SWINE UPDATE

Kansas State University Agricultural Experiment Station
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Methods to Calculate Lysine Requirements Based on Genotype and Environment

Many dietary and non-dietary factors impact optimum growth performance and economics of feeding growing and finishing pigs. The use of high lean genotypes and high health technologies, such as segregated production, have lead to wider variations in growth performance than ever before. However, protein and energy have remained the nutrients with the largest impact on feed cost in the finishing barn. Therefore, a wide variety of diet formulations are needed across swine operations to capture the most economical feed cost per pound of gain. Research efforts at Kansas State University have concentrated on developing cost effective and readily applied tools to improve grow–finish feed cost and growth performance. This method integrates the biologic principles of growth and its impact on nutrient requirements with practical methods to formulate and deliver the most economical diets to groups of pigs.

As with most decision-making tools, including more information in the decision-making process will improve the confidence in the resulting nutrient recommendations. However, the cost of obtaining the detailed information needs to be balanced with the expected cost savings from implementing the extra information. Therefore, these tools were developed for use in a generalized manner when a minimal amount of production information is available or can be easily customized to a particular situation when more detailed production information is available.

How do you determine the optimum grow–finish diet formulation?

There are two different approaches to establishing optimum nutrient fortifications in grow–finish diets. The traditional approach has been that nutrient intake will dictate growth rate and carcass leanness. For example, a pig will grow only as fast or become as lean as the diet it is offered will allow (providing genetic capacity for lean growth is not limiting). The major difficulty of this approach in commercial production systems is accurately predicting feed intake. There are too many factors affecting feed intake, with varying degrees of influence, to practically apply the results on a widespread commercial basis. A second approach is that a combination of growth rate, efficiency, and tissue accretion will dictate nutrient intake. An example of this approach would be to determine daily protein accretion of a group of pigs, then calculate the requirements of amino acids and energy necessary to deposit that amount of protein. We have chosen this second approach because of the consistency and ease of data collection.

What is a systematic way to approach designing a nutritional program for grow–finish pigs?

The systematic approach that we use includes several steps. First, we establish protein and fat deposition curves. These curves are used to determine a lysine to calorie ratio to drive the observed growth. Then, we decide whether fat or other ingredients are economical to include in the grain-soybean meal based diets. These decisions will impact the energy density of the diet. Using the lysine to calorie ratio and energy density of the diet, a dietary percentage is determined. The requirements for other amino acids are determined based on a ratio of the lysine level. Then, levels are set for other nutrients and a feed budget is projected based on expected f/g for the group to facilitate delivery of the correct phases.

Why is the lysine requirement expressed as a lysine to calorie ratio instead of a dietary percentage?

The lysine requirement is expressed as a ratio instead of dietary percentage because as the energy density of the diet increases either feed intake decreases and (or) growth rate increases. Therefore, when feed intake decreases with more energy dense diets, the grams of lysine remains similar resulting in the need for a higher dietary lysine percentage. Thus, the lysine to calorie ratio is used to ensure the right amount of lysine is provided in diets that vary in energy density.

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How do you determine lysine requirements for various operations and genotypes?

Lysine requirements can be determined in one of two manners. If the producer collects the necessary weight and ultrasound information, lysine requirement curves can be developed specifically for the individual operation and genotype. If the detailed information is not available, fat free lean index (FFLI) can be used to develop more generalized recommendations.

How is ultrasound information used to determine lysine requirements?

In order to develop farm-specific lysine recommendations, growth curve data can be translated into nutrient requirements based on the concepts of Dr. Allan Schinckel at Purdue University. Briefly, the procedure involves weighing and obtaining ultrasound measurements for backfat and loin area at approximately 5 to 6 points during the growth period between 50 and 280 pounds. The ultrasound and weight measurements are used to determine the amount of body protein and lipid at each weight. Daily protein and lipid accretion curves are then calculated. The daily lysine requirement in grams per day can then be calculated from daily body protein accretion (P) using constants for the lysine content of protein (L), the efficiency of lysine utilization (E), the maintenance requirement (M), and digestibility (D).

Total lysine requirement,

$$\text{g/day} = \frac{M + \frac{P \times L}{E}}{D}$$

Table 1. Constants to Convert Daily Protein Accretion into Daily Lysine Requirement.

Parameter	Constant or Equation
Lysine content of body protein, L	6.6%
Post-absorptive efficiency of lysine utilization, E	65%
Digestibility of lysine in the diet, D	80%
Lysine needed for maintenance, M	$.036 \times$ Weight, $kg^{.75}$

Daily energy intake driving the observed growth is then calculated from the daily protein and lipid accretion with an allowance for the maintenance energy requirement. The grams of lysine intake can then be divided by the daily energy intake to derive a lysine to calorie ratio that can be converted to a dietary percentage based on the dietary energy concentration. The dietary percentage can be converted into a curve based on body weight. The curve can be used to determine a dietary lysine percentage for each phase.

How is fat free lean index used to make lysine recommendations?

Equations have been developed by K-State Research and Extension that use body weight and fat free lean index (FFLI) to predict a lysine to calorie ratio. This approach requires assumptions on the shape of the curves for growth and protein deposition and that the rate of lipid deposition is dependent on the FFLI at market weight. The lysine to calorie ratio along with the energy density of the diet can then be used to determine a dietary lysine recommendation.

Separate equations were developed for barrows and gilts (Table 2). These equations were used to develop Figures 1 to 4 and the lysine recommendations in Table 3 and 4.

The use of the equation is demonstrated below. A group of gilts that weighs 150 pounds and has a FFLI of 50.0 percent at 265 pounds results in a dietary lysine to calorie ratio of
2.43 grams of Lysine per Mcal of ME.

$$2.43 \text{ g/Mcal} = .019 * 150 - .3369 * 50 + .000021 * 150^2 + .00578 * 50^2 - .000739 * 150 * 50 + 7.046$$

The dietary lysine percentage can then be determined by multiplying the lysine:calorie ratio times the energy level in the diet with the appropriate conversion factors from the metric to english system:

(Lys:Cal * Mcal/lb of feed * 2.205) /10 = Dietary lysine percentage

The group of 150-pound gilts with an expected FFLI of 50 percent has a predicted dietary lysine requirement of:
(2.43 * 1.515 * 2.205) / 10 = .81%

Figures 1 and 2 depict the change in lysine:calorie ratio as the pig grows. Similarly, Figures 3 and 4 depict the dietary lysine needs for pigs fed diets containing 1,505 kcal/lb. This is the energy level of a corn-soybean meal based diet without any dietary fat added. Also, note that the variations in lysine levels among pigs with different FFLI are much greater at lighter weights than at heavier weights. The implication is that phase feeding programs are even more important to economically feed pigs with a high lean growth potential.

Table 2. Equations to Determine Lysine to Calorie Ratios from FFLI and Weight.

Barrows =	$0.0116 * WT - 0.3799 * FFLI + 0.000026 * WT^2 + 0.006052 * FFLI^2 - 0.000628 * WT * FFLI + 8.68$
Gilts =	$0.019 * WT - 0.3369 * FFLI + 0.000021 * WT^2 + 0.00578 * FFLI^2 - 0.000739 * WT * FFLI + 7.046$
Where:	Lys:Cal = Grams of total dietary lysine per Mcal of ME WT = Body weight in pounds FFLI = Pounds of fat free lean per 100 lbs of carcass

How are these recommendations used to make practical diets?

The equations listed in Table 2 or Figures 1 to 4 can be used to determine the appropriate lysine level for any weight range in the grow–finish period. An example of using these data to provide dietary recommendations is shown in Tables 3 and 4. The lysine:calorie ratios listed in Table 3 were used to develop the suggested lysine percentages listed in Table 4. The dietary energy level for the recommendations in Table 4 was assumed to be 1,505 kcal/lb, the level of energy in corn-soybean meal based diets without added fat. As the energy level of the diets increase or decrease, the dietary lysine percentage must be changed to maintain a constant lysine:calorie ratio.

In conclusion, by either determining actual lean growth curves for your farm or simply using FFLI, estimates of protein and lipid deposition can be determined. These estimates can provide useful insight to the nutrient intakes necessary to optimize growth performance. However, pig performance should be monitored to ensure growth performance and carcass leanness targets are being met.

Figure 1. Recommended Lysine:Calorie Ratio for Gilts Based on Fat Free Lean Index.

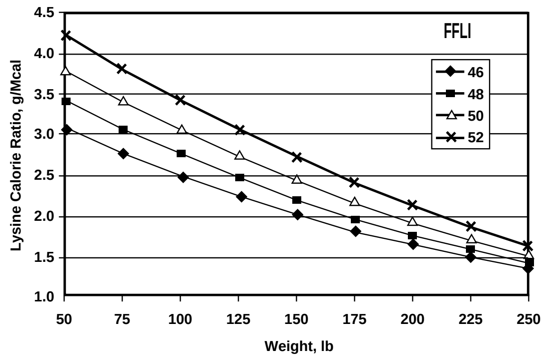

Figure 3. Recommended Total Dietary Lysine Percentages for Gilts Based on Fat Free Lean Index for Diets Containing 1505 kcal/lb.

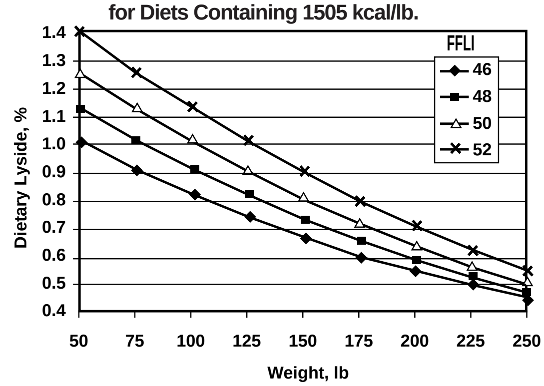

Figure 2. Recommended Lysine:Calorie Ratio for Barrows Based on Fat Free Lean Index.

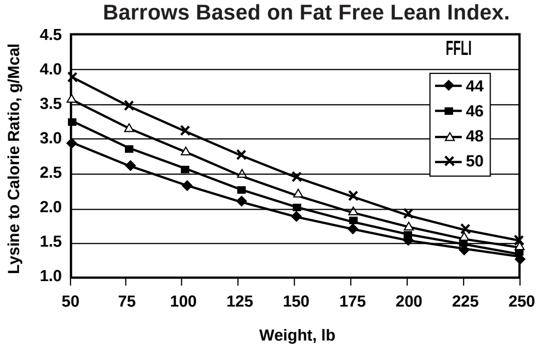

Figure 4. Recommended Total Dietary Lysine Percentages for Barrows Based on Fat Free Lean Index for Diets Containing 1505 kcal/lb.

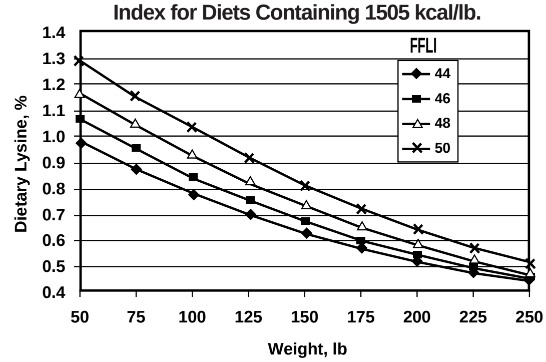

Table 3. Recommended Lysine to Calorie Ratios (g/Mcal ME) based on Fat Free Lean Index.

	Sex:	Barrow				Gilt			
Weight Range, lb	FFLI:	44	46	48	50	46	48	50	52
50 to 80		2.75	3.00	3.29	3.64	2.89	3.21	3.57	3.98
80 to 120		2.34	2.54	2.79	3.09	2.49	2.75	3.06	3.42
120 to 160		1.94	2.10	2.30	2.55	2.09	2.30	2.55	2.85
160 to 200		1.64	1.74	1.89	2.09	1.76	1.91	2.10	2.34
200 to 250		1.39	1.44	1.53	1.67	1.47	1.55	1.68	1.85

Table 4. Recommended Total Dietary Lysine Percentages based on Fat Free Lean Index for Diets Containing 1505 kcal/lb.

	Sex:	Barrow				Gilt			
Weight Range, lb	FFLI:	44	46	48	50	46	48	50	52
50 to 80		.91	.99	1.09	1.21	.96	1.06	1.18	1.32
80 to 120		.78	.84	.93	1.03	.83	.91	1.02	1.13
120 to 160		.65	.70	.76	.85	.69	.76	.85	.94
160 to 200		.54	.58	.63	.69	.59	.63	.70	.78
200 to 250		.46	.48	.51	.56	.49	.52	.56	.61

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SWINE UPDATE

UPCOMING EVENTS

KPPC Environmental Field Day
Prairie View Farms
Melvin and Gary Stanford
Admire Junction
August 19
9:30 a.m. to 3:30 p.m.

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KSU Swine Industry Day
Manhattan, KS
November 19

Jim L. Nelssen
Extension Specialist
Swine

Robert D. Goodband
Extension Specialist
Swine

Mike D. Tokach
Extension Specialist
Livestock Production
& Management, NE

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