Kansas State University

Growing–Finishing Pig Recommendations

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Introduction

Feed is the largest cost center in pork production. Over 70 percent of the feed cost is accrued during the grow-finish phase. Additionally, feeding diets above or below the amino acid requirements will have a greater impact on performance and profitability than in any other phase of production. Thus, correct diet formulation in the finisher phase is critical.

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

The first component of the nutritional program is diet formulation. The diet formulation keys in the finisher are to:

1. determine the most economical energy level;
2. determine the lysine:calorie ratio to use for the genetics and production situation;
3. determine the ratio for the other amino acids; Formulation has progressed from using total amino acids to formulating using true ileal digestible (TID) amino acid values.
4. determine the available phosphorus level; again available P concentrations should be set relative to the energy density of the diet using a available P to energy ratio.
5. set levels of vitamins, trace minerals, calcium, salt, and other ingredients.

Next, a feed budget is determined according to the feed efficiency projected for the group to facilitate delivery of the correct phases. Finally, performance of the grow–finish group is monitored to make sure that projected growth performance targets are being achieved.

Determining the optimal energy level will depend on many criteria including the relative cost of grains, fat sources, and byproducts. Another criterion that must be considered is the relative importance and value of ADG and impact of energy level on growth rate in the production situation. If growth rate is improved by increasing the dietary energy level, margin over feed cost should dictate the correct energy level in the diet instead of feed cost per unit of gain. In many situations, increasing dietary energy will increase ADG, but it will also increase feed cost per unit of gain. If ample facility space is available, such that pigs will reach the optimal market weight before they must exit the building, optimal feed cost per unit of gain should dictate the energy level. However, if facility space is not available to allow pigs to reach the optimal market weight, margin over feed should dictate the optimal energy level. In most production systems, adequate facility space is not available during the hot summer months. Thus, dietary energy levels higher than those required to minimize feed cost are often economical.

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, a higher dietary lysine percentage is required to maintain a similar lysine intake (grams/day). If energy density results in increased growth rate while feed intake remains constant, more lysine is required for the increased growth. Both scenarios require higher dietary lysine percentages but the amount of lysine needed per calorie of energy remains relatively constant. Thus, the lysine to calorie ratio is used to ensure the right amount of lysine is provided in diets that vary in energy density.

Amino Acid Levels

What are TID amino acids?

The term "TID" refers to the true ileal digestiblility of the feed ingredient. True ileal digestibility values are calculated from measuring the digestibility of feed samples collected at the end of the ileum. By collecting samples here, microbial use or contributions of amino acids are avoided. The digestibility is then corrected for endogenous amino loss, usually as amino acids in sloughed intestinal cells digestive enzymes. True ileal digestibility values are a more precise method of determining the actual uptake of the various amino acids and because of greater precision using true ileal digestibility values, diets used in the guide are based on true ileal digestible (TID) values.

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

Lysine requirements can be determined using several methods. First, the lysine requirement can be adapted from research data of others. Universities, such as Kansas State University, feed companies, or genetic companies can be good sources of standard lysine recommendations for a particular genetic line. Because the pigs used in the research to develop these recommendations may not have the same level of growth performance, feed intake and protein deposition rates due to differences in health status, exact genetic background, housing, etc, caution must be used in applying the recommendations to a different production system. In many cases, however, these recommendations are the best data available for the situation. For example, the amino acid recommendations in Table 1 were developed using PIC genetics in commercial grow-finish research facilities.

A second method to develop the lysine recommendations is by collecting the necessary weight and ultrasound information in the production system. Using this method, lysine requirement curves can be determined for the particular genetics and production system. However, outside expertise and precision is required for this method. Additionally, unless the measurements start very early and are collected well past the normal market weights, the lysine requirements at the beginning and end of the growing period can be over or under estimated.

A third method is to assume that pigs require 20 g of TID lysine per kg of ADG (9 g/lb of gain). By establishing a growth and feed intake curve, the recommended lysine percentage can be calculated for any phase. The biggest problem with this method is that several assumptions must be made that don't always hold true. However, this simple rule of thumb can be used to help set initial amino acid levels to test in titration experiments.

The fourth method is to conduct experiments in research barns within the production system. This is the most accurate method, but also is the most expensive. The production system has to have access to research barns that are similar to their normal production barns for this option. If research barns are available, conducting lysine titration trials for each 50 lb weight range allows calculation of a lysine requirement curve.

How is ultrasound information used to determine lysine requirements?

In order to develop farm-specific lysine recommendations with ultrasound information, 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 TID lysine requirement in grams per day can then be calculated from daily body protein accretion (P) using constant from NRC (1998), which indicates that 0.12 g of TID lysine are required for each gram of protein accretion. The constant 0.12 contains two factors including the lysine content of protein (6.5 to 7.5%) and the efficiency of lysine utilization (54 to 65%). The maintenance requirement ($0.036 \times \text{Weight, kg.}^{75}$) also must be considered. Thus, the TID lysine requirement (g/d) is calculated as: ($0.036 \times \text{Weight, kg.}^{75}$) + 0.12 x protein accretion, g/d.

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.

What happens if pigs are fed above or below their lysine requirement?

If pigs are fed diets above their lysine requirement, feed cost will be increased. In the finisher phase, pigs tend to become slightly leaner as lysine levels exceed the requirement. Thus, lean premiums may increase and offset a portion, but not all, of the increased feed cost. In the grower periods, feed cost is increased without any beneficial return.

If pigs are fed diets below their lysine requirement, growth rate will decline and feed efficiency will become poorer. The reduction in growth performance is greater in the finisher phase than in the grower phase. Thus, feeding diets below the lysine requirement is more detrimental in the finisher period than in the grower period.

How do you determine the requirements for the other amino acids?

After the dietary lysine percentage is determined, levels for other essential amino acids are determined by using a ratio for each amino acid relative to lysine. This ratio of amino acids is often called an "ideal amino acid pattern." Considerable debate exists on the appropriate ideal amino acid pattern to use for grow–finish pigs. The pattern also can be expressed on a total amino acid basis, apparent digestible basis, or true digestible basis. The patterns listed in Table 1 were adapted from work at several universities.

Can I use more than 3 pounds of synthetic lysine per ton of feed?

In practical terms, the use of an ideal amino acid pattern determines the amount of synthetic lysine that can be used in a grain-soybean meal based diet. Under most practical conditions when a maximum of 3 pounds of synthetic lysine is used, lysine will be the limiting amino acid. When using alternative feed ingredients or very high or low protein diets, the individual situation must be analyzed. In many of these cases, less synthetic lysine should be used in the diets unless other synthetic amino acids also are added.

In certain situations, it may be desirable to use high levels of synthetic amino acids in the diet to decrease nitrogen excretion. Using 3 pounds of L-lysine HCl per ton to replace soybean meal in the diet will decrease nitrogen excretion by 20 percent. Higher levels of synthetic lysine in combination with other synthetic amino acids (usually DL-methionine and L-threonine) can be safely used in the diets and nitrogen excretion can be decreased by over 40 percent. However, producers should not expect an improvement in pig performance. A review of the numerous trials conducted in this area reveal the following facts. First, reducing the crude protein content of the diet by adding synthetic amino acids will not result in superior performance to an intact protein source, such as soybean meal. Second, although the evidence is not conclusive, using high levels of synthetic amino acids in some cases results in increased back fat compared to feeding intact protein sources. Following the amino acid ratios in Table 1 increases the success rate with the use of synthetic amino acids.

How much L-lysine HCl can be added to a corn-soybean meal diet with a synthetic threonine and methionine source before growth performance is reduced?

With our current knowledge, the maximum amount of L-lysine HCl that should be used in conjunction with L-threonine and a methionine source is 7 lb/ton in the early grower phase and 4.5 lb/ton in the late finisher phase in corn-soybean meal diets.

Dietary Fat Additions

How do I determine whether to use other ingredients in my milo- or corn-soybean meal based diets?

Several other ingredients may be used in traditional grain-soybean meal based diets to decrease cost. Each of these ingredients must be evaluated individually following the guidelines in the fact sheet, *General Nutrition Principles for Swine,* MF2298. Besides determining the economics of the ingredients based on their impact on diet cost, careful consideration must be made as to whether the ingredient influences growth rate. If growth rate is decreased, the impact on margin over feed must be considered in the economic analysis.

How do I determine whether to add fat to my milo- or corn-soybean meal based diets?

Assuming the fat is of acceptable quality, the economics of using added fat can be evaluated by calculating the diet cost with and without added fat. The percentage improvement needed to pay for the increased diet cost when adding fat is calculated by the following equation:

$$\frac{\text{Added fat diet cost} - \text{Without added fat diet cost}}{\text{Added fat diet cost}}$$

The expected improvement in the ratio of feed to grain (F/G) is 2 percent for every 1 percent added dietary fat. Therefore, if the percent improvement needed to justify the added fat diet cost is greater than the expected improvement in F/G, feeding the added dietary fat is economically justified on a feed efficiency basis. As an example, if the cost of a diet without added fat is $136/ton and the cost per ton with 5 percent added fat is $148, the F/G improvement needed to justify the higher priced added fat diets is (148–136)/148=8.1 percent. The added fat diet is economical to feed based on 8.1 percent being less than the expected improvement in F/G (10% for a diet with 5% added fat).

What about the influence of dietary fat additions on ADG or backfat?

This equation for determining the economics of dietary fat additions is based on feed efficiency and does not take into account the impact of added dietary fat on ADG or the influence on backfat and carcass lean content. Most research suggests that the impact on ADG is greater during the grower and early finisher phase with little impact on ADG of pigs greater than 200 pounds. Some recent research has indicated that pigs have a greater response to fat in the late finisher period if they were being fed a diet without added fat prior to that time. Thus, the growth response to fat may vary based on previous diet as well as genetics and production system.

In addition to variable response in ADG, the value of the additional ADG is not the same in all situations. For example, the economic value of ADG is higher when finishing space is limited than when there is a shortage of pigs. In the first scenario, an extra pound from increased ADG is worth the margin over feed cost (market price minus feed cost). In the second scenario, extra pounds are only worth the savings in fixed costs.

Previous research has indicated that feeding added dietary fat increases carcass backfat and reduces carcass leanness. Other recent research indicates the impact on backfat and carcass lean is negligible with high-lean pigs in the summer time. Other considerations not accounted for in the equation are additional costs for the equipment and utility expenses to handle added dietary fat. An economic value also has not been determined for the impact of added dietary fat on dust control.

Adding fat to the diet also will increase the softness of the fat. Fat softness is often determined by measuring the iodine value. If the fat is too soft, the meat products are less acceptable for the high value export market. Soft fat in the belly also causes slicing problems. Vegetable oils have more negative impact on fat softness than more saturated fat sources, such as choice white grease and tallow. Thus, iodine value of the diet and projected iodine value of the carcass also must be considered when making the decision on added fat level in the diet.

What are some general guidelines for added dietary fat usage?

1. Fat will be more economical in the grower diets than in finisher diets because grower diets are more expensive and increasing the energy density of the diet improves ADG more in grower pigs than finisher pigs.

2.When purchased competitively, fat from animal sources (choice white grease or high quality tallow) will almost always be economical in early grower diets.

3. Due to their high cost, fat from vegetable sources (soybean oil or corn oil) are rarely economical to add to the diet.

4.Some producers add fat to the diet for dust control even when not economical for growth performance.

5.Iodine value of the carcass (fat softness) will increase as dietary fat addition increases with more unsaturated fats (oils) having more impact than saturated fat sources, such as choice white grease or tallow.

Is there a software tool available to determine the whether fat is economical?

The link to a fat economic calculator can be found at: *www.ksuswine.org*. By entering the corn, soybean meal, fat and market hog prices an expected economic response to adding fat can be determined for each dietary phase.

Calcium and Phosphorus

What are the recommendations for calcium, phosphorus, trace minerals and vitamins?

Calcium and phosphorus recommendations are listed in Table 1. Although some research data suggests lower available phosphorus levels can be fed without influencing growth performance, field experience leads to these recommendations. Feeding diets with lower levels of phosphorus has resulted in increased trim loss in the processing plant due to vertebrae breaking during the stunning process. Vitamin and trace mineral specifications are listed in Table 2. These recommendations are met by using the KSU vitamin and trace mineral premix or base mix recommendations. These recommendations can be found at: *www.ksuswine.org*.

Example Diets

How are the nutrient requirements put together into a set of diets?

Example diets for grower and finisher pigs are listed in Table 3. Note that as fat is added to the diet, the TID lysine level is increased in order to maintain a constant lysine to calorie ratio. These diets are formulated for terminal market pigs. If gilts are destined for the breeding herd, higher levels of calcium and phosphorus should be fed.

What about adding other ingredients to the diets?

With the help of someone skilled in diet formulation and nutrition, several ingredients can be added to grow-finish diets without reducing grow-finish pig performance. Guidelines for inclusion rates for many ingredients are provided in the fact sheet, *General Nutrition Principles for Swine,* MF2298. Diet examples with ingredients, such as dried distiller grain with solubles, can be found at: *www.ksuswine.org*.

How should diets be adjusted when Paylean® is used?

Examples of diets using Paylean® are shown in Table 4. The diet containing Paylean® should contain approximately 0.3% TID lysine above that required by a pig of the same weight without Paylean®. In corn-soybean meal based diets, the lysine level can be increased by increasing the soybean meal level or with increased amino acids (lysine, threonine, and methionine) and soybean meal. Vitamins and minerals do not have to be increased and amino acid ratios for the 110 lb pig can be used.

Table 1. Nutrient targets for finishing pigs.

	Weight, lb											
Item	50	70	90	110	130	150	170	190	210	230	250	270
Required TID Lys: Cal Ratio	3.30	3.07	2.86	2.67	2.50	2.34	2.20	2.08	1.98	1.89	1.82	1.77
TID Lysine Required, % (corn-soy, no fat diet)	1.10	1.03	0.96	0.89	0.84	0.78	0.74	0.70	0.66	0.63	0.61	0.59
Total lysine required, % (corn-soy, no fat diet)	1.25	1.17	1.09	1.02	0.95	0.90	0.84	0.80	0.76	0.72	0.70	0.68
Minimum amino acid ratios												
TID Isoleucine:lysine ratio, %	55	55	55	55	55	55	55	55	55	55	55	55
TID Methionine:lysine ratio, %	28	28	28	28	28	28	29	29	29	29	30	30
TID Met & Cys:lysine ratio, %	57	56	56	55	55	56	56	56	57	58	59	60
TID Threonine:lysine ratio, %	61	61	60	60	60	60	61	61	62	63	64	66
TID Tryptophan:lysine ratio, %	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
TID Valine:lysine ratio, %	65	65	65	65	65	65	65	65	65	65	65	65
Minimum avail P levels												
Avail P:ME ratio, g/mcal (terminal)	0.90	0.85	0.80	0.76	0.72	0.69	0.66	0.64	0.63	0.62	0.61	0.61
Avail P:ME ratio, g/mcal (Replacements)	1.16	1.15	1.10	1.06	1.02	0.99	0.97	0.94	0.93	0.92	0.91	0.91
Available P, % (Terminal, corn-soy diet)	0.30	0.28	0.27	0.25	0.24	0.23	0.22	0.21	0.21	0.21	0.20	0.20
Available P, % (Replacements, corn-soy diet)	0.38	0.38	0.37	0.35	0.34	0.33	0.32	0.32	0.31	0.31	0.31	0.31
Ca:P ratio, minimum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ca:P ratio, maximum	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Lysine: CP ratio, maximum	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Equations for minimum ratios of amino acids												
TID lysine:ME, g/Mcal	(0.000025*(wt)^2 - 0.016*(wt)+ 4.53)*0.87											
TID Isoleucine:lysine ratio, %	55											
TID Methionine:lysine ratio, %	0.000000416*(wt)^2 - 0.000036654*(wt) + 0.280606061											
TID Met & Cys:lysine ratio, %	0.000002335*(wt)^2 - 0.000572488*(wt) + 0.588523784											
TID Threonine:lysine ratio, %	0.00000268*(wt)^2 - 0.00064541*(wt) + 0.63872902											
TID Tryptophan:lysine ratio, %	16.5											
TID Valine:lysine ratio, %	65											
Avail P:ME ratio g/mcal (terminal)	0.00000649518*(wt)^2 - 0.00338103746*(wt) + 1.049852											
Avail P:ME ratio g/mcal (Replacements)	0.00000649518*(wt)^2 - 0.00338103746*(wt) + 1.3529											
Available P, % (Terminal, corn-soy diet)	Avail P:ME ratio * ME (Mcal/kg)/10											
Available P, % (Replacements, corn-soy diet)	Avail P:ME ratio * ME (Mcal/kg)/10											
Ca:P ratio, minimum	1.00											
Ca:P ratio, maximum	1.25											
Lysine:CP ratio, maximum	7.00											

Paylean Recommendations:

The Paylean diet should contain approximately 0.3% TID lysine above that required by a pig of the same weight without Paylean. Vitamins and minerals do not have to be increased and amino acid ratios for the 110 lb pig can be used.

Table 2. KSU vitamin and trace mineral recommendations for finishing diets.

	Weight, lb											
Item	50	70	90	110	130	150	170	190	210	230	250	270
KSU vitamin premix, lb/ton	3.0	3.0	3.0	2.5	2.5	2.5	2.0	2.0	1.5	1.5	1.5	1.5
KSU trace mineral premix, lb/ton	3.0	3.0	3.0	2.5	2.5	2.5	2.0	2.0	1.5	1.5	1.5	1.5
---------- Amount per ton ----------												
Vitamin A, IU/ton	6,000,000	6,000,000	6,000,000	5,000,000	5,000,000	5,000,000	4,000,000	4,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Vitamin D, IU/ton	750,000	750,000	750,000	625,000	625,000	625,000	500,000	500,000	375,000	375,000	375,000	375,000
Vit E, IU/ton	24,000	24,000	24,000	20,000	20,000	20,000	16,000	16,000	12,000	12,000	12,000	12,000
Vit K, mg/ton	2,400	2,400	2,400	2,000	2,000	2,000	1,600	1,600	1,200	1,200	1,200	1,200
Vit B12, mg/ton	21.0	21.0	21.0	17.5	17.5	17.5	14.0	14.0	10.5	10.5	10.5	10.5
Riboflavin, mg/ton	4,500	4,500	4,500	3,750	3,750	3,750	3,000	3,000	2,250	2,250	2,250	2,250
Pantothenic, mg/ton	15,000	15,000	15,000	12,500	12,500	12,500	10,000	10,000	7,500	7,500	7,500	7,500
Niacin, mg/ton	27,000	27,000	27,000	22,500	22,500	22,500	18,000	18,000	13,500	13,500	13,500	13,500
Zinc, g/ton	150	150	150	125	125	125	100	100	75	75	75	75
Iron, g/ton	150	150	150	125	125	125	100	100	75	75	75	75
Copper, g/ton	15	15	15	13	13	13	10	10	8	8	8	8
Manganese, g/ton	36	36	36	30	30	30	24	24	18	18	18	18
Iodine, g/ton	0.27	0.27	0.27	0.23	0.23	0.23	0.18	0.18	0.14	0.14	0.14	0.14
Selenium, g/ton	0.27	0.27	0.27	0.23	0.23	0.23	0.18	0.18	0.14	0.14	0.14	0.14
---------- Amount per lb of complete diet ----------												
Vitamin A, IU/lb	3,000	3,000	3,000	2,500	2,500	2,500	2,000	2,000	1,500	1,500	1,500	1,500
Vitamin D, IU/lb	375	375	375	313	313	313	250	250	188	188	188	188
Vit E, IU/lb	12.0	12.0	12.0	10.0	10.0	10.0	8.0	8.0	6.0	6.0	6.0	6.0
Vit K, mg/lb	1.2	1.2	1.2	1.0	1.0	1.0	0.8	0.8	0.6	0.6	0.6	0.6
Vit B12, µg/lb	10.50	10.50	10.50	8.75	8.75	8.75	7.00	7.00	5.25	5.25	5.25	5.25
Riboflavin, mg/lb	2.25	2.25	2.25	1.88	1.88	1.88	1.50	1.50	1.13	1.13	1.13	1.13
Pantothenic, mg/lb	7.5	7.5	7.5	6.25	6.25	6.25	5.0	5.0	3.75	3.75	3.75	3.75
Niacin, mg/lb	13.5	13.5	13.5	11.25	11.25	11.25	9.0	9.0	6.75	6.75	6.75	6.75
Zinc, ppm	165	165	165	138	138	138	110	110	83	83	83	83
Iron, ppm	165	165	165	138	138	138	110	110	83	83	83	83
Copper, ppm	17	17	17	14	14	14	11	11	8	8	8	8
Manganese, ppm	40	40	40	33	33	33	26	26	20	20	20	20
Iodine, ppm	0.30	0.30	0.30	0.25	0.25	0.25	0.20	0.20	0.15	0.15	0.15	0.15
Selenium, ppm	0.30	0.30	0.30	0.25	0.25	0.25	0.20	0.20	0.15	0.15	0.15	0.15

Table 3. Example finishing diets.

	Diets without fat						Diets with fat					
	Weight Range, lb						Weight Range, lb					
	50	75	120	160	195	230	50	75	120	160	195	230
Ingredient, lb/ton	75	120	160	195	230	280	75	120	160	195	230	280
Corn	1,370	1,468	1,566	1,639	1,687	1,727	1,206	1,303	1,417	1,549	1,597	1,645
Soybean meal, 46.5% CP	584	488	392	321	273	233	647	552	440	350	302	254
Choice white grease	—	—	—	—	—	—	100	100	100	60	60	60
Monocalcium P, 21% P	12	9.5	8.5	8	9	9	13	11	9.5	9	10	9.5
Limestone	18	18	18	18	18	18	18	18	18	18	18	18
Salt	7	7	7	7	7	7	7	7	7	7	7	7
Vitamin premix with phytase [a]	3	3	2.5	2	1.5	1.5	3	3	2.5	2	1.5	1.5
Trace mineral premix [a]	3	3	2.5	2	1.5	1.5	3	3	2.5	2	1.5	1.5
Lysine HCl	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Calculated Analysis												
TID lysine, % [b]	1.05	0.93	0.81	0.72	0.66	0.61	1.12	1.00	0.86	0.75	0.69	0.63
Total lysine, %	1.18	1.05	0.91	0.82	0.75	0.69	1.25	1.12	0.97	0.85	0.78	0.72
TID Lysine:ME ratio, g/Mcal	3.15	2.78	2.42	2.15	1.97	1.82	3.15	2.80	2.41	2.15	1.98	1.81
TID Isoleucine:lysine ratio, %	69	70	70	71	71	71	69	69	69	70	70	71
TID Leucine:lysine ratio, %	150	157	167	176	184	191	143	149	158	170	177	185
TID Methionine:lysine ratio, %	27	28	30	31	32	33	26	27	28	30	31	32
TID Met & Cys:lysine ratio, %	55	58	61	64	66	69	53	55	58	62	64	67
TID Threonine:lysine ratio, %	60	61	62	63	64	64	59	60	61	62	63	64
TID Tryptophan:lysine ratio, %	20	19	19	19	19	18	20	19	19	19	19	18
TID Valine:lysine ratio, %	78	79	81	83	85	86	76	77	79	82	83	85
ME, kcal/lb	1,513	1,516	1,519	1,520	1,521	1,521	1,615	1,617	1,620	1,581	1,581	1,582
Protein, %	19.5	17.7	15.9	14.6	13.7	12.9	20.3	18.5	16.4	14.9	13.9	13.0
Calcium, %	0.57	0.53	0.51	0.50	0.50	0.49	0.59	0.56	0.53	0.51	0.51	0.50
Phosphorus, %	0.52	0.47	0.44	0.42	0.42	0.42	0.53	0.49	0.45	0.43	0.43	0.42
Available phosphorus, %	0.20	0.17	0.15	0.14	0.15	0.15	0.21	0.18	0.16	0.15	0.16	0.15
Available phosphorus equivalent, % [c]	0.30	0.26	0.24	0.22	0.21	0.21	0.31	0.28	0.25	0.23	0.22	0.21
Avail P:calorie ratio, g/mcal	0.89	0.79	0.72	0.66	0.63	0.62	0.87	0.79	0.71	0.66	0.64	0.61
Feed budget, lb/pig	52	106	106	106	116	184	46	95	95	100	109	173

[a] Detailed specifications for these premixes can be found at www.ksuswine.org.

[b] True ileal digestible (TID).

[c] The amount of phosphorus provided by the ingredients and released by phytase in the vitamin premix.

Table 4. Example finisher diets containing Paylean®.

Ingredient	0.15% L-lysine HCl No fat	0.15% L-lysine HCl Added fat	0.3% L-lysine HCl No fat	0.3% L-lysine HCl Added fat
Corn	1,456	1,256	1,543	1,342
Soybean meal, 46.5% CP	504	644	410	550
Choice white grease	—	60	—	60
Monocalcium P, 21% P	9	9	9.5	9.5
Limestone	18	18	18	18
Salt	7	7	7	7
Vitamin premix with phytase[a]	1.5	1.5	1.5	1.5
Trace mineral premix[a]	1.5	1.5	1.5	1.5
Lysine HCl	3	3	6	6
DL-Methionine	—	—	1	1.5
L-Threonine	—	—	1.5	1.8
Paylean, 9 g/lb[b]	0.5	0.5	0.5	0.5
TOTAL	2,000	2,000	2,000	2,000
Calculated Analysis				
TID Lysine, %[c]	0.95	1.12	0.95	1.12
Total lysine, %	1.07	1.25	1.06	1.24
TID Lysine:ME ratio, g/Mcal	2.84	3.22	2.84	3.21
TID Isoleucine:lysine ratio, %	70	69	61	62
TID Leucine:lysine ratio, %	156	145	144	135
TID Methionine:lysine ratio, %	28	26	31	31
TID Met & Cys:lysine ratio, %	57	54	58	56
TID Threonine:lysine ratio, %	61	60	62	62
TID Tryptophan:lysine ratio, %	19	20	17	17
TID Valine:lysine ratio, %	79	76	71	69
ME, kcal/lb	1,518	1,579	1,520	1,581
Protein, %	18.0	20.4	16.5	18.9
Calcium, %	0.53	0.55	0.52	0.54
Phosphorus, %	0.47	0.49	0.46	0.48
Available phosphorus, %	0.16	0.17	0.16	0.17
Available phosphorus equiv, %[d]	0.22	0.23	0.22	0.23
Avail P:calorie ratio, g/mcal	0.67	0.67	0.67	0.66

[a] Detailed specifications for these premixes can be found at *www.ksuswine.org*.
[b] Paylean level can be between 0.5 and 1.0 lb per ton (4.5 to 9.0 g/ton).
[c] True ileal digestible (TID).
[d] Available phosphorus equivalent included the phosphorus released due to the inclusion of phytase in the vitamin premix.

Feed Budgets

How can I assure that pigs are being delivered the right amount of diet for each weight range?

Feed budgets are used to ensure the right amounts of each diet are delivered to each group of pigs. An example feed budget is provided with the example diets in Table 3. These budgets are based on a feed efficiency of 2.96 from 50 to 280 lb, which is equivalent to a F/G of 2.8 from 50 to 250 lb. As fat is added to the diet, the quantity of feed required for each phase is decreased such that overall feed efficiency is improved to 2.73 in the example (equivalent to 2.58 from 50 to 250 lb).

With a feed budget, feed deliveries can be tracked from one central location, such as the feed mill. The person in the finishing barn does not have to guess the weight of the pigs for determining which diet to order. The diet to be delivered to the group of pigs is automatically determined by the feed budget.

Use of feed budgeting has resulted in more accurate phase feeding by not over or under delivering diets for each phase. The tracking of feed deliveries from one central location has also lead to improved accuracy of feed records.

How do I alter the feed budget to different weights or feed efficiencies?

A feed budget chart is provided in Table 5, which assumes a feed efficiency of 3.0 from 50 to 250 pounds. If feed efficiency is consistently higher or lower for a particular system, the budget can be scaled up or down to account for the change. A KSU Feed Budget Spreadsheet is also available at: *www.ksuswine.org*. The spreadsheet can be used to easily adjust a feed budget based on overall close out feed efficiency and customized weight breaks.

To use the standard feed chart in Table 5, determine the average weight of the group of pigs when placed in the barn and find the cumulative amount of feed on the feed budget chart. Next, find the cumulative amount of feed at the end of the weight break. Determine the difference and multiply by the number of pigs in the room. For example, grower 1 diet is fed from 50 to 80 pounds and a group of pigs are initially placed on feed at 55 pounds. The cumulative feed intakes to 55 and 80 pounds are 81 and 141 pounds, respectively. Therefore, this phase requires 60 pounds (141 – 81) of feed per pig or 18 tons for a 600-pig group. The subsequent phases are then calculated in the same manner.

How is a customized feed budget developed for a specific production system?

The feed budget chart shown in Table 5 or the KSU Feed Budget Spreadsheet will fit most production systems (*www.ksuswine.org*). With the advent of many large production systems that have similar feeding programs, genetics, and buildings, feed budgets developed specifically for a production system may be desirable. The basic approach is to randomly select six groups for each gender and track feed deliveries to the group. In addition, a random sampling of pens (three or four) in the group are weighed to determine the average pig weight of the group. Feed is inventoried on each weigh day and cumulative feed intake determined. The groups are followed as long as possible with the removal of as few of the pigs as possible. A minimum of 5 data points is needed to develop the curve. A curve can then be fit to the data and an equation derived to determine the cumulative feed intake. This can be easily accomplished by making an X–Y scatterplot in a spreadsheet and using the trendline function to obtain the equation for the curve (Figure 1). The customized budget for each phase can then be calculated by subtracting the cumulative intake at two different points.

Because feed is delivered to an individual group, the average curve is developed from a subsampling of groups within the production system. The development of feed budgets takes into account both the feed required for growth and feed disappearance due to wastage and can be customized for application to specific production systems.

What is the best way to determine the weight break for each phase?

Several factors are used to determine appropriate weight breaks. The nutrient requirements are rapidly changing during the grower and early

Figure 1. Customized feed budgeting.

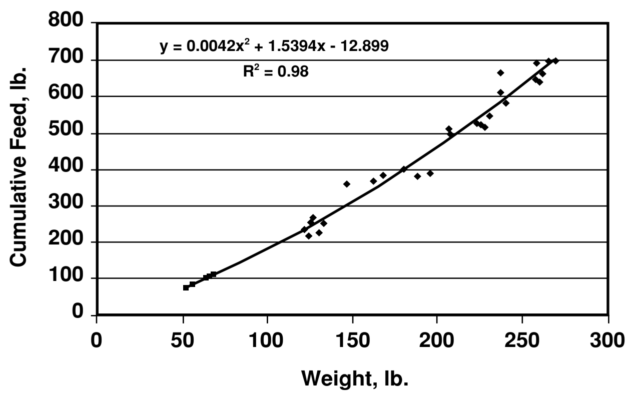

Table 5. Standard feed budget chart based on a feed efficiency of 2.8 from 50 to 250 pounds.

Pig Weight	Total feed	Pig weight	Total feed	Pig weight	Total feed	Pig weight	Total feed	Pig weight	Total feed
10	1	70	111	130	253	190	427	250	630
15	7	75	122	135	267	195	442	255	648
20	14	80	132	140	280	200	458	260	667
25	22	85	144	145	294	205	475	265	686
30	31	90	155	150	308	210	491	270	705
35	40	95	167	155	322	215	508	275	724
40	50	100	178	160	336	220	524	280	743
45	60	105	190	165	351	225	542	285	763
50	70	110	203	170	365	230	559	290	783
55	80	115	215	175	380	235	576	295	803
60	90	120	228	180	396	240	594	300	823
65	100	125	240	185	411	245	612	—	—

finisher phases. Therefore, lower feed budget amounts result in diets more closely matching the nutrient needs of the pigs.

Another method is to use weight breaks that budget similar amounts of feed for each break. Thus, the weight ranges decrease, as the pigs grow heavier. A major advantage of doing this is that it is easy to remember the amount needed for each phase. Monitoring of the budgets is simplified for personnel. Other factors commonly used to determine the budget are based on the size of feed bins, delivery compartments, and the size of batches at the mill.

Feed Efficiency Comparisons and Targets

What is the best biologic measure to monitor if detailed financial records are not available?

Feed efficiency is the best factor to measure because it directly impacts cost per pound of gain. However, several factors that improve feed efficiency also can increase cost so the lowest feed efficiency may not always be the lowest cost.

How do I compare feed efficiency among different groups?

Several factors impact feed efficiency. Expected feed efficiency will be influenced by the entry weight and market weight of the pigs, gender of the pigs, genotype, energy level of the diet, and whether the diets are pelleted. In order to compare feed efficiency among groups, adjustment factors for these major items must be used. Adjustment factors have been developed for entry weight and market weight of the pigs, energy level of the diet, and whether the diets are in pellet or meal form. Therefore, variation among close outs can be accounted for by these factors and may aid in detecting differences among groups for other factors, such as feed wastage.

The following equation can be used to compare different groups with different ending weights and market weights:

Adjusted F/G = observed F/G + (50 – entry wt) × .005 + (250 – market wt) × .005)

This equation adjusts all groups to a common entry weight of 50 pounds and market weight of 250 pounds. Further adjustments can be made to compare groups with different grain sources, dietary energy levels, and pelleted or meal diets.

The adjustment for energy level uses an adjustment for grain source and fat level in the diet (grain factor – (fat level × 2)), where the grain factor is 1 for corn and 1.02 for milo and fat level is the percent fat in the diet. The adjustment for pelleting is (1– pellet factor), where the pellet factor is the percentage improvement in feed efficiency due to pelleting. These adjustment factors are used to develop the feed efficiency targets in Table 6.

The factors can be included in one formula to compare all of the factors at the same time:

Adjusted F/G =
(observed F/G + (50 – entry wt) × .005 + (250 – market wt) × .005))
/ [Grain factor – (fat level × 2))
× (1 – pellet factor)]

As an example, a group of pigs with an entry weight of 40 lb and exit weight of 240 lb being fed a 5% added fat, corn-soybean meal based diet in a meal form has an adjusted feed efficiency of 3.00 with an observed feed efficiency of 2.60. (2.60 + (50–40) × .005 + (250 – 240) × .005) / (1 – .05 × 2) × (1– 0)) = ((2.60 + .05 + .05) / (.9 × 1) = 3.00.

With this equation, groups can be monitored and compared. Consider the following example. Is a F/G of 3.0 from another group of pigs fed milo-based diets without added fat from 60 to 260 pounds better or worse than the previous example of an observed F/G of 2.60 from a corn-soybean meal based diet with 5 percent added fat from 40 to 240 pounds? Using the equation indicates the group fed milo-based diets has an adjusted F/G of 2.84 due to the lower energy level of the milo, no added fat, and heavier starting and ending weight. This is lower than the adjusted F/G of 3.00 for the group fed the corn diets. Therefore, the group fed milo-based diets had a better biologic feed conversion and less feed wastage than the group fed corn-based diets.

These factors are used to adjust between groups to compare expected biologic performance among groups. Economics may dictate that feed cost may be less expensive for pigs fed a milo-based diet with no added fat compared to pigs fed a corn-based diet with added fat even though the group fed the milo diets has a higher F/G.

Table 6. Feed efficiency targets (equivalent to a feed efficiency of 3.0 from 50 to 250 pounds for a corn-soybean meal based diet with no added fat).

		Corn-based diets		Milo-based diets	
Entry Weight, lb	Market Weight, lb	0% Fat	5% Fat	0% Fat	5% Fat
		Meal Diets			
40	250	2.75	2.48	2.81	2.52
40	270	2.85	2.57	2.91	2.62
40	290	2.95	2.66	3.01	2.71
50	250	2.80	2.52	2.86	2.57
50	270	2.90	2.61	2.96	2.66
50	290	3.00	2.70	3.06	2.75
60	250	2.85	2.57	2.91	2.62
60	270	2.95	2.66	3.01	2.71
60	290	3.05	2.75	3.11	2.80
		Pelleted Diets			
40	250	2.59	2.33	2.64	2.37
40	270	2.68	2.41	2.73	2.46
40	290	2.77	2.50	2.83	2.55
50	250	2.63	2.37	2.68	2.42
50	270	2.73	2.45	2.78	2.50
50	290	2.82	2.54	2.88	2.59
60	250	2.68	2.41	2.73	2.46
60	270	2.77	2.50	2.83	2.55
60	290	2.87	2.58	2.92	2.63

When examining cost per pound of gain in the finishing phase do feed processing charges have a big impact on cost?

Yes, accurate accounting of feed processing charges is necessary for accurate cost comparisons among different closeout groups. A processing charge of $12.50 per ton will add approximately $3.75 to the cost of producing a pig. This is equivalent to $0.019 per pound of gain. Similarly, a processing charge of $15 per ton will add $4.50 to the cost of producing a pig, which is equivalent to $0.022 per pound of gain.

Conclusion

Grower–finisher feeds represent the largest share of feed cost in a farrow-to-finish operation. Therefore, decisions to change or modify finishing diets must be made based on economics. Modern production systems have resulted in large groups of similar age and weight pigs which allow for more efficient feed deliveries, phase feeding, and split-sex feeding. Some simple tools to allow farm specific diet formulation and feed budgeting are now available to more efficiently reduce feed cost and improve growth performance in the grower-finisher phase of production.

Notes

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