 0.0105 | < 0.001 | 0.041 |
| Total revenue/pig | 21.55 | 22.36 | 22.57 | 22.57 | 22.73 | 22.82 | 22.95 | 0.567 | 0.051 | 0.405 |
| IOFC | 11.34 | 11.85 | 11.84 | 11.66 | 11.47 | 11.16 | 11.03 | 0.464 | 0.209 | 0.172 |

[1]A total of 616 pigs (600 × 241, DNA; initially 76.4 ± 1.24 kg BW) were used in 2 groups with 8 to 10 pigs per pen and 6 replications for the 0.58% SID Lys treatment; 11 replications for the 0.65, 0.72, 0.79, 0.86, and 0.92% SID Lys treatments; and 5 replications for the 1.00% SID Lys treatment. Each pen contained both barrows and gilts and gender equalized by block.

[2] For high priced diets, corn was valued at $6.00/bu ($235.71/tonne), soybean meal at $440/tonne, L-Lys at $1.76/kg, DL-Met at $5.51/kg,

L-Thr at $2.65/kg, L-Trp at $11.02/kg, and L-Val at $8.82/kg.

[3] Feed cost/lb gain = (feed cost/pig) / total gain.

[4] Total revenue/pig = total gain/pig × gain value ($1.46/kg at high prices; $0.99/kg at low prices)

[5] Income over feed cost = total revenue/pig – feed cost/pig.

[6] For low priced diets, corn was valued at $3.00/bu ($117.86/tonne), soybean meal at $330/tonne, L-Lys at $1.43/kg, DL-Met at $3.75/kg, L-Thr at $1.87/kg, L-Trp at $6.61/kg, and L-Val at $5.51/kg.

**Table 10.** Effects of increasing SID Lys on growth performance of pigs weighing 103 to 128 kg (Exp. 5)[1]

| | SID Lys, % | | | | | | | *P* = | |
|---|---|---|---|---|---|---|---|---|---|
| Item | 0.43 | 0.50 | 0.57 | 0.64 | 0.71 | 0.78 | SEM | Linear | Quadratic |
| BW, kg | | | | | | | | | |
| Initial | 103.8 | 103.8 | 103.9 | 103.6 | 103.8 | 103.8 | 1.32 | 0.980 | 0.966 |
| Final | 125.9 | 127.3 | 127.0 | 127.6 | 128.4 | 127.3 | 1.14 | 0.025 | 0.102 |
| ADG, kg | 0.90 | 0.95 | 0.94 | 0.98 | 1.00 | 0.95 | 0.0256 | 0.043 | 0.108 |
| ADFI, kg | 3.01 | 3.01 | 2.90 | 2.96 | 2.98 | 2.89 | 0.049 | 0.102 | 0.956 |
| G:F | 0.300 | 0.315 | 0.325 | 0.329 | 0.334 | 0.331 | 0.064 | < 0.001 | 0.032 |
| SID Lys, g/d | 12.90 | 15.03 | 16.52 | 18.93 | 21.12 | 22.60 | 0.279 | < 0.001 | 0.408 |
| SID Lys, g/kg gain | 14.43 | 15.87 | 17.54 | 19.48 | 21.30 | 23.75 | 0.376 | < 0.001 | 0.178 |
| Economics, $ | | | | | | | | | |
| High ingredient and pig prices[2] | | | | | | | | | |
| Feed cost/pig | 20.37 | 20.86 | 20.37 | 21.46 | 21.89 | 21.90 | 0.920 | 0.115 | 0.915 |
| Feed cost/kg gain[3] | 0.927 | 0.898 | 0.884 | 0.894 | 0.895 | 0.922 | 0.0082 | 0.929 | 0.032 |
| Total revenue/pig[4] | 32.01 | 33.84 | 33.56 | 34.96 | 35.62 | 34.54 | 1.07 | 0.028 | 0.229 |
| IOFC[5] | 11.63 | 12.98 | 13.18 | 13.52 | 13.73 | 12.65 | 0.450 | 0.020 | 0.001 |
| Low ingredient and pig prices[6] | | | | | | | | | |
| Feed cost/pig | 11.73 | 12.06 | 12.07 | 12.75 | 13.13 | 13.17 | 0.544 | 0.014 | 0.957 |
| Feed cost/kg gain | 0.534 | 0.519 | 0.524 | 0.531 | 0.537 | 0.555 | 0.0107 | 0.044 | 0.077 |
| Total revenue/pig | 21.70 | 22.95 | 22.75 | 23.71 | 24.15 | 23.42 | 0.724 | 0.028 | 0.229 |
| IOFC | 9.97 | 10.89 | 10.69 | 10.98 | 11.02 | 10.25 | 0.324 | 0.397 | 0.004 |

[1]A total of 679 pigs (600 × 241, DNA; initial BW of 228.8 ± 2.9 lb) were used with 8 to 10 pigs per pen and 12 replications per treatment for the 0.43, 0.50, 0.57, 0.71 and 0.78% SID Lys treatments, 11 replications for the 0.64% SID Lys treatment, and were fed trial diets for a 21- or 28-d period in two groups. Each pen contained both barrows and gilts and gender equalized by block.

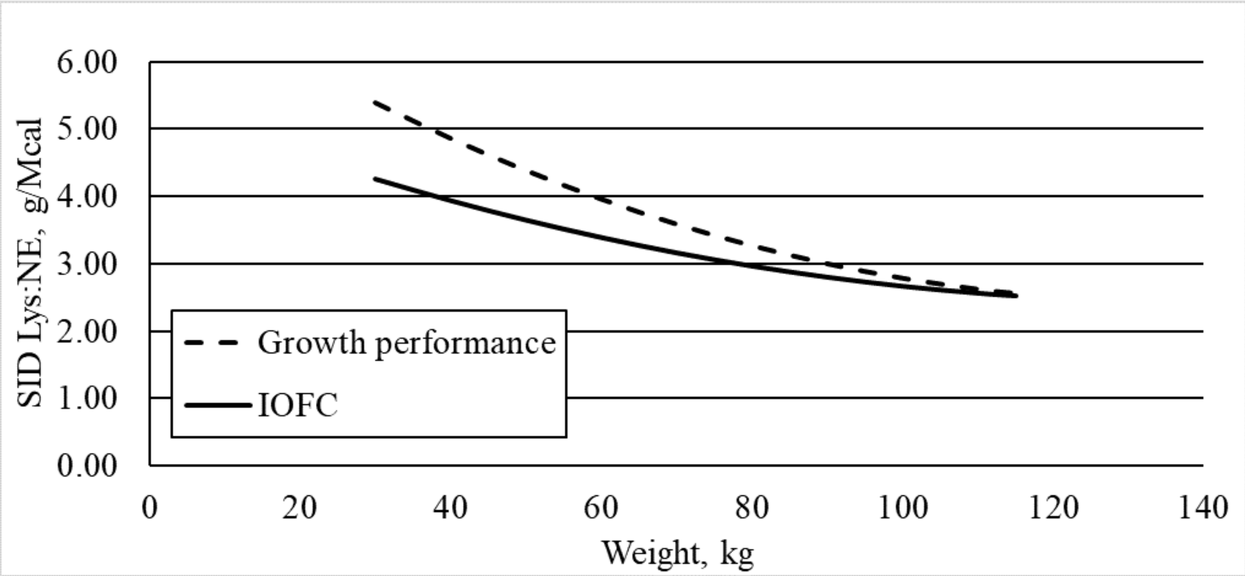
[2] For high priced diets, corn was valued at $6.00/bu ($235.71/tonne), soybean meal at $440/tonne, L-Lys at $1.76/kg, DL-Met at $5.51/kg, L-Thr at $2.65/kg, L-Trp at $11.02/kg, and L-Val at $8.82/kg.
[3] Feed cost/lb gain = (feed cost/pig) / total gain.
[4] Total revenue/pig = total gain/pig × gain value ($1.46/kg at high prices; $0.99/kg at low prices)
[5] Income over feed cost = total revenue/pig – feed cost/pig.
[6] For low priced diets, corn was valued at $3.00/bu ($117.86/tonne), soybean meal at $330/tonne, L-Lys at $1.43/kg, DL-Met at $3.75/kg, L-Thr at $1.87/kg, L-Trp at $6.61/kg, and L-Val at $5.51/kg.

**Table 11.** Summary of the Lys:calorie ratio and associated SID Lys percentage and Lys intake that provided maximal response for growth performance and income over feed cost (IOFC)[1]

| Trial | BW range, kg | Midpoint BW, kg | Lys:calorie ratio, g of SID Lys/Mcal of NE | SID Lys, % | SID Lys intake, g/d | SID Lys g/kg of gain |
|---|---|---|---|---|---|---|
| Growth performance | | | | | | |
| Trial 1 | 18 to 40 | 29 | 5.53 | 1.41 | 20.37 | 22.63 |
| Trial 2 | 36 to 54 | 46 | 4.45 | 1.20 | 23.80 | 22.90 |
| Trial 3 | 53 to 75 | 64 | 3.70 | 0.99 | 23.56 | 22.55 |
| Trial 4 | 76 to 100 | 88 | 3.26 | 0.88 | 25.30 | 23.11 |
| Trial 5 | 103 to 128 | 116 | 2.48 | 0.64 | 18.93 | 19.48 |
| IOFC[2] | | | | | | |
| Trial 1 | 18 to 40 | 29 | 4.39 | 1.12 | 16.46 | 18.46 |
| Trial 2 | 36 to 54 | 46 | 3.56 | 0.96 | 19.00 | 18.60 |
| Trial 3 | 53 to 75 | 64 | 3.37 | 0.91 | 21.11 | 20.20 |
| Trial 4 | 76 to 100 | 88 | 2.89 | 0.78 | 22.50 | 20.84 |
| Trial 5 | 103 to 128 | 116 | 2.48 | 0.64 | 18.93 | 19.48 |

[1]Five trials were conducted to determine maximum SID Lys, % in grow-finish pigs (600 × 241, DNA).
[2]Income over feed cost = total revenue/pig – feed cost/pig.

**Figure 1**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SID Lys:NE, g/Mcal
0
20
40
60
80
100
120
140
Weight, kg
Growth performance
IOFC