University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Historical Materials from University of Nebraska-Lincoln Extension

Extension

1992

EC92-210 Swine Diet Suggestions

Duane E. Reece
University of Nebraska-Lincoln, dreese1@unl.edu

Phillip S. Miller
University of Nebraska-Lincoln, pmiller1@unl.edu

Austin J. Lewis
University of Nebraska-Lincoln, alewis2@unl.edu

Follow this and additional works at: http://digitalcommons.unl.edu/extensionhist

Reece, Duane E.; Miller, Phillip S.; and Lewis, Austin J., "EC92-210 Swine Diet Suggestions" (1992). *Historical Materials from University of Nebraska-Lincoln Extension*. 4685.
http://digitalcommons.unl.edu/extensionhist/4685

This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

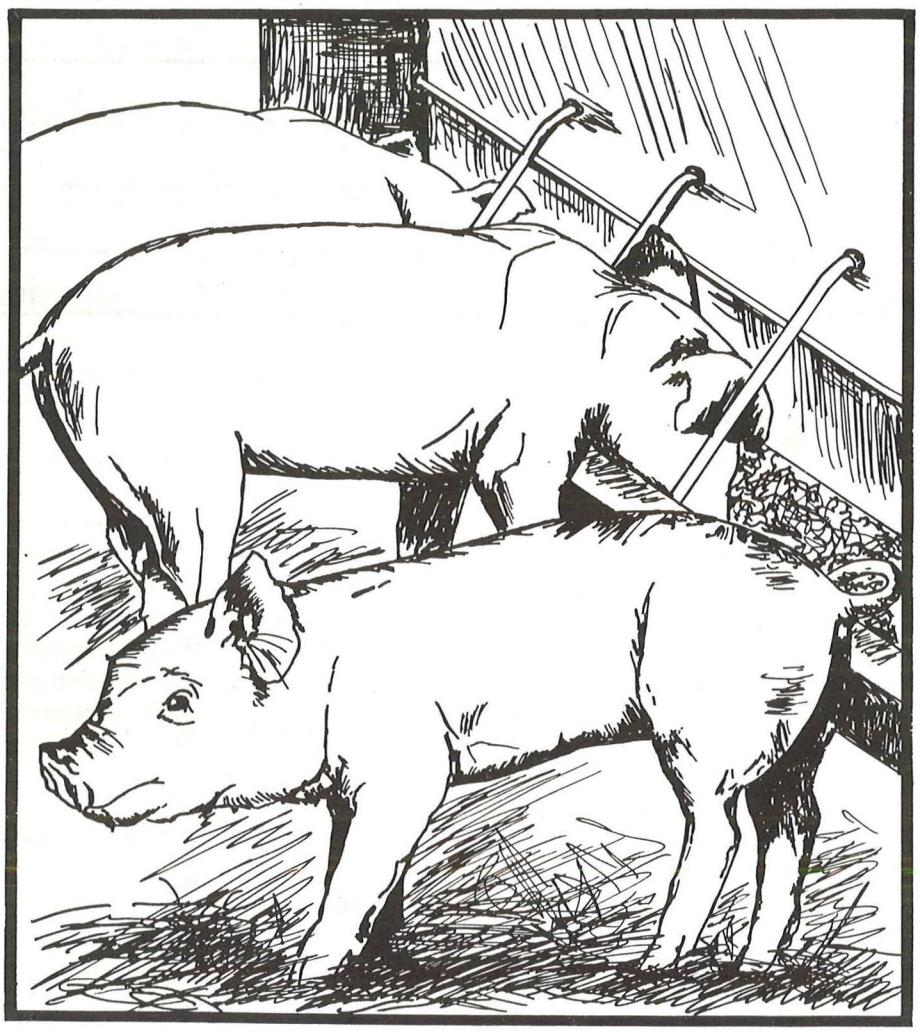
©YT
S
85
E7

Nebraska Cooperative Extension EC 92-210-A
(Revised January 1992)

FEB 28 1992

UNIVERSITY of NEBRASKA

swine diet suggestions



Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

Cooperative Extension provides information and educational programs to all people without regard to race, color, national origin, sex or handicap.

CONTENTS

NUTRIENT ALLOWANCES 3

SOURCES OF ENERGY 3

ALFALFA IN SWINE DIETS 6

PROTEIN AND AMINO ACIDS 7

MINERALS 10

VITAMINS 12

FEED ADDITIVES 12

WATER 13

METHODS OF FEEDING 14

FEED QUALITY 15

SUGGESTED DIETS 15

INGREDIENT COMPOSITION 19

Conversion Factors

Units (a	x	Multiplied by the factor below equals b	=	Units c) (c	x	Multiplied by the factor below equals d	=	Units e)
lb		453.6		g		0.0022		lb
lb		0.4536		kg		2.205		lb
kg		1,000		g		0.001		kg
kg		1,000,000		mg		0.000001		kg
g		1,000		mg		0.001		g
g		1,000,000		µg		0.000001		g
mg		1,000		µg		.001		mg
mg/kg		0.00001		%		10,000		mg/kg
ppm		0.0001		%		10,000		ppm
mg/g		453.6		mg/lb		0.0022		mg/g
mg/lb		2.2		ppm		0.4536		mg/lb
mg/g		1,000		ppm		0.001		mg/g
mg/kg		1.0		ppm		1.0		mg/kg
g/ton		1.1		ppm		0.907		g/ton

UNIVERSITY OF NEBRASKA SWINE DIET SUGGESTIONS

Duane E. Reese
Extension Swine Specialist

Phillip S. Miller
Assistant Professor, Swine Nutrition

Austin J. Lewis
Professor, Swine Nutrition

Michael C. Brumm
Extension Swine Specialist

William T. Ahlschwede
Extension Swine Specialist

Feed is the largest single item among the costs of producing pork. On the average, it accounts for 60% of all costs and represents about 80% of the cash costs. We suggest that pork producers adopt a comprehensive feeding program based on sound nutrition principles and tailored to the operation. This publication provides the basis for such a feeding program.

Since diets, nutritional knowledge, feed ingredients, and methods of feeding change rapidly, this publication is revised periodically to provide the latest recommendations. In addition, this publication will help answer some of the more frequently asked questions.

NUTRIENT ALLOWANCES

Recommended nutrient allowances for all classes of swine are shown in Tables 1 and 2. Daily nutrient allowances for gilts and sows during gestation are presented in Table 3. Allowances shown in Tables 1 to 3 recognize that nutrient requirements change with various classes of swine. *Table 4 presents a convenient method of supplying trace mineral and vitamin additions for all classes of swine using premixes.*

In most instances, the nutrient allowances suggested in Tables 1 to 4 are higher than the minimum requirements established by the National Research Council (NRC) in 1988. Our purpose is to reduce the risk of nutrient deficiencies that might occur because of differences in ingredient quality, environment, health, genetics, and performance on individual farms.

SOURCES OF ENERGY

Corn is the most widely used energy source for swine in Nebraska. However, economic conditions change making other energy sources attractive for inclusion in swine diets.

What determines which energy source is most economical?

The relative feeding value of energy sources shown in Table 5 can help in determining which one is most economical. Corn is assumed to have a feeding value of 100%. Grain sorghum (milo), for example, has a feeding value about 95% that of corn. Thus, milo can economically replace corn when incorporated in diets for less than 95% of the cost of the same weight of corn. Although pigs fed milo will gain similarly to those fed corn, the value of milo is discounted to reflect a 5% decrease in feed efficiency when compared to corn.

The relative feeding values apply when ingredients are included in diets in quantities no higher than those shown in Table 5. Average daily gain and reproductive performance will not normally be reduced by replacing corn with any of the energy sources at the levels shown in Table 5. Using the relative feeding value will help assure that an economically competitive gain will result from using an alternate energy source even though in some cases feed efficiency may be decreased.

Is carcass merit affected by using an alternate energy source?

Yes. Research has indicated alterations in dressing percentage and backfat of pigs fed diets where corn has been replaced with alternate energy sources. The effect on dressing percentage appears to be directly proportional to the amount of the alternative energy source in the diet. Full replacement of corn with barley, milo, oats, and wheat has been shown to decrease dressing percentage by about 1%. At the same time backfat levels have decreased by 0 to 0.1 inches. Adjustments for changes in carcass merit have not been made in the feeding values shown in Table 5. Thus, producers who market hogs on carcass merit may need to adjust feeding values slightly to meet their situation.

How should alternate energy sources be included in the diet?

Two methods are acceptable. One is to substitute the alternate energy source for corn pound-for-pound within the limits given in Table 5. This procedure is acceptable for all energy sources in Table 5 except fat, corn silage, corn and cob meal, potatoes, and molasses. These energy sources contribute limited protein (amino acids) to the diet, thus they must be included in the diet by a second method. This method involves reformulating the diet on a lysine basis. The advantage of this method is that the lysine in wheat and barley, for example, can be effectively utilized, resulting in a reduction in protein supplementation. *Care should be taken*

Table 1. Recommended nutrient allowances for growing swine (as-fed basis)[a]

Type of diet	*Starter 1*	*Starter 2*	*Starter 3*	*Grower*	*Finisher*
Body wt, lb	*< 15*	*15 to 25*	*25 to 50*	*50 to 120*	*120 to market wt*
Expected feed intake, lb/d	*0.6*	*1*	*2.1*	*4*	*6.4*
TOTAL LEVEL, %					
Protein[b]	22 to 20	20 to 18	18	16	14
Lysine	1.40	1.20	1.00	0.80	0.65
Tryptophan	0.22	0.20	0.18	0.15	0.13
Threonine	0.80	0.70	0.60	0.50	0.45
Methionine+cystine	0.70	0.60	0.50	0.45	0.40
Calcium	0.90	0.80	0.75	0.65	0.60
Phosphorus	0.80	0.70	0.65	0.55	0.50
ADDITIONS/TON[c]					
Minerals					
Salt, lb[d]	3 to 6	3 to 6	6	6	6
Copper, g	10	9	8	7	6
Iodine, g	0.20	0.18	0.16	0.14	0.12
Iron, g	100	90	80	70	60
Manganese, g	15	13.5	12	10.5	9
Selenium, g	0.27[e]	0.24	0.22	0.19	0.16
Zinc, g	100	90	80	70	60
Vitamins					
Vitamin A, million IU	4	3.6	3.2	2.8	2.4
Vitamin D_3, thousand IU	500	450	400	350	300
Vitamin E, thousand IU	25	22.5	20	17.5	15
Vitamin K, g[f]	3	2.7	2.4	2.1	1.8
Riboflavin, g	4	3.6	3.2	2.8	2.4
Niacin, g	30	27	24	21	18
Pantothenic acid, g	15	13.5	12	10.5	9
Choline, g	100	90	80	70	60
Biotin, mg	0	0	0	0	0
Vitamin B_{12}, mg	20	18	16	14	12
Folic acid, g	0	0	0	0	0

[a]All diets are full fed (pigs are allowed *ad libitum* access to feed). A mixture of barrows and gilts is assumed.
[b]For corn or milo-soybean meal based diets.
[c]For convenience, one trace mineral mix and one vitamin mix may be used to supply the mineral and vitamin additions for starter to finisher (see Table 4).
[d]Adjust salt additions according to quantity of dried whey included in the diet. Total salt (from whey and salt) should not exceed 1% of the diet.
[e]Maximum legal addition is 0.27 g/ton (0.3 ppm).
[f]Menadione activity.

when formulating diets on a protein basis when using alternate energy sources to avoid creating a lysine deficiency.

What is the value of high lysine corn?

High lysine (Opaque-2) corn is generally higher than regular corn in most essential amino acids except leucine. High lysine corn is especially higher in lysine and tryptophan. Thus, diets formulated with high lysine corn usually contain about 3% less soybean meal (60 lb/ton) than regular corn diets. Pig performance is not affected by the reduction in soybean meal content of the diet.

Because the lysine content of the corn varies widely, we recommend that a lysine analysis be performed before any soybean meal is removed from the diet. High lysine corn tends to powder easily during processing, and therefore, it should be ground more coarsely than normal corn. Some producers prefer a roller mill for processing high lysine corn.

When producers consider growing high lysine corn they must evaluate such economic factors as yield of high lysine corn compared with normal corn and the price of normal corn and soybean meal (see the 1972, 1973, and 1983 *Nebraska Swine Reports* for further information).

What is the feed value of high moisture grain?

High moisture grain, harvested or reconstituted, is similar in feed value to dry grain on a dry matter basis. However, the quantity of grain used in the diet must be adjusted when using high moisture grain to compensate for moisture differences. Refer to Table 6 for the adjustments. Diets containing high moisture grain are not recommended for pigs less than 40 pounds. Automated systems are available for feeding complete diets with high moisture grain. If high moisture grain is fed, diets should be prepared frequently (every 1 or 2 days) to prevent spoilage. Mold inhibitors are effective in extending the shelf-life of high moisture grain diets. Diets should be prevented from bridging in the feeders. The major factor to consider in deciding whether to feed high moisture grain is how to harvest and store grain.

How does fat affect pig performance?

Fat has several unique properties that make it a popular ingredient in swine diets. As little as 2.5% added fat (50 lb/ton) reduces dust in confinement buildings by about 25%. Similar effects are observed in feed mills. Reduced dust

Table 2. Recommended nutrient allowances for breeding swine (as-fed basis)[a]

Type of diet	*Developing boar*		*Developing gilt*		*Gestation (4 lb/d) and adult boar (5 lb/d)*	*Lactation*
Body wt, lb	*50 to 120*	*120 to 240*	*120 to 200*	*200 to breeding*		
Expected feed intake, lb/d	*3.7*	*6*	*5.6*	*6*	*4 and 5*	*11*
TOTAL LEVEL, %						
Protein[b]	18	17	16	14	13	15
Lysine	1.00	.85	.80	.65	.55	.75
Tryptophan	.18	.17	.15	.13	.12	.14
Threonine	.60	.55	.50	.45	.38	.48
Methionine + cystine	.50	.47	.45	.40	.33	.43
Calcium	.75	.70	.65	.75	.90	.90
Phosphorus	.65	.60	.55	.65	.80	.80
ADDITIONS/TON[c]						
Minerals						
Salt, lb	6	6	6	10	10	10
Copper, g	8	7	7	10	10	10
Iodine, g	.16	.14	.14	.20	.20	.20
Iron, g	80	70	70	100	100	100
Manganese, g	12	10.5	10.5	20	20	20
Selenium, g	.22	.19	.19	.27[d]	.27[d]	.27[d]
Zinc, g	80	70	70	100	100	100
Vitamins						
Vitamin A, million IU	3.2	2.8	2.8	5	5	5
Vitamin D_3, thousand IU	400	350	350	500	500	500
Vitamin E, thousand IU	20	17.5	17.5	40	40	40
Vitamin K, g[e]	2.4	2.1	2.1	3	3	3
Riboflavin, g	3.2	2.8	2.8	5	5	5
Niacin, g	24	21	21	30	30	30
Pantothenic acid, g	12	10.5	10.5	20	20	20
Choline, g	80	70	70	500	500	500
Biotin, mg	0	0	0	200	200	200
Vitamin B_{12}, mg	16	14	14	20	20	20
Folic acid, g	0	0	0	1.5	1.5	1.5

[a]All diets (except the diet for developing gilts from 200 lb to breeding and the diet for gestating sows and adult boars) are full fed.
[b]For corn or milo-soybean meal based diets.
[c]**For convenience, one trace mineral mix and two vitamin mixes may be used to supply the mineral and vitamin additions for breeding swine (see Table 4). Diets for developing boars and for gilts from 120 to 200 lb can use a growing pig vitamin premix. Diets for developing gilts from 200 lb to breeding, gestating sows and adult boars, and lactating sows can use breeding swine vitamin premix.**
[d]Maximum legal addition is 0.27 g/ton (0.3 ppm).
[e]Menadione activity.

levels have improved health implications for both pigs and people.

Feeding fat to sows during late gestation and lactation has generally increased sow energy intake during lactation and improved baby pig survival to weaning. The greatest response to fat is achieved in herds where pig preweaning survival rate is less than 80% (two or more live born pigs/litter die before weaning) and/or sows eat poorly during lactation (less than 10 lb/day) resulting in reduced pig weight at weaning and delayed postweaning estrus. To best improve pig survival, sows should consume at least 2.5 lb of **added** fat before farrowing. Feeding a lactation diet with 3% added fat (Table 13) at the rate of 6 lb/day for 14 days before farrowing would be sufficient. Maintaining farrowing house temperatures at 65 to 70°F with zone heating for baby pigs will encourage increased feed consumption by lactating sows.

In growing-finishing diets fat consistently improves feed efficiency. On the average feed efficiency is improved by 2% for each 1% increment of added fat. Feed efficiency and daily gain are improved more by feeding fat to pigs during summer than winter. Carcass quality is not greatly altered unless added fat levels exceed 5% of the diet. Fat is often added to weanling pig diets to aid in overcoming problems associated with low feed intake at weaning and in the manufacture of diets.

What sources of fat are available?

Common sources of animal and vegetable fats, and their metabolizable energy values are listed in Table 14. Also available are blended combinations of animal fat, vegetable oil, and restaurant grease.

Animal fat and soybean oil are the most common fat sources used in swine diets. Animal fats generally include tallow and lard (choice white grease). These are solid at room temperature and must be melted before they can be blended into the diet. In contrast vegetable oils are liquid at room temperature, and can be added to the diet without melting.

Fats are available from a variety of sources including complete diets, commercial supplements, dried fat products, whole soybeans, refiners, and renderers. Probably the easiest method of incorporating soybean oil in diets is to use whole

Table 3. Daily nutrient allowances for gilts and sows during gestation

Nutrient	*Nebraska allowance per day*
TOTAL DAILY INTAKE FROM DIET	
Protein, g	236
Lysine, g	10
Tryptophan, g	2.2
Threonine, g	7
Methionine + cystine, g	6
Calcium, g	16
Phosphorus, g	14.5
TOTAL DAILY INTAKE FROM ADDITIONS	
Salt, g	9
Copper, mg	20
Iodine, µg	400
Iron, mg	200
Manganese, mg	40
Selenium, µg[a]	540
Zinc, mg	200
Vitamin A, IU	10,000
Vitamin D_3, IU	1,000
Vitamin E, IU	80
Vitamin K, mg[b]	6
Riboflavin, mg	10
Niacin, mg	60
Pantothenic acid, mg	40
Choline, mg	1,000
Biotin, µg	400
Vitamin B_{12}, µg	40
Folic acid, mg	3

[a]Maximum legal addition.
[b]Menadione activity.

Table 4. Convenient method of supplying trace minerals and vitamins from premixes[a]

Type of diet *Body wt, lb*	*Starter* *< 15 to 50*	*Grower-finisher* *50 to market wt*	*Breeding swine*[b]
ADDITIONS/TON			
Copper, g	10	10	10
Iodine, g	0.20	0.20	0.20
Iron, g	100	100	100
Manganese, g	20	20	20
Selenium, g[c]	0.27	0.27	0.27
Zinc, g	100	100	100
Vitamin A, million IU	4	2.8	5
Vitamin D_3, thousand IU	500	350	500
Vitamin E, thousand IU	25	17.5	40
Vitamin K, g[d]	3	2.1	3
Riboflavin, g	4	2.8	5
Niacin, g	30	21	30
Pantothenic acid, g	15	10.5	20
Choline, g	100	70	500
Biotin, mg	0	0	200
Vitamin B_{12}, mg	20	14	20
Folic acid, g	0	0	1.5

[a]Two vitamin mixes (one for starter to finisher and one for breeding swine) will supply these additions.
[b]Developing boars and gilts (120 to 200 lb) may be provided the vitamin additions for starter.
[c]Maximum legal addition is 0.27 g/ton (0.3 ppm).
[d]Menadione activity.

soybeans. Diets that contain whole soybeans as the sole supplemental protein source provide 3% to 4% added fat. Fat that is added to a swine diet should be stabilized with an antioxidant (BHT or ethoxyquin) to avoid the possibility of rancidity.

What problems are associated with adding fat to diets?

The major problems associated with fat additions are physical in nature. Animal fats are solid at room temperature and must be melted for addition to diets and to assure proper mixing. If the fat content of diets is increased above 3% to 4%, the diet becomes sticky and tends to bridge and hang up in delivery tubes, bins, and feeders.

Are some energy sources better suited for pigs in the summer than winter?

Yes. Fat will improve pig performance more when provided in the summer than in the winter. Less heat is produced by pigs when they digest fat compared with starch or fiber. This allows pigs fed diets with added fat to continue to consume large amounts of energy during hot weather when feed intake is normally depressed. Thus fat is generally more cost effective when fed in the summer than the winter. In contrast, when low energy, high fiber feedstuffs such as alfalfa, are digested by pigs, heat production is increased. This extra heat can be utilized to help maintain body temperature during the winter. Alfalfa is therefore more cost effective for pigs fed during winter than summer.

ALFALFA IN SWINE DIETS

Can alfalfa be considered in the formulation of swine diets?

Yes. Gestation diets containing from 25% to 66% good quality alfalfa hay have supported good reproductive performance. To facilitate proper incorporation of the hay in the diet we recommend that the hay be ground using a 1/4" to 3/8" screen. High levels of alfalfa hay can be fed most accurately when mixed with the other diet ingredients and fed in pelleted form. However, the cost of pelleting may not be justified. Therefore, if diets contain more than 66% alfalfa hay, feed the daily level of ground alfalfa hay plus 1 lb/hd/day of a corn-vitamin-mineral mixture. In this way, the proper level of supplemental vitamins and minerals will be mixed with ground corn, which serves as a carrier. The alfalfa hay is fed separately from the corn-vitamin-mineral mixture. If diets contain 66% alfalfa hay or less, the hay can be fed as a ground mixture with the other needed diet ingredients.

Alfalfa may be included in growing-finishing swine diets at the rate of 2.5% of the total diet. This level serves as a safety factor to help ensure the presence of certain vitamins and minerals. Higher levels of alfalfa in the growing-finish-

Table 5. Relative feeding value of energy sources

Ingredient (as-fed)	Feeding value relative to corn %[a]	Maximum recommended percent of complete diet[b]				Remarks
		Starter	Grower-finisher	Gestation	Lactation	
Alfalfa meal, dehy	75 to 85	0	5	25	10	Low energy, high in B vitamins
Alfalfa hay, early bloom	75 to 85	10	10	66	10	Low energy, high in B vitamins
Bakery waste, dehy	95 to 110	20	40	40	40	High energy, about 13% fat
Barley (48 lb/bu)	90 to 100	25	85	90	80	Low lysine
Beet pulp	70 to 80	0	0	10	10	Bulky, high fiber, laxative
Corn and cob meal	80 to 90	0	0	70	10	Bulky, low energy
Corn distillers grains w/solubles, dehy	115 to 130	5	15	40	10	B vitamin source, low lysine
Corn gluten feed	75 to 85	5	10	90	10	Dry pelleted source preferred
Corn, high lysine	100 to 105	60	90	90	90	Test lysine level
Corn silage (25-30% DM)	20 to 30	0	0	90	0	Bulky, low energy, for sows only
Fat (stabilized)	185 to 210	5	5	5	5	High energy, reduces dust
Hominy feed	100 to 105	0	60	60	60	Subject to rancidity
Millet, proso	90 to 95	40	75	90	40	Low lysine
Milo, grain sorghum	95 to 97	60	85	90	80	Low lysine
Molasses (77% DM)	55 to 65	5	5	5	5	Energy source, used in pelleting
Oats (36 lb/bu)	85 to 95	15	20	70	10	May reduce gut edema and nutritional scours
Oats, high protein	90 to 100	20	50	70	10	May reduce gut edema and nutritional scours
Oat groats	110 to 115	20	85	90	90	Palatable, but expensive
Potatoes (22% DM)	20 to 25	0	25	80	0	Should be cooked, low protein
Rye	85 to 90	0	25	20	20	Watch for ergot toxicity
Triticale	90 to 95	20	75	90	40	Watch for ergot toxicity
Wheat bran	60 to 65	0	0	30	10	Bulky, high fiber, laxative
Wheat, hard	100 to 105	35	85	40	40	Low lysine, avoid fine grinding
Wheat middlings	110 to 125	5	15	30	10	Partial grain substitute

[a]Corn = 100%; Values apply when ingredients fed at no more than the maximum recommended % of complete diet; ranges presented to compensate for quality variation.
[b]Higher levels may be fed, although performance may decrease.

ing diet depend on the price of the supplemental protein source, energy source, and the performance desired. Due to its fiber content, alfalfa has a greater feeding value in a cool environment than in a warm environment. Recent Nebraska research has indicated that alfalfa hay can replace oats in weaning diets. Further details about feeding alfalfa are available in NebGuide G74-117, "Alfalfa in Swine Diets."

Table 6. Conversion factors for high moisture grain

If corn or milo contains this moisture	Increase amount of grain in diet by this much
%	
15	0
17	2.4
19	4.9
21	7.6
23	10.4
25	13.3
27	16.4

PROTEIN AND AMINO ACIDS

Swine of all ages and stages of the life cycle require protein and amino acids to enable them to grow, reproduce, and lactate. General recommendations for the level of protein and amino acids in the diet for major classes of swine are given in Tables 1 and 2. Daily amino acid and protein intake for gilts and sows during gestation are shown in Table 3.

What is the relationship between amino acids and protein?

Amino acids are the structural units of protein. During digestion, proteins are broken down into amino acids. The amino acids are then absorbed into the body and are used to build new proteins, such as muscle. Thus it is really amino acids, not protein, that pigs require.

Diets that are "balanced" with respect to amino acids contain a desirable level and ratio of the 10 essential amino acids required by swine for maintenance, growth, and reproduction. The proteins of corn and other cereal grains are deficient in certain essential amino acids. Protein supple-

ments are used to correct the amino acid deficiencies in grains. For example, a combination of grain and soybean meal provides a fairly good balance of amino acids.

The recommended allowances for the three most critical amino acids (lysine, tryptophan, and threonine) are given in Tables 1 and 2. Lysine is the first limiting (most critical) amino acid in a corn-soybean meal and milo-soybean meal diet. Generally, when using conventional feedstuffs, if the lysine allowance is met the other amino acids will be adequate also. *Therefore, checking the lysine level is usually a good measure of the overall amino acid adequacy of a swine diet.*

If amino acids are important, why do we bother to list PROTEIN allowances?

Protein allowances are still widely used in the swine industry, and commercial feeds and supplements by law must have their protein contents listed on the feed tag. The protein allowances quoted in this publication refer primarily to corn-soybean meal or milo-soybean meal diets. In these types of diets, the protein level that is listed will meet the amino acid requirements of pigs of the intended weight and stage of life cycle. If ingredients with similar amino acid levels and balance are used, specifying the protein level is satisfactory. However, we recommend that the diet be formulated on an amino acid basis when using feedstuffs with markedly different amino acid patterns. Unfortunately, it is much more expensive to analyze for amino acids than protein.

Can soybean meal be fed as the only source of supplemental protein?

Research at many locations, including the University of Nebraska, has shown that soybean meal is an excellent protein supplement for swine. For sows and growing-finishing pigs, soybean meal provides an adequate balance of amino acids, and is equal to any other source of protein or combination of proteins. For orphan pigs and weanling pigs, we recommend that additional, highly digestible protein supplements such as milk products and fish meal be included (Table 10).

If soybean meal contains an adequate balance of amino acids, why do many commercial supplements and feeds contain or list on the feed tag a variety of protein sources?

When feed manufacturers register feed, they list all feedstuffs that they may want to include. Then, depending on the price and limits of good nutrition, they substitute less expensive protein sources for higher priced ones. Thus, feed manufactures are able to pass on these economic advantages to pork producers.

Can cooked whole soybeans be used as a protein source?

Cooking raw soybeans with extruders or roasters produces an acceptable source of protein for swine. When raw soybeans are heated adequately (e.g., at 250°F for 2.5 to 3.5 minutes in a roaster) the anti-growth factors present in raw soybeans are destroyed. After the whole beans have been cooked and cooled they should be ground through a 1/8" to 1/4" screen and mixed with the other diet ingredients. Because the protein content of whole soybeans may vary, a protein analysis is recommended before formulating the diet. A greater quantity (25% to 30% more by weight) of whole soybeans will be required to meet a specified diet protein or lysine level than would be needed with 44% soybean meal as whole soybeans contain less protein than soybean meal. Details on feeding cooked soybeans to pigs are available in Neb-Guide G90-994, "Full Fat Soybeans for Swine."

Can raw soybeans be used as a protein source?

Yes, but only for mature swine. The anti-growth factors present in raw soybeans make them unacceptable as a protein source for nursery and growing-finishing pigs, but they cause few problems with sows. Gestation diets using raw soybeans to replace soybean meal have supported acceptable performance. Experiments using raw soybeans as the sole source of supplemental protein in lactation diets have indicated reductions in sow feed intake, greater sow weight losses, and reductions in pig weaning weights. If raw soybeans are fed, they should be incorporated as a part of a complete diet in the same way as cooked soybeans.

The storage requirements of raw, unground soybeans are similar to those of corn. Rancidity can be a problem in the storage of raw, ground soybeans. We recommend that soybeans be ground and diets mixed at frequent intervals to prevent rancidity problems. If raw ground soybeans are stored during warm weather for longer than one week, we recommend that an antioxidant be added. Common antioxidants include BHT and ethoxyquin. Follow the manufacturer's recommendations on inclusion rates. Details on feeding raw soybeans to gestating sows are available in NebGuide G90-994, "Full-Fat Soybeans for Swine."

Can meat and bone meal and meat meal be fed as the only source of supplemental protein?

Research at the University of Nebraska and elsewhere has shown that high levels of meat and bone meal in the diet reduces the growth rate of finishing swine. Our general recommendation is that meat and bone meal and/or meat meal should not exceed 5% of the diet or 25% of the protein supplement. The primary reason for limiting the amount of meat and bone meal and meat meal in the diet is to avoid the excess levels of minerals (calcium and phosphorus) that occur when high levels of these products are included. In addition, the heating that occurs in the processing of meat and bone meal and meat meal can damage the proteins, and this also limits their use. Obviously, economics will play a role in deciding how much of these protein sources to feed. There is no evidence that the inclusion of meat and bone meal and/or meat meal in the diet reduces the incidence of tail biting among pigs.

Are there differences in uniformity of product between protein sources?

Animal protein products vary more in composition and quality than plant protein sources. Meat and bone meal and meat meal are by-products of the meat packing industry, and their composition depends on the animals slaughtered. Methods of processing also influence the quality of animal proteins, and unless properly processed, they may be contaminated with salmonella.

Plant proteins, on the other hand, are more uniform because they are made from a single source. Also, methods of processing plant proteins have become standardized, and the same kind of product can be produced year round. However, improper processing can occur in the production of soybean meal and other plant proteins. Also, calcium carbonate (limestone) can be added to plant protein products (up to 0.5%) to prevent them from becoming lumpy and to maintain flowability. Added calcium is no problem as long as one knows how much is in the protein source.

Is it economical to supplement swine diets with crystalline amino acids?

Sometimes yes; sometimes no. It depends on the price of the crystalline amino acids and the prices of grain and supplemental protein sources. The use of crystalline lysine is often economically sound. Crystalline tryptophan and threonine can be purchased in feed-grade forms, but they are rather expensive. Crystalline methionine is widely used in the poultry industry, but supplementing practical swine diets with methionine does not improve performance and often depresses performance.

When using crystalline lysine, we recommend that no more than 100 lb of soybean meal be replaced per ton of diet. A useful rule of thumb is that 3 lb of L-lysine•HCl (containing 78% pure lysine) plus 97 lb of corn contribute the same amount of *available* lysine as 100 lb of 44% protein soybean meal. If 48% protein soybean meal is being replaced, a little more crystalline lysine is needed (3.2 lb of L-lysine•HCl plus 96.8 lb of corn). Further information is available in NebGuide G74-128, "Crystalline Lysine in Swine Diets."

What is meant by available amino acids?

A certain proportion of each of the amino acids in a feedstuff is not biologically available to swine. This is because feedstuffs are not completely digested and because amino acids occasionally occur in forms that pigs are not able to use. There can be quite large differences in availability between feedstuffs. In the most precise type of diet formulation, adjustments are made for these differences. The amino acid availability can be reduced substantially if a feedstuff is overheated during its processing. Differences in availability are of little consequence and can be ignored when formulating diets that consist primarily of corn or milo and soybean meal (with no by-product ingredients).

Is it possible to feed too much protein?

Feeding excessive amounts of protein is wasteful and uneconomical, but high protein levels generally cause few problems for swine. Sows and growing-finishing pigs are able to tolerate very high protein levels with no ill effects except occasionally a mild diarrhea. Increased water consumption will also occur. High protein levels do not lead to a poisoned condition. There is concern that high protein (primarily soybean meal) diets at weaning may precipitate diarrhea. This effect has not been observed in experiments at the University of Nebraska, and when weanling diarrhea occurs there are usually other environmental factors involved in addition to high protein diets. If necessary, the amount of soybean meal in weanling pig diets can be reduced by replacing it with milk products or with corn and crystalline lysine.

What is the most economical protein level to feed to growing-finishing pigs when corn or milo and soybean meal prices vary?

Figures 1 and 2[1] can be used to determine the most economical protein levels to feed to growing-finishing pigs based on corn and soybean meal prices. For example, in Figure 1 if corn is $2 a bushel, and soybean meal is $175 per ton, we arrive at point (a) shown by the dotted lines. This point is in the 16% area of the chart. Thus, at these corn and soybean meal prices, a 16% protein diet would take pigs from 50 to 120 lb at a lower cost than would a 14 or 18% protein diet. Figure 2 applies to pigs weighing 120 lb to market weight.

Producers using milo instead of corn can use the charts by converting the price of milo to a bushel basis. Also producers are advised to choose their preferred type of soybean meal (44% or dehulled) and proceed to use the charts.

If the point arrived at is on the boundary line, the higher protein diet may be chosen because the pigs would probably reach market weight at the same time or sooner for the same cost. Other alternatives are:

1. Feed the higher protein diet while the pigs are in the lower part of the weight range, and then start feeding the lower protein diet when they reach the upper part of the weight range. *Gilts intended for breeding should not be fed diets containing less than 14% protein.*

2. Consider feeding a diet with a protein level which is between the two levels of protein on each side of the boundary line.

3. If a new group of pigs is not waiting for the facility and if the producer has extra time to care for the pigs, the lower protein level could be chosen. *The figures consider the added cost of slower gaining pigs resulting from the lower protein diets.*

---

[1]Bitney, Larry L. and Duane E. Reese. 1988. Choosing economic levels of protein for pigs. NE Swine Rpt. 88-219.

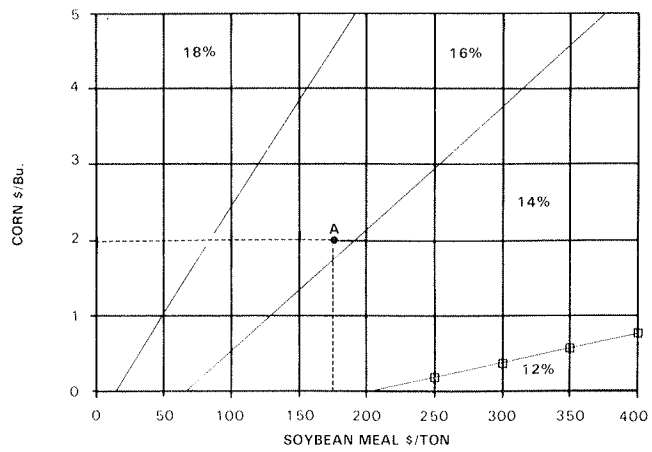


Figure 1. Suggested protein levels for growing-finishing diets, based on corn and soybean prices, for pigs from 50-120 lb.

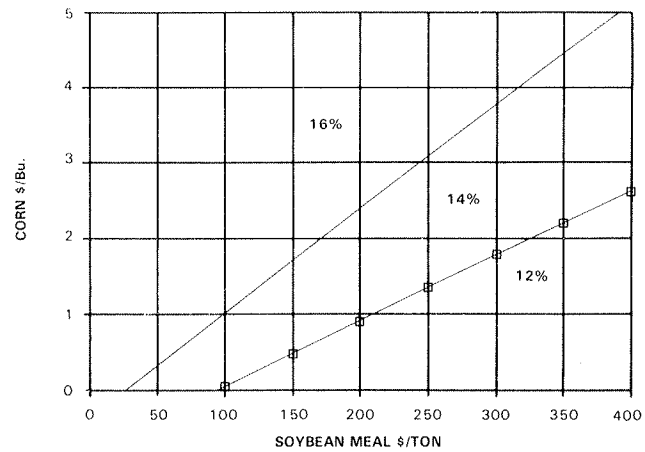


Figure 2. Suggested protein levels for growing-finishing diets, based on corn and soybean meal prices, for pigs from 120 lb to market weight.

MINERALS

What minerals and what level of each should be included in diets for swine?

Minerals and levels to be included in swine diets are shown in Tables 1 and 2. Daily mineral intake for gilts and sows during gestation are given in Table 3. A convenient method of supplying trace mineral additions for all classes of swine using premixes is shown in Table 4.

How should minerals be fed—as part of a complete diet, part of a protein supplement, or offered free choice?

If you wish to make sure that pigs meet their daily requirements for minerals, and not exceed them, feed minerals in a complete mixed diet.

What happens if high levels of minerals are fed?

Most commercial protein supplements and base mixes are fortified with minerals to meet the pig's needs when the supplement or base mix is combined with grain according to the manufacturer's recommendation. Minerals should not be added haphazardly. If leg abnormalities, a reduction in performance, or other problems develop, all management components including diets, genetic defects, disease, type of floor, and floor surface should be analyzed before changes or additions in the mineral content are made. *Warning! Adding extra minerals without reason may cause more harm than good.*

What are the major sources of minerals for swine?

Major sources of the minerals commonly added to swine diets are listed in Table 7.

What levels of calcium and phosphorus should be fed?

The optimum levels of calcium and phosphorus to feed are shown in Tables 1 and 2. Regardless of level, we recommend that the ratio of calcium to phosphorus be about 1.3 parts total calcium to 1 part total phosphorus. Calcium levels in the diet should not exceed 1.25% of the diet as a reduction in performance may occur.

When should replacement gilts begin receiving "Breeding Herd" levels of minerals?

A good time to start replacement gilts on increased levels of mineral fortification is when they are separated from market hogs, preferably at 200 lb. Calcium and phosphorus levels in finishing diets support excellent rates of gain, but are not sufficient to build the skeletal structure and mineral reserves needed by sows to reduce "downer sow" problems. Gilts selected as replacements should be restricted in energy intake at this time, but receive enough feed to continue to grow (5 to 7 lb/hd/day of a corn/milo-soybean meal diet). If gilts are switched to the higher levels of mineral intake (16 g Ca and 14.5 g P/day) at 200 lb or 70 days before breeding, they will have sufficient time to develop an adequate skeleton to support themselves during gestation and lactation.

What is meant by available phosphorus?

The allowances for phosphorus shown in Tables 1 and 2 are for total phosphorus. Ideally, allowances should be listed as available phosphorus or the amount the animal can actually use. Research has determined the available phosphorus in several feedstuffs, but values for many others are lacking. Laboratory analysis for total phosphorus in a feed is reliable and is relatively inexpensive. As a general guide, 60 to 70% of the total phosphorus from all the combined phosphorus sources in a corn/milo-soybean meal diet will be available phosphorus. Our allowances for total phosphorus have taken this into consideration to assure that there are adequate levels of available phosphorus in the diets for all classes of swine.

What is parakeratosis and what is its relation to zinc?

A deficiency of zinc in the diet will cause a nutritional

Table 7. Sources of minerals for swine[a]

Mineral	*Source*	*Mineral %*		*Mineral Availability*
		Ca%	P%	
Calcium and phosphorus	Ground limestone (calcium carbonate)	38	0	Inexpensive, Excellent
	Dicalcium phosphate	20 to 24	18.5	Excellent
	Monocalcium phosphate	22	21	Excellent
	Sodium tripolyphosphate or monosodium phosphate	0	21.8	Excellent
	Defluorinated phosphate	32	18	Excellent
	Steamed bone meal	30	13	Good to excellent
	Low fluorine rock phosphate	30 to 36	14	Fair
	Soft rock phosphate	17 to 20	9	Poor
Iron	Ferrous sulfate (7 H_2O)		21.4	Good
	Ferrous sulfate (1 H_2O)		32.3	Good
	Ferric chloride		20.7	Fair
	Ferrous carbonate		39.6	Usually poor
	Ferrous oxide		75.4	Limited
Copper	Cupric carbonate		55.0	good
	Cupric oxide		79.1	poor
	Cupric sulfate		25.4	good
Manganese	Manganous carbonate		46.4	All are good
	Manganous oxide		76.7	
	Manganous sulfate		32.5	
Zinc	Zinc carbonate		51.6	All are good
	Zinc oxide		78.0	
	Zinc sulfate		22.3	
Iodine	Calcium iodate		65.1	All are good
	Potassium iodide		76.4	
	Cuprous iodide		66.6	
Selenium	Sodium selenite		44.7	All are good
	Sodium selenate		41.8	

[a]Analysis may vary. Check with supplier for typical analyses for mineral products.

disease called parakeratosis. Also, the combination of a high level of calcium (over 0.9%) and a zinc level under 50 ppm may result in parakeratosis. The condition can be identified by the animal's mangy appearance. The skin becomes dry and scaly, particularly behind the ears, on the hind legs, tail, and under region of the body. The condition can be prevented by keeping the level of calcium below 0.9% and by adding 60 to 100 ppm of zinc per ton of complete diet.

Should selenium be supplemented in Nebraska swine diets?

Selenium deficiency and toxicity are regional problems within the United States. Some feedstuffs grown in areas of northeast Nebraska have a history of being high in selenium content. In other regions of the state feedstuffs contain too little selenium to meet the animal's requirement. Because symptoms of selenium deficiency, such as mulberry heart and white muscle disease continue to be diagnosed in Nebraska, we recommend that as a safety factor selenium be added to all swine diets as shown in Tables 1 and 2. Selenium is not toxic to pigs unless dietary levels exceed 5 ppm.

What are chelated or complexed trace minerals?

Generally, trace minerals are added to swine diets as inorganic salts, such as copper sulfate, iron sulfate, zinc oxide, etc. Recently, chelated forms of some trace elements have become available. Chelated forms of trace elements are bound to a compound such as a protein or individual amino acid, for example, zinc-methionine, and iron-lysine. It has been suggested that chelated forms of trace minerals are more available for swine than inorganic salts. Research indicates that the availability of trace minerals from chelated forms is 0 to 15% higher than from inorganic salts. The choice of which source to use should be based on cost per unit of available trace element and compatibility with other trace mineral sources.

How important are dietary electrolytes?

Electrolytes (minerals) are essential to maintaining water balance in pigs. Electrolyte balance is particularly important for young pigs because they are more susceptible to stress and diarrhea, conditions that can cause severe loss of body

water. The major electrolytes are sodium, potassium, magnesium, and calcium, but sodium and potassium predominate. University of Nebraska research indicates no benefit to including electrolytes in swine diets at levels exceeding those shown in Tables 1 and 2.

VITAMINS

Certain vitamins need to be added routinely to swine diets. The recommended vitamin additions per ton of complete diet are shown in Tables 1 and 2. Daily vitamin intakes from additions to diets for gilts and sows during gestation are shown in Table 3. A convenient method of supplying vitamin additions for all classes of swine using premixes is shown in Table 4.

Vitamin potency may decrease with extended storage and can be completely destroyed when in contact with minerals over a prolonged period of time. If the vitamins and minerals are purchased in one premix, they should be used within 30 days of purchase for optimum vitamin potency.

Vitamin-mineral premixes should be stored in a cool, dry, and dark place. Stabilizing agents increase the shelf-life of vitamin-mineral premix combinations.

Should vitamin E be added to swine diets?

Vitamin E (along with selenium) prevents the accumulation of toxic compounds in the body before they damage tissues. Since feedstuffs vary in their vitamin E content and the stability of natural vitamin E is poor in the presence of trace minerals, we recommend that vitamin E be added to swine diets as shown in Tables 1 and 2. Leafy alfalfa hay is an excellent source of natural vitamin E.

Why is choline added to swine diets?

Research indicates that supplementing choline at a level of 500 grams per ton of complete diet during gestation increases the number of live pigs born and weaned. Choline supplementation is recommended at 60 to 70 grams per ton of a complete growing-finishing swine diet. Although the requirement for this vitamin has not been defined, we recommend its addition for prevention of a possible choline deficiency in the growing-finishing pig. Choline has not corrected the "shaker" and spraddle-legged conditions at birth in either university or field tests. Evidence indicates that the "shaker" condition may be caused by a virus or combination of viruses. Spraddle-legged pigs are often associated with slick floors in the farrowing crate.

Should swine diets be supplemented with biotin?

There is no need to supplement diets for growing-finishing swine with biotin. Recent research suggests that number of pigs farrowed and survival rate are improved when biotin is added to diets for gestating and lactating sows. Biotin is somewhat expensive and its cost must be balanced against the benefits received. Dehydrated alfalfa meal, soybean meal, dried whey, dried brewer's yeast, and other distiller products are good sources of biotin.

Are high levels of vitamins toxic to swine?

Over fortification of swine diets with vitamins A and D can result in decreased gain, feed conversion, and death. The most serious problems have been with Vitamin D. Thus, we recommend that swine diets should never exceed 40,000,000 IU of vitamin D per ton of feed (about 80 times the recommended level).

What is the approximate cost of adding premixes and base mixes to corn-soybean meal diets?

As a guide, a premix containing trace minerals and vitamins will cost $4 to $6 to fortify a ton of complete feed. A base mix containing both vitamins and trace minerals, including calcium, phosphorus, and salt, may cost $10 to $25 to fortify a ton of complete feed.

FEED ADDITIVES

What antibiotics should be fed and at what levels?

The response to specific antibiotics varies considerably due to age of pig, disease level, kind, and level of antibiotic, season of year, and other environmental factors. Rotation of antibiotics and use of approved mixtures seem to be more effective than antibiotics used singly or continually. Rotation may be annually or with changes in protein levels. *Antibiotics should not be used to replace good management.*

What are the recommended levels of antibiotics per ton of complete diet?

Level of usage depends upon the type of antibiotic selected. Thus, when using antibiotics comply with the manufacturer's directions.

Is copper sulfate an effective growth promoting additive?

Copper has been established as a required nutrient for normal pig growth. It is routinely added to swine diets at 6 to 10 g/ton to meet the pig's nutritional need. Research has demonstrated a growth promoting effect in nursery and growing-finishing diets from the addition of 115 to 230 g/ton (125 to 250 ppm) copper (1 to 2 pounds copper sulfate per ton), but the Food and Drug Administration currently does not allow a feed manufacturer to include this claim on the feed tag. The incorporation of higher levels (over 230 g/ton or 250 ppm) may cause toxicity problems. More details on the use of copper sulfate are discussed in the 1982 Nebraska Swine Report.

Should antibiotics be fed to the breeding herd?

Herds that have experienced problems with conception rates and numbers of pigs born and weaned have often been helped by the addition of antibiotics to sow diets. Antibiotics are most effective if fed for 2 weeks before and after breeding and/or from 1 week before farrowing to weaning. In in-

stances where reproductive problems prevail in a herd, a specific diagnosis should be made in consultation with a veterinarian or swine specialist.

What are the withdrawal periods for feed additives?

Certain feed additives must be withdrawn from the feed before slaughter at varying intervals to ensure residue-free carcasses. Withdrawal periods for many feed additives are listed in Table 8. The availability and withdrawal time of feed additives can change. The law requires the withdrawal time to be stated on all feed tags.

Table 8. Withdrawal time for additives in swine feeds[a]

Additive	*Withdrawal time before slaughter*
Albac[50]-(Bacitracin Zinc)	None
Apralan (Apramycin)	28 days
Atgard (Dichlorvos)	None
Aureomycin (Chlortetracycline)	None
Aureo SP 250 (Chlortetracycline/Sulfamethazine/Penicillin)	15 days
Baciterm (Bacitracin Zinc)	None
Banminth (Pyantel Tartrate)	24 hours
BMD (Bacitracin methylene dislicylate)	None
CLTC (Chlortetracycline)	None
Colmix (E. coli bacterin)	21 days
CSP 250 (Chlortetracycline/Sulfathiazole/Penicillin)	7 days
CTC (Chlortetracycline)	None
Denagard (Tiamulin)	2 days[b]
Fermycin (Chlortetracycline)	None
Flavomycin (Bambermycins)	None
Hygromix (Hygromycin)	15 days
Lincomix (Lincomycin)	6 days[c]
Mecadox (Carbadox)	10 weeks
NEO/OXTC (Neomycin/Oxytetracycline)	d
Neo-terramycin (Neomycin/Oxytetracycline)	d
OXTC (Oxytetracycline)	None[e]
PfiChlor (Chlortetracycline)	None
Pencillin P-100 (Procaine Penicillin)	None
Piperazine (Piperazine)	None
Pro-Gen (Arsanilic Acid)	5 days
Rabon Oral Larvicide	None
Roxarsone	5 days
Safe-Guard (Fenbendazole)	None
Stafac (Virginiamycin)	None
TBZ (Thiabendazole)	30 days
Terramycin (Oxytetracycline)	None[e]
Tramisol (Levamisole hydrochloride)	72 hours
Tylan (Tylosin)	None
Tylan-sulfa (Tylosin/Sulfamethazine)	15 days
3-Nitro (3-nitro-4-hydroxyphenylarsonic acid)	5 days

[a]Feed Additive Compendium, 1991.
[b]Required only for 35 g/ton level.
[c]Required only for 100 or 200 g/ton level.
[d]Withdraw from feed 10 days before slaughter when neomycin base level is 140 g/ton and 5 days before slaughter when neomycin base level is below 140 g/ton.
[e]At 500 g/ton use level withdraw 5 days before slaughter.

What are probiotics or bacterial cultures?

Probiotics play a different role than antibiotics in the digestive tract. It has been theorized that probiotics increase the population of desirable microorganisms instead of killing or inhibiting undesirable organisms. The most common microorganisms included in probiotic products are Lactobacillus species which are normal inhabitants of the digestive tract of healthy animals. These bacteria may help remove waste products and inhibit the growth of certain undesirable bacteria.

Research has shown that stress conditions, such as weaning, diet, environmental changes, or poor sanitation can alter the microflora of the digestive tract. Probiotics may be advantageous, especially for early weaned pigs, to combat these stresses. However, most research does not show any consistently positive response in pigs fed probiotics.

What are organic acids?

There are a number of organic acid compounds available for use in swine feeds. Fumaric and citric acid have been shown to improve gain and feed efficiency by about 5% on the average when added to young pig diets. Pigs fed simple corn-soybean meal diets benefit more from organic acid supplementation than pigs fed more complex diets. Also, the younger the pig the greater the response to these organic acids. It is theorized that organic acids lower the gut pH and that this may aid protein digestion. Optimum inclusion rates and the economic benefits of fumaric and citric acids are currently being debated. Adding fumaric or citric acid to a starter diet generally increases the cost of one ton of feed by $25 to $50.

Other organic acids, such as propionic acid and sorbic acid are added to swine diets to prevent the development of mold. Research has shown that these inhibitors will prevent high moisture feed from becoming moldy for 10 days or longer. The mold-inhibitor organic acids are particularly useful where grains being fed are higher than normal in moisture.

WATER

Water is one of the most important components of a feeding program for swine. It is vital for all body functions. Water accounts for as much as 80% of body weight of pigs at birth and declines to approximately 50% in market swine.

How much water does a pig consume?

Refer to Table 9 for estimated water needs of various classes of swine. In general, a pig will consume 1/4 to 1/3 gal of water for every pound of dry feed. Water intake in gestation is related to body size. Water intake in lactation increases with increasing litter sizes. Water intake will increase in warm weather or if excessive amounts of salt or protein are included in the diet.

Table 9. Water consumption by pigs

Class	*Water Consumption gal/hd/day*
Gestating sows	2 to 3
Lactating sows	4 to 5
Weaned pig (15 to 50 lb)	1/2 to 1
Growing pig (50 to 120 lb)	1
Finishing pig (120 lb to mkt)	1.5 to 2

What about water quality?

Water that meets standards for human consumption is ideal. Problems with water quality on Nebraska swine farms occur primarily from bacterial contamination either in the well or water lines. Water containing elevated levels of sulfates will cause a slight to moderate diarrhea with a characteristic black color in the feces. Water containing up to 3000 ppm sulfate or 5000 ppm total dissolved solids can be consumed safely by swine.

While not as clearly defined, nitrate-nitrogen is considered to be no problem at levels less than 50 ppm NO_3-N (220 ppm NO_3) and generally is safe at levels under 100 ppm NO_3-N (440 NO_3).

METHODS OF FEEDING

The most common method of feeding swine is to use a complete diet. Another method is grain and supplement free choice. We recommend the use of a complete diet because it provides better control of protein, mineral, and vitamin intakes. Over or under consumption of protein supplement is eliminated. Each pig gets a balanced diet with every unit of feed.

What influence does fineness of grind have on pig performance?

All feedstuffs should be ground for swine. However the optimum fineness of grind depends on several factors. Varying results have been reported due to (1) age of the pig, (2) method of processing, (3) type of grain, and (4) amount of feed wastage. From a practical standpoint it appears that a medium grind using a 1/4" to 3/8" screen will give the best overall results. Grinding finer than this tends to increase feed wastage and may increase the incidence of gastric ulcers. Grinder speed, condition, and maintenance will affect the particle size and uniformity of the finished product.

Should swine diets be pelleted?

The use of a complete pelleted diet with corn or milo as the grain source can be expected to improve feed efficiency by approximately 5% to 8% compared to the same diet in meal form. Pelleting barley and oat-based diets improves feed efficiency by 7% to 10%. In general, the more expensive a diet is, the more economical it is to offer the diet to pigs as a pellet.

Should "wet" feeders be used?

Several manufacturers have feeders that allow pigs to wet their feed with water before consumption. Feed conversion has been equal to and in some instances slightly better for pigs consuming feed from these feeders compared to conventional "dry" feeders. Proper feeder adjustment still has major influence in affecting feed efficiency. Wet feeders may require more intensive management than dry feeders. Also, they should be placed close to the dunging area in the pen to avoid wetting the sleeping area.

Will "floor" or "drop" feeding improve feed conversion?

Growing-finishing pigs that are limit-fed to a level of 90% to 95% of the amount that they would consume free choice can be expected to have an increased feed efficiency of about 3% to 5%. They will also have decreased backfat and may have a slightly slower rate of gain, depending on the exact degree of feed restriction. More severe restrictions than this will result in a marked decrease in rate of gain.

Should gilts and sows be limit- or full-fed?

A "limit-feeding" program is recommended for gilts and sows during pre-breeding and gestation. However, a "limit-feeding" program limits only the energy intake and not the other nutrients, such as protein, amino acids, minerals, and vitamins. The energy is limited to keep sows from becoming too fat. Excessive feeding of gilts and sows leads to increased feed cost and interferes with reproduction. Sows that are over fed immediately after breeding and throughout gestation often suffer high embryonic mortality, thus producing smaller litters than sows fed the proper amounts. Sows that have become too fat have a tendency to have more farrowing difficulties, crush more pigs and eat poorly during lactation. This is especially true during the summer when sows are subject to heat stress.

Diets for sows must meet their daily requirements for all essential nutrients. During normal (spring/fall) weather conditions about 6,000 kcal of metabolizable energy (ME) per head per day (4 to 4.5 lb of a corn/milo-soybean diet) will keep sows in "good" condition. However, energy intake will need to be decreased or increased depending upon the condition of the sow and as environmental conditions change. Sows housed outside during the winter should receive about 7,500 kcal of ME/day (5 to 5.5 lb of a corn/milo-soybean meal diet).

When daily feed intake is adjusted it is important that the concentration of protein, amino acids, minerals, and vitamins in the diet be adjusted accordingly. For example, the daily allowance for total and available phosphorus during gestation is 14.5 and 10 g/day, respectively. At a feeding rate of 5 lb/day, the diet should contain .68% phosphorus to meet the daily phosphorus allowance (Table 12, diet #2). If feed

intake is 4 lb/day, the amount of phosphorus in the diet should be .8% to meet the daily phosphorus allowance (Table 12, diet #1). Daily nutrient allowances for gilts and sows during gestation are given in Table 3.

The success of limit-feeding of sows and gilts depends upon controlling the intake of each animal. Care must be taken to see that each gets her share. Individual sow feeding stalls are effective devices for controlling boss sows. Another practical method for limiting the feed intake of sows during pregnancy is interval feeding. With interval feeding sows are allowed to consume two or three days worth of feed in one day and then wait two or three days before being provided access to feed again. Adjustments in daily intake are made by altering either the time on the feeder (2 to 12 hours) or time off the feeder (2 or 3 days). Research results have shown that 2 hours out of 72 is an adequate feeding time. With time on the feeders restricted, one feeder hole per sow is needed. *Every third day feeding of gilts is not recommended.*

Sows should be full-fed during lactation to obtain maximum milk production. To assure continued optimum reproductive performance sows should consume at least 10 to 11 lb of a corn/milo-soybean meal diet daily during lactation. Hand feeding sows to appetite the first 2 to 3 days after farrowing may aid in the detection of lactational problems. Sows going off feed and constipation are two early symptoms of lactational problems. Further details on feeding management of the breeding herd are available in the Nebraska Swine Reproductive Management publication (EC89-212).

FEED QUALITY

Good quality feed is an important component of a sound nutritional program. Careful attention must be given to feed quality if a pork producer chooses to mix feed on the farm. Errors in formulation and misuse of feed mixing equipment can be costly.

How can producers make good quality feed on the farm?

1. Weigh feed ingredients. Weighing is more accurate than measuring by volume. Furthermore, using scales allows producers to keep more accurate feed records. If feed is measured by volume it is important that the calibration on *each* diet be checked at least once per month.

2. Premix certain ingredients. Some ingredients such as feed additives and vitamin and trace mineral mixes, represent less than 2% of the diet. Ingredients representing such small quantities are difficult to mix adequately into the complete diet unless, for example, they are premixed with ground corn or soybean meal before being added to the mixer. Generally when using vertical screw mixers, ingredients should be premixed if they represent less than 2% of the diet (40 lb/ton). For horizontal mixers ingredients representing less than 1% (20 lb/ton) of the diet should be premixed prior to being added to the mixer. Concrete mixers work well to premix ingredients.

3. Sequence ingredients. Add at least half of the grain or all of the supplemental protein to the mixer before adding other ingredients.

4. Allow adequate mixing times. Turning the mixer off too soon after the last ingredient is added results in uneven mixing. As a rule of thumb, a single screw vertical mixer should run for 10 to 15 minutes and a horizontal mixer should run for 5 minutes after the last ingredient is added to the mixer. Longer mixing times do not cause feed quality problems.

Further information on good feed manufacturing practices are presented in NebGuide G88-892, "Mixing Quality Swine Feed."

What nutrients should feed samples be analyzed for?

Feed ingredients and finished feeds sometimes do not contain the level of nutrients expected. Obtaining representative samples and submitting them to a laboratory for analysis can help avoid pitfalls in feed quality. Generally a crude protein analysis on grain and soybean meal is satisfactory. Finished feeds could be analyzed for crude protein, calcium, and phosphorus to check feed quality. Be sure to compare analyzed and expected nutrient values when interpreting laboratory results. Expected nutrient values for many feed ingredients are shown in Table 14. Calculate expected nutrient values for diets from the formula. *Major changes in a nutritional program should not be made based on test results from one feed sample.*

SUGGESTED DIETS

Suggested diets for all classes of swine are presented in Tables 10, 11, 12, and 13. Ingredient analysis values in Table 14 were used to formulate the diets. In general the diets promote least cost gain. Since ingredient price and availability are not constant, the use of alternate feedstuffs should be considered to minimize cost of gain. Refer to Table 5 for guidelines when using alternate energy sources.

Other possible ingredient substitutions are:

1. High protein (48%) soybean meal can replace 44% soybean meal by substituting 93.5 lb of 48% soybean meal and 6.5 lb of corn or milo for each 100 lb of 44% soybean meal.

2. Iodized salt and trace minerals can be replaced by trace mineralized salt.

Young Pig Diets

Orphan pig diets. There is no adequate replacement for sow's colostrum. If a newborn pig does not receive colostrum within 4 to 6 hours of birth, chances of survival are reduced. In cases where colostrum is limiting, producers are encouraged to place pigs with another sow that has just farrowed (foster sow) or to dose pigs with warm sow or cow colostrum via a stomach tube. An orphan pig should remain with the foster sow after receiving colostrum. If this is not possible, a milk replacer can be used. Several excellent

commercial milk replacers are available. An example of a homemade milk replacer is shown below:

1 quart whole cow's milk
1 pint half-and-half
1 raw egg
oral, water soluble antibiotic.

Feed about 1/4 cup/pig of this mixture every 2 to 3 hours in a clean, shallow pan. This makes a total feeding of 2 to 3 cups/pig/day. Pigs should not be allowed to over-consume. If possible orphan pigs should be fed a 20% to 22% crude protein diet (Starter 1, Table 10) from 5 to 7 days of age until they weigh 15 lb. At this time the pigs can be switched to an 18% to 20% diet (Starter 2, Table 10).

Creep and starter diets. Creep feed is recommended beginning at about 2 weeks of age for pigs weaned at 3 1/2 to 4 weeks of age or later. For pigs weaned at younger ages the value of creep feed is questionable. To encourage creep feed consumption, provide small amounts of feed in a shallow pan or on the floor several times each day.

Producers can buy ingredients and manufacture their own diets for young pigs. Suggested diets for young pigs are shown in Table 10. However, because of problems with stocking several ingredients and the difficulty in securing and maintaining quality, fresh ingredients, two other options should be considered. These are (1) buying complete diets or (2) buying a base mix that contains several special ingredients that the producer can then combine with grain and soybean meal on the farm to make the complete diet. More details concerning nutrition and management of weaned pigs are available in NebGuide G86-821, "Weaned Pig Management and Nutrition."

Growing-Finishing Pig Diets

Diets for growing-finishing pigs are shown in Table 11. The diets are designed to be full-fed throughout the growing-finishing period.

Breeding Herd Diets

Suggested gilt developing, gestation, adult boar, and lactation diets are shown in Tables 12 and 13. All the diets in Table 12 are designed for gestating gilts and sows and adult boars except diet #3 which is for developing gilts (200 lb to breeding).

Can sow constipation be controlled by feeding a specific feed ingredient?

Producers can use fibrous feedstuffs or chemical laxatives in the prefarrowing-farrowing diet to help alleviate constipation. Fibrous feedstuffs such as beet pulp, alfalfa, oats, pysillium, and wheat bran have a high water binding capacity, and can act as a laxative. Caution should be taken to avoid feeding a beet pulp that has been ammoniated or mixed with urea. Adequate access to water is particularly important when this type of diet is fed. Chemical laxatives include potassium chloride (15 lb/ton), Epsom Salts (30 lb/ton) and Glauber salts (60 lb/ton) when feeding at the rate of 4 to 5 lb/hd/day. The level can be cut in half when sows are full-fed. Natural laxative feedstuffs are preferred since the mineral salts can alter the water balance in the body of the sow and may irritate the digestive system. When using laxatives it is important to provide them to sows 3 to 4 days before and after farrowing. Feeding the sow to appetite starting immediately after farrowing is important in reducing constipation problems.

Boar Diets

Developing boars can be fed diets containing nutrient levels as described in Table 2. Adult boars can be limit-fed any of the gestation diets in Table 12. As with sows the daily feeding rate must be changed to reflect differences due to season, condition, and work load of the boar. Boars under heavy use should be fed 6 lb per head per day of a corn/milo-soybean meal diet.

Table 10. Suggested diets for young pigs (% of diet)

	Diet number					
	1	*2*	*1*	*2*	*1*	*2*
Ingredient	*Starter 1 (< 15 lb)*		*Starter 2 (15 to 25 lb)*[a]		*Starter 3 (25 to 50 lb)*[a]	
Ground corn	30.45	34.55	48.25	52.65	66.48	70.65
Soybean meal, 44%	21.55	17.25	25.95	21.32	28.75	24.36
Dried skim milk	20.00	20.00				
Edible dried whey	20.00	20.00	15.00	15.00		
Fish meal			4.00	4.00		
Fat (stabilized)	4.00	4.00	3.00	3.00		
L-lysine•HCl		0.15		0.15		0.15
Ground limestone	0.35	0.35	0.45	0.43	0.82	0.80
Dicalcium phosphate (22% Ca, 18.5% P)	1.20	1.25	0.90	1.00	1.50	1.59
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Trace mineral mix[b]	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin mix[b]	1.00	1.00	1.00	1.00	1.00	1.00
Copper sulfate	0.05	0.05	0.05	0.05	0.05	0.05
Antibiotic	1.00	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis:						
Lysine, %	1.40	1.40	1.20	1.20	1.00	1.00
Protein, %	21.40	20.00	20.00	18.40	18.30	16.90
Calcium, %	.90	.90	.80	.80	.75	.75
Phosphorus, %	.80	.80	.70	.70	.65	.65

[a]Ground whole oats or alfalfa hay can be substituted for corn pound-for-pound up to 15% to 10% of the diet, respectively, if edema disease and nutritional scours are a problem.
[b]See Table 4 for nutrient levels. Percent of diet will depend on carrier.

Table 11. Suggested diets for growing-finishing pigs (% of diet)

	Diet number							
	1	*2*	*3*	*4*	*1*	*2*	*3*	*4*
Ingredient	*Grower (50 to 120 lb)*				*Finisher (120 lb to mkt)*			
Ground corn or milo	75.40		67.80	80.22	81.39		75.44	86.16
Ground wheat		79.10				85.12		
Soybean meal, 44%	21.50	18.00		16.50	15.73	12.14		10.73
L-lysine•HCl				0.15				0.15
Soybeans, full-fat, cooked			29.20				21.73	
Ground limestone	0.90	1.00	0.90	0.83	0.86	1.06	0.88	0.86
Dicalcium phosphate (22% Ca, 18.5% P)	1.10	0.80	1.00	1.20	0.92	0.58	0.85	1.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Trace mineral mix[a]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin mix[a]	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis:								
Lysine, %	0.80	0.80	0.82	0.79	0.65	0.65	0.67	0.63
Protein, %	16.00	17.90	16.60	14.40	14.00	16.10	14.50	12.40
Calcium, %	0.65	0.65	0.65	0.65	0.60	0.60	0.60	0.60
Phosphorus, %	0.55	0.55	0.55	0.55	0.50	0.50	0.50	0.50

[a]See Table 4 for nutrient levels. Percent of diet will depend on carrier.

Table 12. Suggested diets for developing gilts (200 lb to breeding), gestating sows and adult boars (% of diet)[a]

	Diet number							
Ingredient	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Ground corn or milo	83.1	85.5	79.9	59.5	36.4	63.0	42.8	78.7
Ground oats				25.0	50.0			
Ground alfalfa hay, 16%						25.0	50.0	
Soybean meal, 44%	12.0	10.3	16.0	10.8	9.1	8.1	3.8	
Ground soybeans[b]								16.3
Ground limestone	0.7	0.6	0.8	0.7	0.7		0.1	0.7
Dicalcium phosphate (22% Ca, 18.5% P)	2.6	2.0	1.7	2.4	2.2	2.3		2.7
Monosodium phosphate							1.7	
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Trace mineral mix[c]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vitamin mix[c]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Daily intake:								
Feed, lb	4.0	5.0	6.0	4.2	4.4	4.5	5.2	3.9
Metabolizable energy, kcal	5750	7250	8688	5750	5750	5750	5750	5750
Lysine, g	10.0	11.4	17.7	10.5	10.9	11.2	13.0	10.1
Protein, g	227.0	272.4	381.0	246.0	261.7	265.5	316.4	230.2
Calcium, g	16.3	16.6	20.4	16.4	16.6	17.8	16.5	16.5
Phosphorus, g	14.5	15.4	17.7	14.7	14.8	14.5	14.6	14.5
Calculated analysis:								
Lysine, %	0.55	0.50	0.65	0.55	0.55	0.55	0.55	0.57
Protein, %	12.50	12.00	14.00	12.90	13.10	13.00	13.40	13.00
Calcium, %	0.90	0.73	0.75	0.86	0.83	0.87	0.71	0.93
Phosphorus, %	0.80	0.68	0.65	0.77	0.74	0.70	0.62	0.82

[a]Diet 3 is for developing gilts (200 lb to breeding).
[b]Raw or cooked.
[c]See Table 4 for nutrient levels. Percent of diet will depend on carrier.

Table 13. Suggested diets for lactating sows (% of diet)

	Diet number					
Ingredient	*1*	*2*	*3*	*4*	*5*	*6*
Ground corn	75.7	66.6	66.0	67.8	71.5	68.7
Ground oats		10.0				
Beet pulp			10.0			
Ground alfalfa hay, 16%				10.0		
Fat (stabilized)					3.0	
Soybean meal, 44%	19.5	18.6	19.3	17.7	20.7	
Ground soybeans[a]						26.6
Ground limestone	0.7	0.7	0.5	0.3	0.7	0.7
Dicalcium phosphate (22% Ca, 18.5% P)	2.5	2.5	2.6	2.6	2.5	2.4
Salt	0.5	0.5	0.5	0.5	0.5	0.5
Trace mineral mix[b]	0.1	0.1	0.1	0.1	0.1	0.1
Vitamin mix[b]	1.0	1.0	1.0	1.0	1.0	1.0
	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis:						
Lysine, %	0.75	0.76	0.78	0.75	0.78	0.77
Protein, %	15.00	15.00	15.00	15.10	15.20	15.60
Calcium, %	0.90	0.90	0.90	0.90	0.90	0.90
Phosphorus, %	0.80	0.80	0.80	0.80	0.80	0.80

[a]Cooked. Raw soybeans have resulted in decreased pig weaning weights and increased sow weight loss during lactation compared with soybean meal.
[b]See Table 4 for nutrient levels. Percent of diet will depend on carrier.

Table 14. Ingredient composition (as fed basis)

Feedstuff	*Protein (%)*	*Lysine (%)*	*Tryptophan (%)*	*Threonine (%)*	*Methionine + cystine (%)*	*Calcium (%)*	*Phosphorus (%)*	*Metabolizable energy (kcal/lb)*	*Crude Fat (%)*	*Fiber (%)*
Alfalfa meal, dehy	17.4	0.85	0.34	0.71	0.56	1.40	0.23	773	2.8	24.0
Alfalfa hay, early bloom	16.0	0.68	0.30	0.67	0.50	1.30	0.20	800	2.5	24.0
Bakery waste, dehy	9.8	0.31	0.10	0.49	0.34	0.13	0.24	1695	11.7	1.2
Barley	11.5	0.40	0.15	0.36	0.37	0.05	0.34	1379	1.7	5.0
Beet pulp	8.8	0.60	0.10	0.40	0.02	0.62	0.09	1225	0.5	18.2
Corn and cob meal	7.8	0.17	0.07	0.29	0.26	0.06	0.24	1339	3.2	8.2
Corn distillers grain										
w/sol., dehy	27.0	0.70	0.17	0.92	0.78	0.14	0.66	1512	9.3	9.1
Corn gluten feed	23.3	0.64	0.15	0.79	0.80	0.18	0.99	1222	2.7	6.8
Corn, high lysine	10.1	0.40	0.11	0.40	0.29	0.02	0.20	1560	4.0	3.7
Corn, yellow	8.5	0.25	0.09	0.36	0.40	0.03	0.28	1551	3.6	2.3
Dried brewers yeast	43.8	3.23	0.51	2.06	1.18	0.14	1.36	1300	0.9	3.0
Dried fish solubles	31.5	1.85	0.33	0.90	1.09	0.16	0.57	736	6.1	0.5
Dried skim milk	33.3	2.54	0.43	1.57	1.35	1.28	1.02	1619	1.1	0.2
Dried whole whey	13.3	0.94	0.18	0.89	0.49	0.86	0.76	1401	0.8	0.2
Fats/oils[a]										
Animal-poultry fat	—	—	—	—	—	—	—	3625	100.0	—
Tallow	—	—	—	—	—	—	—	3588	100.0	—
Lard	—	—	—	—	—	—	—	3523	100.0	—
Corn oil	—	—	—	—	—	—	—	3341	100.0	—
Soybean oil	—	—	—	—	—	—	—	3309	100.0	—
Fish meal, Menhaden	61.2	4.74	0.65	2.51	2.33	5.19	2.88	1497	9.6	0.9
Hominy feed	10.6	0.36	0.13	0.40	0.29	0.06	0.52	1501	5.7	5.0
L-lysine•HCl	95.8	78.00	—	—	—	—	—	—	—	—
Meat and bone meal, 50%	50.9	2.89	0.28	1.60	1.14	9.40	4.58	1034	9.7	2.4
Meat meal, 55%	55.6	3.09	0.38	1.78	1.41	8.27	4.10	1095	8.7	2.3
Millet, proso	11.6	0.26	0.17	0.40	—	0.03	0.30	1387	3.5	6.1
Milo, grain sorghum	8.9	0.23	0.10	0.27	0.29	0.03	0.28	1488	2.8	2.2
Molasses, beet	6.6	—	—	—	—	0.12	0.03	1080	0.2	0.0
Molasses, cane	4.4	—	—	—	—	0.77	0.08	909	0.1	0.0
Oats	11.8	0.40	0.15	0.38	0.37	0.08	0.34	1241	4.7	10.7
Oat groats	15.8	0.53	0.19	0.44	0.41	0.08	0.43	1549	6.1	2.5
Rye	12.0	0.41	0.11	0.35	0.36	0.06	0.32	1363	1.5	2.2
Soybeans, full-fat, cooked	36.7	2.25	0.54	1.42	1.01	0.26	0.61	1644	18.8	5.2
Soybean meal, dehulled, solv.	48.5	3.12	0.69	1.90	1.41	0.26	0.64	1535	0.9	3.4
Soybean meal, solvent	44.0	2.90	0.64	1.70	1.18	0.30	0.65	1461	1.1	7.3
Sugar	—	—	—	—	—	—	—	1668	—	—
Triticale	15.8	0.52	0.18	0.57	0.50	0.05	0.30	1383	1.5	4.0
Wheat bran	15.5	0.56	0.25	0.41	0.43	0.13	1.16	978	4.0	10.0
Wheat, hard	12.6	0.35	0.17	0.37	0.52	0.04	0.37	1497	1.6	2.6
Wheat middlings	16.5	0.68	0.19	0.57	0.41	0.13	0.89	1345	4.3	7.8

[a]100% dry matter basis; Feed grade products usually contain water and other non-fat materials, thus energy concentrations should be adjusted accordingly.