IDAHO SWINE NUTRITION GUIDE

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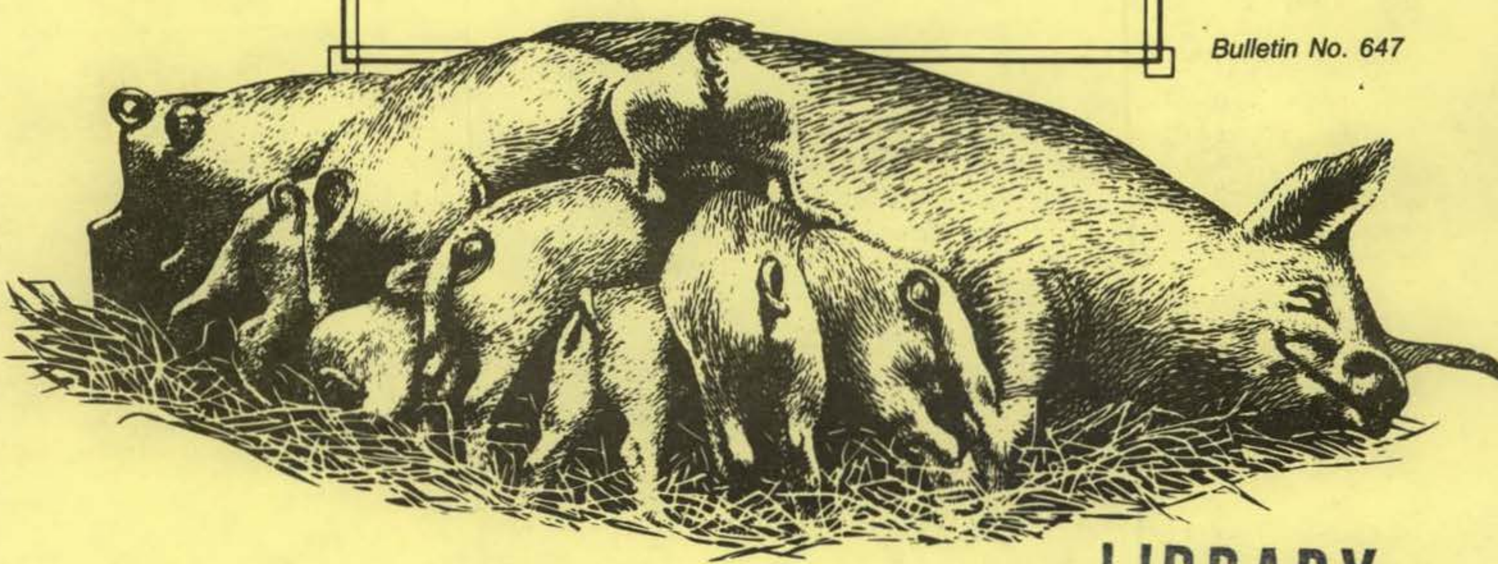

Cooperative Extension Service

University of Idaho

College of Agriculture

Idaho Swine Nutrition Guide

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Summary

Sixty to 70 percent of the expense of raising swine goes toward feed. Because of this, producers are searching continually for ways to minimize feed cost. Balanced diets that meet animal requirements in terms of energy, protein, amino acids, minerals and vitamins are an important part of a good management program. Using ingredients which meet the animal's needs at a reasonable cost should be a goal of the manager.

Idaho is in a favorable position from the standpoint of swine production potential. Feed grains are produced in abundance, with Idaho ranking third in the nation in barley production and fifth in spring wheat production. When these local feed grains are combined with other nutrient supplementation, high quality swine rations can be formulated.

Because overall efficiency of the swine herd is dependent upon feeding programs, an understanding of nutrition will be beneficial. Through the use of this publication, swine producers should gain a broader perspective on the local feed situation and enhance their understanding in its utilization.

Feed Mixing

Swine rations can be purchased as complete feeds from a feed manufacturer or mixed by the producer. On-farm mixing can take on several variations, from purchase of a base mix containing protein, vitamins and minerals to purchase of individual ingredients and mixing these in proper proportion with on-farm grains. Each method will have certain advantages and disadvantages. Complete ration purchase will require a trust and respect for the knowledge and quality control of the feed manufacturer. On-farm mixing will force self discipline to ensure proper weighing and mixing. On-farm mixing requires an understanding of nutrition to ensure proper ration formulation. Labor and management time used in on-farm mixing could also be directed to other areas needing attention.

Farm delivery necessitates additional transportation cost and likewise, owning your own mixer entails costs as well. It is evident that no single method is best for all farm situations. Swine producers must evaluate each alternative and reach a workable decision.

Table 1 lists standard nutrient requirements of swine. When purchasing or formulating rations, steps should be taken to ensure these minimum requirements are being met.

Table 1. Nutrient requirements of swine.[1]

	Pounds					
Liveweight	**1 to 22**	**22 to 44**	**44 to 120**	**120 to market**	**Gestation**	**Lactation**
					(5 lb/head)	
Protein %	22	18	16	14	12	13
Lysine %	1.12	.79	.66	.57	.43	.58
Methionine + cystine %[2]	.66	.51	.43	.30	.23	.36
Threonine %	.66	.51	.42	.37	.34	.43
Tryptophan %	.18	.13	.12	.10	.09	.12
Calcium %	.85	.65	.58	.5	.75	.75
Phosphorus %	.65	.55	.48	.4	.60	.50

[1]These nutrient levels are the **minimum** amounts necessary. Rations are often formulated to contain 10 to 20 percent higher levels. This safety margin will depend upon many factors such as animal growth rate, daily consumption levels and reproductive development programs.

[2]At least one-half of this level should come from methionine.

Nutrient Classification

The following discussions on energy, protein, vitamins, minerals and feed additives are taken from the Idaho Pork Producers Manual. More detail can be found by referring to the publication specified in parenthesis.

Energy (Nutrition I)

The value of a feedstuff is based on several factors: acceptability (how well the material will be consumed by an animal), energy availability and as a source of other nutrients (protein, vitamins, minerals). Should a swine producer buy corn or wheat or oats as a feed ingredient? This will depend primarily on the cost of these ingredients and their value as a source of energy for the animal.

The pig requires energy to maintain normal body processes to grow and to reproduce. Energy is the major component of all swine diets, and the intake of many other nutrients is related to the energy content of the diet. Carbohydrates from cereal grains are the most abundant energy source in swine rations. Fats and oils contain more energy than carbohydrates but are used to a lesser extent. Protein may serve as an energy source only if included in the ration in excess of the animal's requirement for protein.

Feed energy can be defined in several ways. The total energy is referred to as gross energy (G.E.) and is expressed as calories per unit weight. Some G.E. is lost during digestion so G.E. is a poor estimate of energy for the pig. Metabolizable energy (M.E.) is the "usable" energy of a feed for the pig to live and grow. Most feedstuffs have energy expressed in kilocalories (kcals) per unit weight. An example for barley would be 1,360 kcals M.E. per pound. Determination of energy values requires special equipment and/or animal feeding trials.

Protein (Nutrition III)

No pig can develop lean tissue (muscle) to its genetic potential nor can a sow realize her maximum reproductive potential unless her diet contains sufficient protein with the correct amino acid composition. Protein is made up of many sub-units called amino acids. During the digestive process, proteins are broken down into individual amino acids. The animal absorbs amino acids from the intestines and recombines them within the body tissue into new protein molecules.

Muscle protein is composed of about 22 different amino acids. Ten of these amino acids must be supplied in the pig's diet; the others can be synthesized in the body rapidly enough for maximum growth if a source of dietary nitrogen and adequate energy are present. The 10 that must be supplied in the diet are called essential amino acids; the others are classified nonessential.

Protein synthesis is an "all or nothing" type of synthesis. If any one of the essential amino acids needed to form a protein is deficient, that protein cannot be formed. Nothing explains the concept of limiting amino acids better than the age old illustration that likens a protein to a wooden barrel made up of rings and staves. The amino acids are the staves, and since a barrel will only hold water to the height of its lowest stave, a protein will only allow the pig to lay down meat to the extent of the amino acid present in the least amount. This amino acid, the shortest stave in the protein barrel, is called the first-limiting amino acid, the next in shortest supply, the second-limiting amino acid and so on. The quality of protein (presence and amount of the 10 essential amino acids), therefore, is more important than the total amount of protein fed.

Vitamins (Nutrition IV)

Vitamins are one of the classes of nutrients required for normal metabolism functions in the animal body. They are required in much smaller amounts than most of the other nutrients as they are not used as an energy source or a structural component. Some of the vitamins can be produced within the pig's body in sufficient quantities to meet the pig's need. Others are present in adequate amounts in feedstuffs commonly used in swine diets. Several vitamins need to be added to swine diets, however, to obtain optimal performance.

Vitamin needs are more critical today than previously because of the use of simpler types of diets containing fewer ingredients and the trend toward confinement rearing that has reduced the use of pasture. Young, lush green grass or legumes are good sources of vitamins.

Those vitamins that should be added to swine diets can be divided in two groups:

1. Fat soluble vitamins: Vitamin A, vitamin D, vitamin E and vitamin K.
2. Water soluble vitamins (known as B complex vitamins): Riboflavin or B_2, pantothenic acid, niacin, vitamin B_{12} and choline.

Minerals (Nutrition VII)

Minerals serve a variety of structural and metabolic functions in swine. Most minerals are believed present in adequate quantities in natural feedstuffs. The use of simpler swine diets with few ingredients, however, may necessitate consideration of their importance in the future. Currently, the following 10 mineral elements are regularly added to swine diets.

Those minerals that should be added to swine diets can be divided into two groups.

1. **Macro minerals** — Calcium, phosphorus, sodium and chlorine.
2. **Micro minerals** — Iron, zinc, iodine, selenium, copper and manganese.

Feed Additives (Nutrition VI)

The use of feed additives in swine rations has been extensive in the United States for more than 25 years. Feed additives are used by most swine producers because of their demonstrated ability to increase growth rate, improve feed utilization and reduce mortality and morbidity from clinical and sub-clinical infections.

In general, additives available for swine producers fall into three classifications: (1) antibiotics, (2) chemotherapeutics and (3) anthelmintics (dewormers):

Antibiotics are compounds synthesized by a living organism that inhibits the growth of another, therefore, it is biologically derived from bacteria and molds. The one thing antibiotics have in common in improving animal performance is their demonstrated ability to kill or inhibit the growth of certain micro organisms.

Chemotherapeutics are organic compounds with bacteriostatic or bactericidal properties similar to those of antibiotics. But, unlike antibiotics, these compounds are produced chemically rather than microbiologically.

Anthelmintics, or dewormers, are also organic compounds added to swine diets generally for short intervals to help control worm accumulation in growing-finishing swine and the breeding herd.

Some feed additives may remain in tissues longer than others. The level fed and the duration of feeding also influence clearance rates. Therefore, producers should abide by the required withdrawal times and use only the approved levels when incorporating additives into their rations.

Feeding Swine In Idaho

Idaho's feed grain situation offers swine producers a wide assortment of usable products. Common energy feeds like wheat, barley and corn can all be used successfully. The major factor in using any of these products is to understand what you are using and take appropriate measures to ensure a balanced diet. The previous discussion of protein makes clear the need to use products like soybean meal. Without protein products, swine performance will not be satisfactory.

Many swine producers in Idaho are faced with several critical decisions. A major concern is the price and availability of protein products. Soybean meal is a product that must be brought in. In fact, price differentials between soybean meal in Idaho and soybean meal in Illinois can be 65 percent higher in Idaho. This difference is reflected in the cost of production and ultimately in the ability of Idaho swine producers to raise pork competitively. The location advantages of Idaho, such as reduced disease risk, climate and proximity to some markets, may or may not be enough to offset these differences. Local protein sources and proper understanding of their use are critical areas of concern for swine producers.

Local Energy Feeds

The many varieties of wheat and barley available for feeding can make some differences in performance of swine. Table 2 points out wheat variety research from Washington State University. As an example, 'Walladay' was significantly superior to 'Nugaines' as measured by average daily gain and feed to gain ratio. Tables 3 and 4 illustrate results of five barley varieties on performance of swine in two weight categories. WSU research results demonstrated that 'Steptoe' barley is not the best variety for swine feeding. This is important since most Idaho barley is the Steptoe variety. Young pigs did not perform as well on Steptoe as they did on 'Klages'. These differences were not as great in older pigs.

Table 2. Performance of growing-finishing pigs (81 to 201 pounds) fed 10 varieties of wheat.

Variety	Avg. daily gain	Avg. daily feed	Feed to gain ratio
	(lb)	(lb)	
Luke SWW	$1.76^{1,2}$	$5.41^{1,2}$	3.07^{1}
Walladay SWW	$1.78^{1,2}$	$5.55^{1,2}$	$3.13^{1,2,3}$
Yamhill SWW	$1.64^{1,2,3}$	$5.31^{1,2}$	$3.24^{1,2,3}$
Nugaines SWW	1.52^{3}	5.05^{2}	3.33^{3}
Stephens SWW	$1.72^{1,2,3}$	$5.59^{1,2}$	$3.26^{1,2,3}$
Daws SWW	$1.73^{1,2}$	$5.37^{1,2}$	$3.10^{1,2}$
Urquie SWS	$1.70^{1,2,3}$	$5.20^{1,2}$	$3.05^{1,2}$
Twin SWS	$1.63^{1,2,3}$	$5.37^{1,2}$	$3.29^{2,3}$
Wampum HRS	$1.58^{2,3}$	$5.22^{1,2}$	$3.31^{2,3}$
Wared HRS	$1.66^{1,2,3}$	$5.50^{1,2}$	3.33^{3}

^{1,2,3}Means in the same column without a common superscript are significantly different (P = < .05).

Table 3. Performance of growing pigs (43 to 77 pounds) fed five varieties of barley.

Variety	Avg. daily gain	Avg. daily feed	Feed/gain
	(lb)	(lb)	
Advance	1.41^{1}	3.28	2.34^{1}
Kamiak	1.36^{1}	3.12	2.32^{1}
Klages	1.41^{1}	3.28	2.31^{1}
Lud	$1.21^{1,2}$	3.26	2.72^{2}
Steptoe	1.23^{2}	3.26	2.66^{2}

^{1,2}Means without a common superscript are significantly different (P = < .05).

Table 4. Performance of growing-finishing pigs (77 to 223 pounds) fed five varieties of barley.

Variety	Avg. daily gain	Avg. daily feed	Feed/gain
Advance	1.61^{1}	$5.63^{1,2}$	3.54^{1}
Kamiak	1.67^{1}	5.70^{1}	3.43^{1}
Klages	1.63^{1}	$5.50^{1,2}$	3.40^{1}
Lud	1.39^{2}	5.24^{2}	3.91^{2}
Steptoe	1.61^{1}	5.76^{1}	3.58^{1}

^{1,2}Means without a common superscript are significantly different (P = < .05).

Triticale is another feed product that is a good energy as well as protein source. Triticale is a cross between wheat and rye and has potential in reducing the amount of soybean meal necessary to balance diets. At the same time, performance can be satisfactory as indicated in Tables 5 and 6. Daily gains and feed efficiency using Palouse triticale were not found to differ greatly from corn based rations in grower age pigs. While performance was not quite as good in finisher stage swine in these particular WSU trials, other trials have shown no difference.

Table 5. Performance of grower pigs fed three varieties of triticale.

Grain	Avg. daily gain	Avg. daily feed	Feed/gain
	(lb)	(lb)	
Corn	1.69[1]	5.15[1]	3.04[1]
Beagle triticale	1.54[2]	4.86[1,2]	3.16[1,2]
Palouse triticale	1.63[1,2]	5.10[1]	3.17[1,2]
Siskiyou triticale	1.39[2]	4.71[2]	3.41[3]

[1,2,3]Means in the same column without a common superscript are significantly different (P = <.05).

Table 6. Performance of finisher pigs fed three varieties of triticale.

Grain	Avg. daily gain	Avg. daily feed	Feed/gain
	(lb)	(lb)	
Corn	1.96[1]	6.73[1]	3.44[1]
Beagle triticale	1.58[1]	6.36[1,2]	3.97[2]
Palouse triticale	1.67[1]	6.47[1]	3.93[2]
Siskiyou triticale	1.39[3]	5.90[2]	4.22[2]

[1,2,3]Means in the same column without a common superscript are significantly different (P = <.05).

Table 7 presents the results of University of Idaho field trials. Pigs between an average of 120 and 200 pounds did as well on diets using Palouse triticale as compared with diets using corn. Both rations were formulated to be equal in protein and lysine content.

Idaho's position as the leading potato producing state justifies an explanation of the feasibility of surplus potatoes as a swine feed source. Potato protein has been shown to have a high value in relation to other plant proteins. The gross energy of the potato dry matter has also been shown to be high. The primary concerns for feeding potatoes to swine are: (1) the quantity of water that is present in raw potatoes and (2) the necessity of cooking before to feeding in order to enhance digestibility and consumption.

Table 7. Performance of finisher pigs (120 to 200 pounds) fed triticale or corn-soymeal diets.

Grain	Avg. daily gain	Avg. daily feed	Feed/gain
	(lb)	(lb)	
Triticale	2.02	7.42	3.68
Corn-soymeal	2.03	7.87	3.87

Many studies confirm that raw potatoes are unpalatable and support only minimal growth in swine. Once cooked, potatoes can be fed along with a balanced supplement. Swine should have access to enough of the supplemental diet to meet all nutrient needs except daily energy. The cooked potatoes can then be given free choice.

Proper cooking is important and is suggested to be a 20 minute steaming at 100 °C. Both over and under cooking can be detrimental on feed quality. The two rations listed in Table 8 are examples of specially formulated diets which when fed in limited amounts will provide all nutrients except energy. Free choice cooked potatoes should complete the energy needs of the hog. These diets are not designed for free choice feeding. The economics of this type of program should be evaluated closely.

Local Protein Products

Idaho swine producers realize that protein products that are necessary to balance rations are expensive. The most common protein source, soybean meal, is processed in the Midwest. Transportation cost added to an already costly ingredient places an extra burden on breakeven price at market time. There are at least several other products that offer potential for all or some soybean meal replacement. The cost-effectiveness of these alternatives will need to be evaluated by producers.

Table 8. Two rations of specially formulated diets.

40 to 120 pound pigs - 3 lb/head/day		120 pound to market pigs - 5 lb/head/day	
Corn	1,423	Corn	1,423
Soymeal 44%	511	Soymeal 44%	500
Dicalcium phosphate	24	Dicalcium phosphate	34
Limestone	17	Limestone	18
Salt	10	Salt	10
Vitamin - TM pack	15*	Vitamin-TM pack	15*
	2,000		2,000

*Assumes the vitamin and trace mineral concentration of a normal 10 pound per ton pack.

Meat and bone meal has been used quite effectively at limits up to 10 percent of the diet. Although a good source of lysine, calcium and phosphorus, meat and bone meal is low in energy. The high calcium and phosphorus content also means attention must be focused on final ration levels of these major minerals when meat and bone meal is used.

Triticale offers potential rewards, both in terms of energy as discussed earlier and in its lysine content. Producers in Idaho have successfully used triticale and eliminated some soybean meal expense.

Canola meal is primarily a product of Canada and has been used successfully in swine diets. Because of the lower protein content as compared to soybean meal, approximately 25 percent more must be used to replace the equivalent amount of protein. Canola meal is lower in energy than soybean meal which may limit its use in some rations. Tests have shown that canola can be used in all swine production phases.

In order for canola meal to be cost effective, the price must be no more than 65 to 70 percent of the cost of soybean. One important point to remember regarding canola meal is that it can be confused with rapeseed meal. Actually, the new canola meals are low in a toxic compound whereas rapeseed meal is not. Feeding canola meal, as opposed to rapeseed meal, can provide a reasonable alternative to soybean meal.

Faba beans, also known as field beans or horsebeans, represent another selection for Idaho swine producers. Fabas have been tested at several universities. The faba can be fed raw in properly balanced diets and support reasonable growth and efficiency. Table 9 points out Montana State University results using faba combinations in barley based rations.

Table 9. Faba bean study (67 pounds to market).

Treatment	Daily gain	Daily feed	Feed/gain
	(lb)	(lb)	
Barley-soybean meal control	1.63	5.76	3.52
Raw faba bean	1.59	5.49	3.46
Extruded:			
75:25 faba:soybean	1.76	5.84	3.32
50:50 faba:soybean	1.53	5.00	3.28
25:75 faba:soybean	1.57	5.17	3.29

Chickpeas have been used in swine feeding and been found to support favorable performance. Table 10 points out results of tests from WSU. Like the Faba, chickpeas do not require cooking or heating before use. Because chickpeas are low in the sulfur amino acids methionine and cystine, attention will need to be focused on these amino acids during formulation.

Cull peas can be used by Idaho producers and work quite well. One important point to remember about peas is that they, like chickpeas, are low in the amino acid, methionine and, therefore, may require additional supplementation. Dry beans offer another protein alternative to Idaho producers. Beans must be cooked before feeding them to swine since this will destroy a toxin and promote digestibility.

Table 10. Performance of pigs fed chickpeas (52 to 96 pound pigs corn-barley diet).

	% chickpeas in diet			
Item	0	10	20	40
Average daily gain (lb)	1.58	1.54	1.48	1.28
Average daily feed (lb)	4.03	3.82	3.64	3.61
Feed to gain ratio	2.55	2.49	2.46	2.83

With any of these non-conventional feed products, it is important to be aware of certain use limitations. Some should be used as a partial dietary source only. Some products may require certain amino acid supplementation to enhance performance. Swine producers should work with University of Idaho Cooperative Extension Service agricultural specialists or feed manufacturers to assure diets are properly balanced. Table 18 points out some of the special considerations for using certain protein alternatives.

Determining Comparative Values of Feeds

Many swine producers are interested in feeding rations that allow hogs to gain weight at the least cost. Feeding the most cost effective product is a difficult decision. The different feeds have different levels of energy and protein (amino acids) and, consequently, can't be compared on price alone. The difficulty of these decisions makes the use of comparative value formulas appropriate. Formulas in Tables 11 and 12 are based on the contributing nutrients of energy and lysine. These formulas will help determine the feed value of an ingredient when compared with corn and soybean meal. When alternative ingredients can be obtained for less than their comparative feed value, they may be a good purchase.

Swine Rations

The rations in Tables 13 through 17 have been designed to take advantage of many of the products discussed earlier. Nutrient levels have been established above the minimum requirements from Table 1 and more accurately reflect current feeding practices. While listing all possible ration combinations is not feasible, a variety for each animal stage (starter, grower, etc.) has been compiled.

Starter diets use both skim milk and corn as ingredients. This helps promote digestibility and acceptability and also allows for a high energy formula. Steptoe variety barley has not been used in starters because of low energy. Klages variety reflects a good quality, heavyweight barley throughout all animal stages. Consequently, a larger portion of good quality barley can be used while maintaining suitable ration energy lev-

Table 11. Comparative values (corn-soybean 48%).

Soft wheat	(.96622 x c/pc*) + (.03378 x c/ps*)
Steptoe barley	(.75505 x c/pc) + (.01828 x c/ps)
Klages barley	(.88795 x c/pc) + (.02143 x c/ps)
Oats	(.76433 x c/pc) + (.04367 x c/ps)
Triticale	(.84831 x c/pc) + (.08169 x c/ps)
Canola meal	(.24871 x c/pc) + (.56928 x c/ps)
Faba beans	(.39027 x c/pc) + (.36973 x c/ps)
Cull peas	(.55016 x c/pc) + (.41917 x c/ps)

Table 12. Comparative values - (corn-soybean 44%).

Soft wheat	(.96241 x c/pc)[1] + (.03759 x c/ps)[2]
Steptoe barley	(.75298 x c/pc) + (.02035 x c/ps)
Klages barley	(.88281 x c/pc) + (.02386 x c/ps)
Oats	(.75940 x c/pc) + (.04860 x c/ps)
Triticale	(.83910 x c/pc) + (.09090 x c/ps)
Canola meal	(.18451 x c/pc) + (.63349 x c/ps)
Faba beans	(.34857 x c/pc) + (.41143 x c/ps)
Cull peas	(.50289 x c/pc) + (.46644 x c/ps)

[1]c/pc = cost per pound of corn
[2]c/ps = cost per pound of soybean meal

Example: When corn is $7 per cwt and soybean meal 48 percent is $14 per cwt, what is the value of wheat?

$$(.96622 \times .07) + (.03378 \times .14)$$

$$.06764 + .00473 = .07237 \times 100 = \$7.24$$

Wheat is worth $7.24 per cwt based on its comparative feed value.

els. Although more Steptoe barley can be used, ration energy will decrease to a point where animal performance may not be satisfactory.

Canola meal and peas have been used in some examples. In the case of grower diets, it is necessary to include supplemental methionine to create a proper balance when using peas.

These rations will provide ideas on how products can be used. Other combinations are possible and should be developed on an individual basis through your feed manufacturer or Extension county agent.

It is important to realize that although certain barley and wheat varieties have shown different results in feeding trials and in laboratory analysis, these variations are not always consistent from year to year. It has been demonstrated by several universities that lysine content may not increase in proportion to an increase in protein. If a diet was formulated based on a high protein value, it is still possible that the final ration would be deficient. This problem is not answered easily. It would seem that one reasonable approach would be to formulate on a lysine basis using Table 19 figures. The margins of safety (percent increase in nutrients over levels as in Table 1) will also take care of some variation. Without a complete feed analysis for certain amino acids, it basically means that some guesswork is involved. For these reasons, producers should pay close attention to ration changes and resulting pig performance.

Table 13. Starter 22 to 44.

	1	2	3	4	5	6	7	8	9	10
Fat (vegetable)	—	—	—	—	—	—	50	50	50	50
Corn	500	445	1,287	1,219	425	460	840	800	810	785
Wheat (soft)	826	825	—	—	827	840	—	—	—	—
Barley-Klages	—	—	—	—	—	—	350	370	418	480
Soymeal (48%)	411	—	435	—	—	335	—	—	345	412
Soymeal (44%)	—	467	—	510	388	—	494	415	—	—
Canola meal	—	—	—	—	100	105	—	105	117	—
Limestone	20	20	20	20	20	20	20	20	20	20
Dicalcium phosphate	23	23	25	23	20	20	23	20	20	23
Vitamin - TM pack*	10	10	10	10	10	10	10	10	10	10
Salt	10	10	10	10	10	10	10	10	10	10
Skim milk	200	200	213	208	200	200	203	200	200	210
	2,000	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**
Protein (%)	19.6	19.8	19.6	20.0	19.9	19.7	19.8	19.9	19.6	19.4
Lysine (%)	1.07	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Calcium (%)	.9	.9	.9	.9	.88	.88	.9	.88	.88	.9
Phosphorus (%)	.64	.65	.65	.65	.65	.65	.65	.65	.65	.65
ME/kcal/lb	1,414	1,407	1,410	1,403	1,404	1,410	1,435	1,430	1,433	1,436

*A vitamin-trace mineral package should be included in all of the rations. Table 22 lists the minimum amounts needed in complete rations for the stages of animal life. The vitamin-trace mineral package will normally take care of these requirements when combined with levels present in feedstuffs.

Table 14. Grower 44 to 120.

	1	2	3	4	5	6	7	8	9	10
Corn	1,177	465	570	—	—	—	—	—	—	—
Wheat (soft)	—	—	—	1,650	1,590	1,455	1,277	1,200	1,185	294
Barley										
Steptoe	386	—	935	—	—	193	—	450	—	—
Klages	—	1,092	—	—	—	—	—	—	460	948
Soymeal (48%)	371	186	330	280	168	—	60	285	—	—
Soymeal (44%)	—	—	—	—	—	287	—	—	290	95
Canola meal	—	200	—	—	200	—	—	—	—	—
Cull peas	—	—	—	—	—	—	600	—	—	600
Dicalcium phosphate	34	22	33	34	23	33	28	32	32	28
Limestone	12	15	12	16	19	12	14	13	13	14
Salt	10	10	10	10	10	10	10	10	10	10
Vitamin - TM pack	10	10	10	10	10	10	10	10	10	10
Methionine	—	—	—	—	—	—	1	—	—	1
Fat (vegetable)	—	—	100	—	—	—	—	—	—	—
	2,000	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**
Protein (%)	16	16	15	15.3	16	15	15	15.3	15	15.7
Lysine (%)	.8	.75	.75	.7	.7	.7	.78	.72	.7	.79
Calcium (%)	.7	.7	.7	.8	.8	.7	.72	.75	.74	.73
Phosphorus (%)	.65	.65	.65	.65	.62	.65	.63	.65	.65	.65
ME/kcal/lb	1,350	1,334	1,370	1,419	1,410	1,389	1,432	1,350	1,390	1,360

Table 15. Finisher 120 to market.

	1	2	3	4	5	6	7	8	9	10
Corn	1,185	—	—	—	—	—	—	—	—	—
Wheat (soft)	—	1,764	1,690	1,384	1,223	1,218	890	830	500	—
Barley										
Steptoe	495	—	—	354	463	544	—	582	—	—
Klages	—	—	—	—	—	—	757	—	1,000	1,400
Soymeal (48%)	265	176	—	—	—	185	—	—	—	—
Soymeal (44%)	—	—	—	208	—	—	—	—	—	—
Canola meal	—	—	258	—	268	—	300	—	—	—
Cull peas	—	—	—	—	—	—	—	536	446	548
Dicalcium phosphate	19	19	10	18	8	17	16	15	15	12
Limestone	16	21	22	16	18	16	17	17	19	20
Salt	10	10	10	10	10	10	10	10	10	10
Vitamin - TM pack	10	10	10	10	10	10	10	10	10	10
	2,000	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**
Protein (%)	14	13.4	13.7	13.5	13.7	14.4	14.5	13.3	13.2	14
Lysine (%)	.65	.6	.6	.6	.6	.6	.6	.65	.6	.63
Calcium (%)	.60	.7	.68	.6	.6	.6	.67	.6	.6	.64
Phosphorus (%)	.5	.5	.5	.5	.5	.5	.6	.5	.5	.5
ME/kcal/lb	1,350	1,438	1,425	1,378	1,350	1,350	1,360	1,350	1,380	1,350

Table16. Sow gestation.

	1	2	3	4	5	6	7	8	9	10
Alfalfa hay	—	—	—	—	—	—	—	—	630	669
Wheat (soft)	1,817	—	730	—	—	1,756	—	—	1,315	—
Triticale	—	—	—	—	—	—	—	1,906	—	—
Barley										
Klages	—	1,805	—	—	1,777	—	1,735	—	—	1,279
Steptoe	—	—	1,072	1,790	—	—	—	—	—	—
Soymeal (48%)	110	127	128	—	—	—	—	—	—	—
Soymeal (44%)	—	—	—	150	155	—	—	—	—	—
Canola meal	—	—	—	—	—	177	203	21	—	—
Dicalcium phosphate	33	28	30	20	28	27	22	23	35	32
Limestone	20	20	20	20	20	20	20	30	—	—
Salt	10	10	10	10	10	10	10	10	10	10
Vitamin - TM pack	10	10	10	10	10	10	10	10	10	10
	2,000	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**
Protein %	12.2	13	12.1	12	13.1	12.4	13.3	14.7	12.5	13.1
Lysine (%)	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Calcium (%)	.87	.82	.85	.7	.83	.84	.80	.9	.93	.93
Phosphorus (%)	.62	.62	.62	.5	.65	.65	.65	.63	.65	.65
ME/kcal/lb	1,428	1,303	1,250	1,136	1,303	1,420	1,298	1,340	1,273	1,175
Feeding rate lb/head/day*	5	5.25	5.5	6.25	5.25	5	5.5	5.25	5.5	6.0

*Because gestation diets are limit-fed, it is necessary to include a suggested feeding rate. These rates help ensure that even though percent of nutrients between diets are different, the total amount of nutrients supplied are similar.

Table 17. Sow lactation.

	1	2	3	4	5	6	7	8	9	10
Corn	1,566	—	—	1,145	—	—	—	—	—	1,429
Wheat (soft)	—	1,590	1,547	—	1,432	1,460	1,133	1,573	1,248	—
Alfalfa hay*	—	100	100	—	—	—	—	—	340	—
Barley										
Klages	—	—	—	—	—	—	525	—	—	—
Steptoe	—	—	—	385	200	200	—	—	—	—
Soymeal (44%)	—	—	277	397	300	—	—	—	—	—
Soymeal (48%)	352	234	—	—	—	270	270	—	—	—
Canola meal	—	—	—	—	—	—	—	360	350	500
Dicalcium phosphate	42	36	36	39	34	35	34	24	25	26
Limestone	20	20	20	14	14	15	18	23	17	25
Salt	10	10	10	10	10	10	10	10	10	10
Vitamin - TM pack	10	10	10	10	10	10	10	10	10	10
	2,000	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**	**2,000**
Protein (%)	15	14.78	15	15.6	15	15	15	15	16	15.8
Lysine (%)	.75	.70	.71	.78	.71	.71	.70	.68	.77	.71
Calcium (%)	.99	.99	.99	.85	.80	.80	.87	.90	1.00	1.00
Phosphorus (%)	.72	.67	.67	.7	.7	.67	.67	.7	.7	.75
ME/kcal/lb	1,403	1,391	1,383	1,339	1,380	1,380	1,380	1,400	1,306	1,378

*Bulky products like alfalfa hay are not normally recommended for lactation diets. In some cases, however, the additional bulk helps prevent constipation and is, therefore, beneficial.

Table 18. Maximum suggested limitations.[1]

	Starter	Grower	Finisher	Gestation	Lactation
Chickpeas	10%	100% P[2]	100% P	100% P	100% P
Cottonseed meal	0	50% P	50% P	50% P	50% P
Peas	10%	100% P	100% P	100% P	100% P
Alfalfa hay	0	20%	20%	50%	0
Fish meal	5%	5%	5%	5%	5%
Meat and bone meal	5%	5-10%	5-10%	10%	5%
Wheat	60%	85%	85%	80%	80%
Skim milk	10%	0	0	0	0
Whey	20%	5%	5%	5%	5%
Faba beans	20%	20%	25%	25%	25%
Sugar	5%	0	0	0	0
Barley	25%	85%	85%	80%	80%
Fat	5%	5-10%	5-10%	10%	10%
Canola meal	5-10%	50% P	100% P	100% P	100% P
Cull beans	0	20%	40%	40%	40%

[1]All percentages are expressed as a portion of the total ration unless otherwise specified. Adjustments in formulation or daily consumption may be necessary when ingredient percentages are changed.

[2]P means supplemental protein. For example, 50 percent of the supplemental protein could be supplied by Canola meal in grower diets. The remainder should be supplied from the grain and soybean meal.

Table 19.

Ingredient	Dry matter	Protein	Fat	Fiber	ME energy	Calcium	Phosphorus	Lysine	Methionine	Cystine	Threonine	Tryptophan
	(%)	(%)	(%)	(%)	(kcal/lb)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
Alfalfa hay flower to 1/10 bloom	80	17.9	1.5	34.0	925	1.41	.28	.90	.21	.15	.78	.35
Barley												
Advance	89	11.7	1.8	3.9	1,298	.07	.36	.33	.12	.19	.38	.17
Kamiak	89	9.8	1.8	5.6	1,360	.07	.36	.28	.12	.19	.33	.17
Klages	89	10.6	1.8	2.9	1,360	.07	.36	.31	.12	.19	.35	.17
Lud	89	11.6	1.8	3.6	1,298	.07	.36	.31	.12	.19	.44	.17
Steptoe	89	9.7	1.8	4.8	1,160	.07	.36	.31	.12	.19	.33	.17
Beans, faba	85	31	1.0	9.2	1,140	.08	.43	1.68	.19	.28	3.96	.24
Beans, pinto	89	22.6	*	4.0	1,410	.13	.46	1.6	.08	.06	.30	*
Canola meal	92	38	5.8	13.0	1,227	.07	1.17	2.3	.68	.47	1.7	.44
Chickpeas	89	20.0	1.0	7.0	1,250	.15	.33	1.2	.19	.28	*	*
Corn and cob meal	85	5.7	2.0	7.1	1,302	.04	.23	.20	.14	.14	.36	.07
Corn, sweet	90	11.6	7.2	2.5	1,594	.01	.41	.33	.20	.15	.39	.09
Corn, yellow	89	8.8	3.8	2.2	1,500	.02	.28	.24	.20	.15	.39	.09
Cottonseed meal	94	50	1.38	8.4	1,148	.23	.92	1.71	.52	.64	1.32	.47
Fat, vegetable	100	—	100	—	3,590	—	—	—	—	—	—	—
Fish meal	88	52	5.8	.7	980	7.27	3.25	3.25	.62	.61	2.96	.33
Meat and bone meal	93	49.5	11.1	1.8	820	11	6.0	3.29	.65	.35	1.7	.29
Milo	89	9	2.8	2.0	1,467	.02	.3	.22	.13	.14	.3	.09
Oats	89	11	4.2	11.0	1,212	.06	.27	.40	.18	.22	.43	.16
Peas Austrian	89	23	3.3	6.1	1,454	.17	.50	1.52	.19	.17	.84	.25
Potatoes	23	2.2	.1	.6	366	.01	.05	.11	.04	.04	.07	*
Safflower seed meal	91	21.6	6.6	32.2	907	.24	.61	.65	.37	.53	1.3	.28
Skim milk	94	33.5	.9	4.9	1,530	1.28	1.02	2.4	.93	.44	1.6	.44
Soybean meal	89	44	1.8	7.3	1,295	.25	.60	2.93	.70	.07	1.81	.62
Soybean meal	91	48	1.1	2.9	1,310	.29	.65	3.2	.74	.83	2.0	.64
Sugar	100	—	—	—	1,360	—	—	—	—	—	—	—
Sunflower seed meal	89	32.3	1.9	23.7	1,044	.38	.97	1.66	1.57	.69	1.4	.59
Triticale (Palouse)	89	15	2.0	2.1	1,395	.05	.42	.50	.22	.25	.46	.13
Wheat, hard red												
Wampum	89	13.9	1.7	3.0	1,460	.05	.35	.38	.27	.40	.47	.16
Wared	89	14.4	1.7	3.0	1,460	.05	.35	.42	.11	.41	.48	.16
Wheat, soft whites												
Daws	89	12.6	1.8	2.2	1,500	.05	.3	.37	.24	.34	.42	.12
Luke	89	12.4	1.8	2.2	1,500	.05	.3	.37	.24	.37	.40	.12

Table 19. (cont'd).

Nugaines	89	10.9	1.8	2.2	1,500	.05	.3	.45	.22	.36	.44	.12
Stephens	89	10.8	1.8	2.2	1,500	.05	.3	.41	.22	.34	.42	.12
Twin	89	13.2	1.8	2.2	1,500	.05	.3	.40	.26	.57	.44	.12
Urquie	89	13.2	1.8	2.2	1,500	.05	.3	.36	.27	.40	.43	.12
Walladay	89	12.4	1.8	2.2	1,500	.05	.3	.35	.25	.40	.39	.12
Yamhill	89	12.6	1.8	2.2	1,500	.05	.3	.36	.11	.36	.40	.12
Whey (dried)	94	12.0	.8	1.3	1,420	.97	.76	.97	.19	.30	.89	.19

*Values unavailable

Table 20. Sources of minerals for swine.

Mineral	Source	Chemical formula	Mineral %[1]		Remarks
			Ca%	P%	
Calcium and phosphorus	Ground limestone (calcium carbonate)		39	0	Excellent availability, usually cheapest source of Ca
	Dicalcium phosphate		20-24	18.5	Excellent availability
	Monocalcium phosophate		16-19	21.0	Excellent availability
	Sodium tripolyphosphate or monosodium phosphate		0	25.0	Excellent availability
	Phosphoric acid		0	23.7	Excellent availability
	Defluorinated phosphate		30-34	18.0	Good to excellent availability
	Streamed bone meal (NRC)		26	12.5	Good to excellent availability
	Low fluorine rock phosphate or Curacao		30-36	14.0	Fair availability
	Soft rock phosphate		17-20	9	Poor availability
Iron	Ferrous sulfate	$FeSO_4 \cdot 7H_2O$	20.1% Fe		Good availability
	Ferrous sulfate	$FeSO_4 \cdot H_2O$	32.9%		Good availability
	Ferric ammonium citrate		16.5-18.5% Fe		Good availability
	Ferrous fumerate	$FeC_4H_2O_4$	32.9% Fe		Good availability
	Ferric chloride	$FeCl_3 \cdot 6H_2O$	20.7% Fe		Mediocre availability, picks up moisture
	Ferrous carbonate	$FeCO_3$	48.2% Fe		Availability varies depending on solubility
	Ferric oxide	Fe_2O_3	69.9% FE		Limited availability, used for red color
	Ferrous oxide	FeO	77.8% Fe		Limited availability
Copper	Cupric carbonate	approx. $CuCO_3 \cdot Cu(OH)_2\text{-}H_2O$	50-55% Cu		
	Cupric chloride	$CuCl_2 \cdot 2H_2O$	37.3%		All are good sources of copper
	Cupric oxide	CuO	79.7% Cu		
	Cupric sulfate	$CuSO_4 \cdot 5H_2O$	25.4% Cu		
Manganese	Manganese carbonate	$MnCO_3$	47.8% Mn		
	Manganous chloride	$MnCl_2 \cdot 4H_2O$	27.8% Mn		All are good sources of manganese
	Manganous oxide	MnO	77.4% Mn		
	Manganese sulfate	$MnSO_4 \cdot 5H_2O$	22.8% Mn		
Zinc	Zinc carbonate	approx. $5ZnO\text{-}2CO_3 \cdot 4H_2O$	56.0% Zn		
	Zinc carbonate	$ZnCl_2$	48.0% Zn		All are good sources of zinc
	Zinc oxide	ZnO	80.3% Zn		
	Zinc sulfate	$ZnSO_4 \cdot 7H_2O$	22.7% Zn		
Iodine	Calcium iodate	$Ca(IO_4)_2$	65.1% I		All are good sources of iodine
	Potassium iodide	KI	76.4% I		
	Cuprous iodide	CuI	66.6% I		
Selenium	Sodium selenite	Na_2SeO_3	45.7%		Good availability
	Sodium selenate	Na_2SeO_4	41.8%		Good availability

[1]The percentage of the mineral listed for those compounds where a chemical formula is given is for the pure compound. The percent purity for technical and feed grade sources should, therefore, be multiplied by the listed percentage in this table to arrive at the percent of the element in the source being used.

Source: *Table from *Life Cycle Swine Nutrition,* Iowa State Univ., 1982.

Feed analysis can be beneficial when assessing the quality of feed. The laboratories in Table 21 can provide the proximate analysis. Proximate analysis allows for determination of dry matter, protein, ash, ether extract and nitrogen free extract. By using these nutritional properties, the laboratory can estimate the metabolizable energy of the ration, in addition to general adequacy such as protein level.

Estimation of metabolizable energy can be determined by multiplying 3.61 kcal ME by the grams of TDN in a sample. If a feed sample is 70 percent TDN, then 317.8 grams per pound (454 g/lb × 70%) is TDN times 3.61 equals an equivalent of 1,147 kcal ME/pound.

Analysis for calcium and phosphorus is also a routine procedure which may be useful. Analysis for trace minerals and vitamins is generally a more involved process than is normally needed. Amino acid screening is expensive but may be useful to some producers as an occasional evaluation.

Table 21. Commercial analytical laboratories for feed analysis.[1]

ABC Labs	P.O. Box 1097	Columbia, Missouri 65205[2]	314/474-8579
Bar Diamond	Route 2, Box 2518	Parma, Idaho 83660	208/722-6761
Western Labs	P.O. Box 400	Parma, Idaho 83660	208/722-6564
Agri-Test Labs	269 Addison Ave. W	Twin Falls, Idaho 83301	208/734-2303
Drumheller Analytical Lab	701-03 Payton Bldg. Box 710	Spokane, Washington 99201	509/624-2809
Hazelton Labs[2]	P.O. Box 7545 3301 Kinsman Blvd.	Madison, Wisconsin 53707	608/241-4471
Northwest Labs	901 North Lincoln	Jerome, Idaho 83338	208/324-7511
Hibbs Labs	2808 Cassia	Boise, Idaho 83705	208/343-7830

[1]This is not a recommendation or a complete list of available laboratories.
[2]These laboratories are equipped to do amino acid analysis.

Table 22. Vitamins and trace minerals.

Liveweight	1 to 22	22 to 44	44 to 120	120 to market	Gestation	Lactation
Per pound of diet						
Vitamin A-I.U.	998	794	589	589	1,814	907
Vitamin D-I.U.	98	91	79	57	91	91
Vitamin E-I.U.	4.98	4.98	4.98	4.98	4.54	4.54
Vitamin K-I.U.	.91	.91	.91	.91	.91	.91
Riboflavin, mg	1.36	1.36	1.08	.99	1.36	1.36
Niacin, mg	9.98	8.16	5.89	4.54	4.53	4.53
Pantothenic acid, mg	5.89	4.98	4.98	4.98	5.44	5.44
Vitamin B_{12}, mg	9.98	6.80	4.98	4.98	6.80	6.80
Choline, mg	499	408	283	181	567	567
Thiamin, mg	.59	.498	.498	.498	.454	.454
Vitamin B_6, mg	.68	.68	.49	.49	.454	.454
Biotin, mg	.045	.045	.045	.045	.045	.045
Folacin, mg	.272	.272	.272	.272	.272	.272
Magnesium, mg	181	181	181	181	181	181
Iron, mg	68	36	25	18	36	36
Zinc, mg	45	36	25	23	23	23
Manganese, mg	1.81	1.36	.90	.90	4.54	4.54
Iodine, mg	.064	.064	.064	.064	.064	.064
Selenium, mg	.158	.158	.068	.068	.068	.068
Copper, mg	2.72	2.27	1.58	1.36	2.27	2.27

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