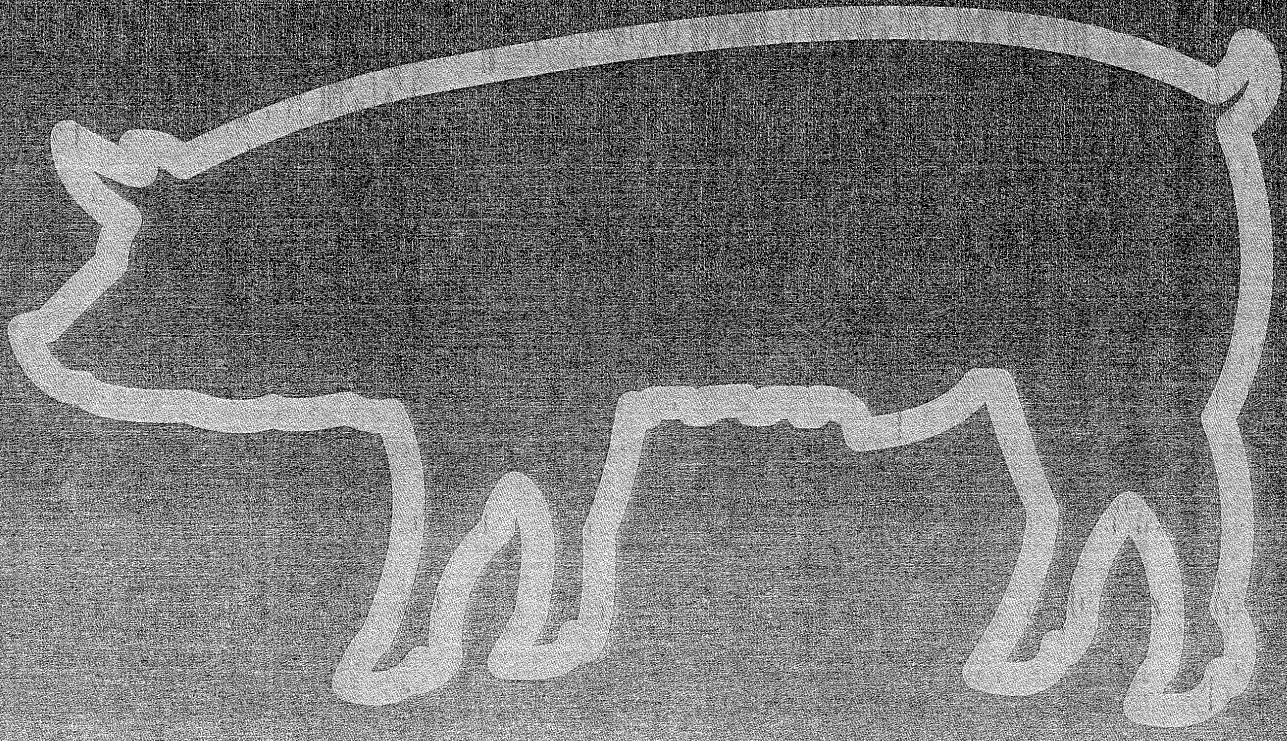
NATIONAL PORK PRODUCERS COUNCIL

FEED PURCHASING MANUAL



This manual is designed to provide information in regard to the subject matter covered. The material contained in this manual is not intended to be a definitive analysis of the subjects discussed. This manual is distributed with the understanding that the National Pork Producers Council is not engaged in rendering legal, accounting, or other professional service. If legal advice or other expert assistance is required, the service of a competent professional person should be sought.

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Foreword

The pork industry is changing very rapidly. One change is the growing interest in pork producer networking arrangements. In these arrangements, producers are forming alliances that have not been common in the past. One such alliance facilitates group purchasing of inputs such as feed for production systems.

Approximately 65% to 75% of total production cost of a market hog is feed. Thus, it is desirable for pork producers to find the most value oriented feeding method to achieve the lowest cost per unit of gain. Pork producers have indicated a need for more information so they can become more knowledgeable about the process of purchasing feed.

To provide this information in a way to avoid potential misunderstandings and other problems, the National Pork Producers Council has developed this Feed Purchasing Manual. The charge to the developers of this manual included determining the parameters and requirements involved, along with the form or format for feed purchasing. The charge did not involve outlining specific formulations for rations.

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This manual went through four major revisions during development and was reviewed by more than one hundred people including producers, nutritionists, veterinarians, feed manufacturers, and others in allied industry.

Earl Dotson
Editor

Chapter 1: Introduction

Producers have many feed purchasing and production decisions to consider.

They may choose one of these options or a combination:

1. Swine producers may buy feed from independent feed mills, mills of national firms, or cooperatives.
2. Producers may buy premixes, base mixes, and(or) supplements from various companies who also provide nutritional and technical expertise on the proper mixing and feeding of these products.
3. They may purchase individual raw materials and mix them to their own specifications.

Ultimately, the final decision on these alternatives is in the producer's hands. This manual is intended to serve as a reference for producers while making feed purchasing decisions.

Open communications are important at every step in the feed purchasing process.

As with any relationship, open communications between the feed manufacturer and the producer is critical for maintaining a long-term relationship that will benefit both parties. The producer and feed supplier should be partners in the goal of producing a lean pork product at a competitive price. The producer should communicate their goals and aspirations for their pork production enterprise to the feed supplier.

As producers consider making changes in their production goals and(or) methods of purchasing feed, they should communicate with their feed supplier. If the supplier is unaware of questions or concerns, they cannot be part of the solution. Likewise, as suppliers make changes that will affect their processing and(or) delivery capabilities, they should communicate with local producers. As questions arise, open communication is the best means of achieving success. Producers and feed suppliers need to realize good communications will help establish long-term relationships benefiting both parties.

As you use this manual, discuss concerns with your feed supplier, extension specialists, or other advisors. Improved understanding of all facets of feed purchasing will be beneficial to producers in terms of profitability and business relationships.

The decision process involves several steps.

The desired outcome of the feed purchasing decision is to provide each pig with quality feed at a cost-effective price. Several options are available to reach this goal. The decision process regarding feed purchases begins with an investment decision. The producer must decide whether they want to construct, operate, and managed a feed processing facility or buy complete feed. This investment decision should be made with proper recognition given to the fixed costs of a feed mill— storage,

formulation expertise, record keeping, quality control, and management of the operation; and the additional variable operating costs of ingredient purchasing, energy, labor, repairs, and delivery. The opportunity cost of your management time also should be considered.

Equipment choices determine input options.

When considering on-farm mixing, choice of equipment for the mixing operation may determine the acceptable range of inputs that are appropriate. For example, a mill based on volumetric measurement, instead of weight, may be inadequate for mixing a premix. Remaining decisions on the type of raw material to purchase (supplement, base mix, or premix) must be based on the investment required and the risk involved.

Investment and risk are factors to consider.

In general, greater investment in facilities, labor, and management are required as producers move from supplements to premixes and assume more responsibility for adequately mixing their own diets. As the level of responsibility increases, the level of risk and their associated costs also increase. As more ingredients are purchased directly by the producer, the potential for errors in weighing or mixing increases. Monitoring ingredient quality also becomes more critical. However, the advantage to the producer in assuming more responsibility can be lower feed cost. Each producer must weigh the importance of convenience, service, risk, and cost of each option to select the best program for their situation.

Producers have a choice of feeding programs.

A producer should select the program that best fits their particular situation. Here is a brief description of different types of feeding programs available to swine producers:

Complete feeds are prepared and delivered by a commercial mill as a ready-to-feed product. The feed manufacturer may assume all responsibility for ingredient mixing and quality. Complete feeds can be purchased using company specifications or through toll-milling. In toll-milling, the feedmill prepares a custom diet based on the producer's specifications. In this case, the producer may assume more responsibility for feed quality and animal performance.

A **supplement or concentrate** is a mixture of ingredients formulated to complement the nutrients in grain. The producer mixes the supplement with grain to produce a complete diet. Typical inclusion rates are 10 to 40% of the diet.

Base mixes include vitamins, trace minerals, and macro minerals. They must be mixed with energy (grain and fats) and protein sources to make complete diets. Base mixes usually account for 2.5 to 5% of the diet. Some base mixes for nursery diets may contain additional ingredients, such as specialized carbohydrate and protein sources. These nursery base mixes may have inclusion rates of 10

to 20% of the diet. Base mixes also may include other ingredients added at low inclusion rates (ex. synthetic amino acids).

Premixes contain sources of vitamins and(or) trace minerals. The producer mixes a complete diet by combining premixes with grain, and sources of protein and macrominerals (salt, phosphorus, calcium, etc.). Typical inclusion rates for premixes are 0.05 to 0.5% of the diet (1 to 10 lb/ton).

The checklist on the following page can be used as a guide for making feed purchasing decisions. If the producer is unable to answer "yes" to any of these questions, they should further consult this manual, their nutritional advisor, or their feed company.

Feed Purchasing Checklist.

____ I have selected the appropriate type(s) of feeding programs (complete diets, supplements, base mixes, or premixes) for my operation.

____ I understand the risks, advantages, or disadvantages associated with my feeding program decision.

____ I have established an open communication process with potential supplier(s) and have confidence in their abilities to serve my needs.

____ I have reviewed the technical services offered by my supplier(s).

____ I have determined my needs for the services offered by the supplier(s).

____ I have confidence in my source of nutritional advice (myself, feed company, or another source).

____ I have evaluated my need for proprietary information from the supplier.

____ I understand the difference between open, closed, and custom formulas and specifications, and have determined the best method for me.

If I am purchasing feed ingredients or complete diets with custom specifications, I have:

____ • Established levels of acceptable ingredients (Chapter 2),

____ • Agreed to nutrient specifications on ingredients (Chapter 2),

____ • Clearly written and complete nutrient specifications (Chapter 3).

____ I have determined the appropriate physical form for my diets.

I have established quality control programs for:

____ • Purchased ingredients,

____ • Purchased complete diets,

____ • Complete diets processed on the farm.

____ I understand the pricing method used for the ingredients and complete diets that I am purchasing.

____ I understand who is in charge of freight responsibilities and terms of delivery for purchased ingredients and complete diets.

____ I understand the terms of payment for purchased ingredients and diets.

____ I have a biosecurity plan for the purchase and delivery of ingredients and complete diets.

____ I follow PQA guidelines and good manufacturing procedures concerning feed medications and will keep abreast of regulatory changes.

Identification of Suppliers

An important decision for producers in the feed purchasing process is identification of a supplier or suppliers that can meet their expectations for products and service.

Several factors should be considered in addition to price when selecting potential suppliers.

Bottom-line cost effectiveness has become an even more crucial issue in a global economy. Producers must consider prices for products when selecting a supplier. However, price per unit does not indicate bottom-line value in all instances. Along with price, the following factors also should be considered.

Service and Support. The producer should carefully assess the services and technical support offered by the supplier. Some of these services are presented in more detail later in this chapter. The producer also should consider the value of the services provided by each supplier to their own operation and whether they have specific needs for those services.

Expected Pig Performance. Cost per pound of pork produced and rate of gain should be key factors in selecting a potential supplier. The lowest priced feed per ton may not be the most cost efficient in achieving desired results.

Prompt Delivery. On-time delivery of feed products is critical to business success. Producers should assess their delivery requirements and ensure that potential suppliers can meet their needs. Communication is essential on this point.

Business Goals and Focus. Some pork producers choose suppliers that have an established commitment to the swine industry and goals in common with the producer.

Personal Relationships. A trusting relationship between the producer and supplier is essential for a win-win attitude in the pork production business. Pork producers enjoy working with suppliers they trust. Trust can be developed on a company level, but is usually reflective of the day-to-day interaction with representatives of the supplier.

Information Source. Suppliers can be excellent information sources for the producer. Suppliers may offer newsletters, electronic communications, production manuals, customer meetings, or record-keeping services for producers.

Research, Development, and Innovation. Suppliers have different levels of involvement in research and development programs. Some suppliers have a major commitment to research and product development, while other suppliers rely on outside sources of information for their product development. The degree of involvement in a research and development program by a feed supplier may influence the quality and cost of their feed products.

Financing. Producers often use suppliers as a source of credit. Many suppliers will provide reduced-cost financing or share in the financial risk of running a swine business. One reason for the growing interest in contract production is related to the risks of production and the availability of capital

through contracts. Financing is discussed in more detail in Chapter 8.

Feed Quality Control Programs. Monitoring the physical and nutrient attributes of feeds and feed ingredients, whether purchased, home grown, or home mixed, is fundamental to consistent pig performance and enterprise profitability. Adherence to standards through a quality control program contains many segments. Each of these segments must be conducted with sufficient precision and frequency to be useful. A good quality control program is a continuous activity, requiring effort in collecting data, summarizing, evaluating, and acting upon the results (Chapter 5). Producers should select feed manufacturers and(or) ingredient suppliers who have implemented effective quality control programs. A supplier's commitment to quality control is an indicator of their commitment to protecting your investment as a swine producer. Many feed suppliers also have expertise to help producers institute quality control programs on their operation. This essential investment may add $0.25 to $3.00 to the cost of a complete ton of feed. However, quality control may result in a lower total cost of production.

Reputation. Many suppliers have been in business for many years and have developed an excellent reputation. Past history of performance and service to other producers is an excellent means of gauging a supplier's commitment to swine production and the satisfaction of their customers.

Local Support. Individual producers also must consider the desirability of supporting companies with a local base. For some producers, local feed mills indicate a long-term, strategic commitment to the community by the supplier. Their importance to the local tax base and employment also are considered important by some.

Congruity with Feeding Program. As discussed in this manual, several types of feeding programs, feed manufacturing options and purchasing mechanisms are available to the producer. Ultimately, the choices made will direct the producer toward suppliers offering products and(or) services designed to be used in that program.

Potential Technical Services from Suppliers

Swine producers need a variety of technical services.

These may be purchased or provided by producers themselves. Feed suppliers may bundle some of these services and the associated costs with feed products. The cost, quality, and need for each of these services should be considered when selecting a supplier. Producers should know exactly what they are purchasing from the supplier.

In some instances, these services can be purchased separately from the feed. However, a company's services are usually only available for customers purchasing feed products. If producers enter a bidding process, they should understand what services are included with the purchase and what services they may obtain separately from the supplier.

An important point to remember is that most of the services listed here are needed and have a cost that must be paid at some point. The services must be obtained by the producer from an outside source unless they have the ability to provide the service on their own. Producers must evaluate their needs and decide whether to rely on the feed company for each service. There may be additional cost if that service is not purchased in a bundle with the feed. The quality and frequency of each service must also be evaluated when making the decision on potential suppliers.

Services that may be provided by feed suppliers:

- Nutrition research
- Diet formulation
- Feed processing expertise
- Grain purchasing
- Quality control programs
- Ingredient purchasing
- Ingredients resource
- Ingredient and feed analysis
- Inventory services
- Swine genetics advice
- Sourcing of pigs
- Personnel management
- Environmental planning
- Employee education
- Risk management
- Financial records
- Biological records
- Swine marketing
- Financing (contracts, loans, facilities, etc.)
- Financial planning
- Risk sharing
- Business plans
- Veterinary consulting
- Engineering consultation
- Technical newsletters
- Producer education meetings
- Gifts and apparel
- Genetic multipliers or AI studs
- Production management
- Lean growth modeling

Proprietary Information

Some information is owned by the people who generate it, and it has value.

In making decisions on feeding programs and feed purchasing, producers should consider the proprietary nature of information and its value. Pork production is a competitive industry. Many producers and production companies are unwilling to share the results of their research and lessons with others in the industry until they have been able to recoup a portion of the investment to generate the information. Similarly, some feed manufacturers have excellent research farms, staffs of trained research scientists, in-house laboratories for ingredient analysis and quality control, and purchasing agents to help identify and obtain best cost deals on ingredients. All of these facets lead to generation of proprietary information meant to provide the feed supplier and their clients with a competitive advantage compared to other suppliers.

More information is being privatized in the swine industry as people realize the competitive value. To protect their investment, suppliers and producers must carefully consider the timing and dissemination of information generated within their companies.

For some companies, dissemination is done through products. In other situations, data may be released on a confidential basis to committed, long-term customers. The quality, usefulness, and value of information from companies varies greatly, just as published results from other sources vary.

Producers must determine how they are going to acquire the information they need.

Producers must decide whether to obtain nutrition and production information from a feed company. They can buy it bundled with feed products, purchase information separately, perform on-farm research and analyze the results, or wait until proprietary information becomes public information.

The quality and value of the proprietary information is difficult to ascertain by somebody outside the company. Producers must consider their needs and their ability to access and use information from third parties. They must consider their willingness to share information about their enterprise when making decisions concerning their nutrition program and suppliers.

Chapter 2: Agreement on Acceptable Ingredients

Ingredients are sources of essential nutrients, but can be variable.

An individual ingredient is not essential in a swine diet. However, ingredients are sources of essential nutrients. The goal of the producer and feed manufacturer is to choose the mixture of ingredients that will meet the nutrient requirements of the animal for optimal performance at the lowest cost. Formulating an accurate and complete set of nutrient specifications, as discussed in Chapter 1, is more important than the actual ingredients supplying those nutrients. The most cost-effective mixture of ingredients needed to meet the nutrient requirements will vary with ingredient markets, region of the country, purchasing power of the supplier, and many other factors.

Most producers should seek assistance from an outside source to help make decisions on ingredients that will be acceptable in a final feed product.

Careful thought must be given to the list of acceptable ingredients and allowable limits.

Remember, the goal is to produce quality pork at a competitive price. Extreme limitations on ingredients will increase diet costs. However, lack of limitations may result in a product that does not meet your performance expectations. Seek advice from knowledgeable nutritionists familiar with your region of the country and seasonal price fluctuations of various ingredients to help you expand or condense your list of acceptable ingredients. If your feed supplier is providing this type of service with their feed or feed product, make sure you understand their process and quality assurance program used in selecting ingredients. Most feed suppliers take pride in this process and are willing to share the information with their customers.

Examples of limits on common energy and protein sources are shown in Tables 1 and 2. It must be noted these are only guidelines and need to be tailored to your specific situation. The restrictions may change as new information becomes available. For example, as net energy systems and digestible nutrient values are used in formulation, the restrictions may change. A reason for a limitation on each ingredient also is provided in the tables.

These guidelines are not intended to be absolute values, but can serve as a starting point in setting ingredient limits with an understanding that most of the nutritional limitations can be overcome with careful diet formulation.

Common sources for macro minerals, micro minerals and vitamins are provided in Tables 4, 5, 6, and 7 in Chapter 3.

Minimums and Maximums (See Tables 1 and 2). In consultation with appropriate nutrition advisors, producers should form their own list of ingredients with allowable maximum levels. Minimum levels also should be included

for ingredients desired in a diet. For example, 1% added fat may be desired in a gestation diet for dust control. This minimal level should be specified. In this example, the level must be specified as added fat instead of fat or total fat. Total fat in a corn-soybean meal diet without added fat is approximately 3%. Another example would be a specified minimum level for dried whey and menhaden fish meal in a starter diet.

Ingredient Sources. If a producer prefers a particular source for an ingredient, the source should be specified. An example might be to specify certain suppliers as the source for specialty ingredients, such as animal plasma, blood meal, fish meal, or dried whey.

Specifying the ingredient source is usually done when an ingredient is highly variable in quality and the essential quality attributes are difficult to measure.

The producer can and should modify this list of acceptable ingredient sources when sufficiently warranted by supporting research from suppliers or other sources.

Table 1. Typical Maximum Usage Rates for Common Energy Sources, percent.[a]

	Maximum recommended percent of complete diet[b]				
Ingredient	Starter	Grow-finish	Gestation	Lactation	Limitation
Alfalfa meal, dehy	0	10	25	0	High fiber
Bakery waste, dehy	25	*	*	*	High salt
Barley	25	*	*	25	High fiber
Beet pulp	0	10	50	10	High fiber
Corn	*	*	*	*	None
Corn distillers grains w/solubles, dehy	5	15	40	10	Amino acid balance
Corn gluten feed	5	10	*	5	High fiber
Corn, hominy feed	0	60	60	60	Amino acid balance
Fat/oils	8	5	5	5	Feed handling
Millet	10	40	40	20	Difficult processing
Molasses	0	5	10	5	Low energy
Oats	5	20	50	0	High fiber
Oats groats	*	*	*	*	None
Rye[c]	0	25	25	10	Variability
Sorghum (milo)	*	*	*	*	None
Triticale[c]	10	40	40	40	Variability
Wheat bran	0	10	30	10	High fiber
Wheat, hard	*	*	*	*	None
Wheat middlings	5	25	*	10	High fiber
Wheat shorts	10	40	40	40	Variability
Whey, dried	40	15	5	5	High lactose

[a] Adapted from Kansas Swine Nutrition Guide, Nebraska and South Dakota Swine Nutrition Guide, Swine Nutrition Guide from Prairie Swine Centre.

[b] **Percentages suggest maximum allowable inclusion rates for energy sources. Economics and pig performance standards must be considered for actual inclusion rates. Most or all of the nutritional limitations can be overcome with proper formulation.**

[c] Must be free of ergot.

*Denotes no nutritional limitation in a diet balanced for essential amino acids, energy, minerals, and vitamins.

Table 2. Typical Maximum Usage Rates for Common Amino Acid Sources, percent.[a]

	Maximum recommended percent of complete diet[b]				
Ingredient	Starter	Grow-finish	Gestation	Lactation	Limitation
Alfalfa meal, dehydrated	0	10	25	0	High fiber
Blood meal, spray-dried	3	5	5	5	Low isoleucine
Canola meal	0	15	15	15	Anti-nutrition factor
Corn distillers grains w/solubles, dehy	5	15	40	10	Amino acid balance
Corn gluten meal	10	30	*	10	Amino acid balance
Cottonseed meal	0	10	15	0	Low lysine
Egg protein, spray-dried	6	10	10	5	Anti-nutrition factor
Fish meal	20	6	6	6	"Fishy" pork
Meat and bone meal	5	5	10	5	High minerals
Meat meal	0	5	10	5	High minerals
Porcine plasma, spray-dried	*	*	*	*	None
Skim milk, spray-dried	*	*	*	*	None
Soy protein concentrate	*	*	*	*	None
Soy protein isolate	*	*	*	*	None
Soybean meal	*	*	*	*	None
Soybean, full-fat, heat- treated	*	*	*	*	Overheating
Sunflower meal	0	20	*	0	Low energy
Tankage	5	5	5	5	Quality
Yeast, brewers dried	5	10	10	10	Variability
Wheat gluten, spray- dried	10	*	*	*	Low lysine
Whey, dried	40	15	5	5	High lactose

[a] Adapted from Kansas Swine Nutrition Guide, Nebraska and South Dakota Swine Nutrition Guide, Swine Nutrition Guide from Prairie Swine Centre.

[b] **Percentages suggest maximum allowable inclusion rates for protein sources. Economics and pig performance standards must be considered for actual inclusion rates. Most or all of the nutritional limitations can be overcome with proper formulation.**

*Denotes no nutritional limitation in a diet balanced for essential amino acids, energy, minerals, and vitamins.

Nutrient Specifications for Acceptable Ingredients

Ingredients are sources for essential nutrients but the exact nutrient content of an ingredient is not constant unless the ingredient is manufactured in a controlled industrial process (as in the case of vitamins, trace minerals, crystalline amino acids, etc.).

Diet formulation is based on meeting the overall nutrient specification of a diet by mixing ingredients of different nutrient contents.

Nutritionists use nutrient levels for each ingredient based on their own information from published values, laboratory assays, in plant testing, or personal experience. Thus, two nutritionists can use the same nutrient specifications for a complete diet and the same list of ingredients and formulate different diets due to the use of different nutrient concentrations for the ingredients.

To help avoid these problems, producers, their nutritional advisor, and their feed supplier should agree to standard nutrient specifications on the acceptable ingredients. If your feed supplier is providing this type of service with their feed or feed product, this step is handled by their nutritional staff. Communication with your feed supplier should clarify questions in this area. Standard nutrient specifications are especially important during a bidding process when submitting a formula to multiple feed processors to ensure standardization of comparisons. Because of variation in nutrient content, producers and their feed suppliers also should agree on methods to be used in dealing with ingredient variability.

An example of standard specifications for the major nutrients in various feedstuffs is provided in Table 3. Other sources, such as NRC (1988), United States/Canadian Feeds Tables, or various university publications also can be used as references. Most of these references are updated on a regular basis. The most current information should be used for standard specifications. Many of the sources are listed in the reference section in the Appendix.

Total Nutrients Versus Available Nutrients. Formulating diets using actual availability of nutrients in each ingredient would be more accurate than using total nutrient levels. However, nutrient availability values are not published for all nutrients or all ingredients. In addition, some published values for nutrient availability are derived from single studies with relatively little data. Total nutrient levels can be used with relatively high accuracy when diets are based on only a few ingredients (as in corn-soybean meal diets).

When diet composition changes often, and variable byproduct ingredients are being used in feed, it is best to use available nutrient levels.

The main nutrients in a complete diet that should be formulated on an available basis are phosphorus and amino acids. Available phosphorus concentrations of many of the main ingredients are provided in Table 3.

Table 3. Feedstuff Composition Table (as Fed Basis).[a,b]

Feedstuffs	M.E.[c] kcal/lb	Protein %	Crude Fat %	Crude fiber %	Ca %	Phos. %	Avail Phos. %	Lysine %	Threo-nine %	Trypto-phan %	Methio-nine %	Met & Cystine %
Alfalfa hay, sundried	800	14	2.5	29	1.2	0.2	0.2	0.55	0.5	0.25	0.27	0.5
Alfalfa meal, dehy	775	17	2.8	24	1.4	0.23	0.23	0.85	0.71	0.34	0.27	0.56
Bakery Waste, dehydrated	1695	9.8	11.7	1.2	0.1	0.24	NA[d]	0.31	0.49	0.1	0.17	0.34
Barley	1380	11.5	1.7	5	0.1	0.34	0.1	0.4	0.36	0.15	0.16	0.37
Beet pulp	1225	8.8	0.5	18.2	0.6	0.09	NA	0.6	0.4	0.1	0.01	0.02
Blood meal, spray-dried	1060	86	1.2	1	0.4	0.3	0.28	7.44	3.63	1.05	1.05	2.08
Canola meal	1225	38	3.8	11.1	0.7	1.17	0.19	2.27	1.71	0.44	0.68	1.15
Choice white grease	3515	0	0	0	0	0	0	0	0	0	0	0
Corn gluten meal	1760	42.1	2.3	3.8	0.1	0.4	0.06	0.78	1.42	0.21	1.07	1.73
Corn, high lysine	1575	8.9	NA	2.5	0	0.24	0.03	0.38	0.41	0.14	NA	NA
Corn, yellow	1550	8.5	3.6	2.3	0	0.28	0.04	0.25	0.36	0.09	0.18	0.4
Corn oil	3335	0	0	0	0	0	0	0	0	0	0	0
Cottonseed meal, solvent	1160	41.7	1.8	10.8	0.2	1.17	0.01	1.7	1.23	0.48	0.49	1.06
Egg protein, spray-dried	NA	48	40	0.1	0.2	0.68	NA	3.1	2.25	0.73	1.48	2.57
Fish meal, menhaden	1500	61.2	9.6	0.9	5.2	2.88	2.68	4.74	2.51	0.65	0.7	1.09
Meat and bone meal, 50%	1035	50.9	9.7	2.4	9.4	4.58	3.02	2.89	1.6	0.28	0.68	1.14
Meat meal, 55%	1095	55.6	8.7	2.3	8.3	4.1	NA	3.09	1.78	0.38	0.73	1.41
Millet	1385	11.6	3.5	6.1	0	0.3	NA	0.26	0.4	0.17	0.29	NA
Molasses, cane	910	4.4	0.1	0	0.8	0.08	NA	NA	NA	NA	NA	NA
Oat groats	1550	15.8	6.1	2.5	0.1	0.43	0.06	0.53	0.44	0.19	0.21	0.41
Oats	1240	11.8	4.7	10.7	0.1	0.34	0.07	0.4	0.38	0.15	0.18	0.37
Peanut meal, solvent	1320	49	1.3	9.9	0.3	0.61	0.07	1.45	1.37	0.48	0.44	1.17
Poultry fat	3615	0	0	0	0	0	0	0	0	0	0	0
Rice bran	1300	14	1.5	12.9	0.1	1.37	0.34	0.61	0.53	0.21	0.26	0.47
Rye	1365	12	1.5	2.2	0.1	0.32	0.15	0.41	0.35	0.11	0.17	0.36
Skim milk, dried	1620	33.3	1.1	0.2	1.3	1.02	0.93	2.54	1.57	0.43	0.9	1.35
Sorghum grain (milo)	1480	8.9	2.8	2.2	0	0.28	0.06	0.23	0.27	0.1	0.16	0.29
Soybean meal, 44%[e]	1460	44	1.1	7.3	0.3	0.65	0.2	2.85	1.78	0.6	0.62	1.32

Table 3. Feedstuff Composition Table (as Fed Basis).[a,b]

Feedstuffs	M.E.[c] kcal/lb	Protein %	Crude Fat %	Crude fiber %	Ca %	Phos. %	Avail Phos. %	Lysine %	Threo-nine %	Trypto-phan %	Methio-nine %	Met & Cystine %
Soybean meal, 46.5%[e]	1535	46.5	0.9	3.4	0.3	0.64	0.15	3.01	1.89	0.64	0.65	1.4
Soybean meal, 47.5%[e]	1535	47.5	0.9	3.4	0.3	0.64	0.15	3.08	1.93	0.65	0.66	1.43
Soybean meal, 48.0%[e]	1535	48.0	0.9	3.4	0.3	0.64	0.15	3.11	1.95	0.66	0.67	1.44
Soybean meal, 48.5%[e]	1535	48.5	0.9	3.4	0.3	0.64	0.15	3.14	1.97	0.66	0.68	1.45
Soybean oil	3302	0	0	0	0	0	0	0	0	0	0	0
Sunflower meal	1195	45.5	2.9	11.7	0.4	0.94	0.03	1.68	1.63	0.6	0.82	1.55
Tallow	3580	0	0	0	0	0	0	0	0	0	0	0
Tankage, 60%	980	60	NA	2	4.6	2.5	NA	3	2.48	0.58	NA	NA
Triticale	1385	15.8	1.5	4	0.1	0.3	0.14	0.52	0.57	0.18	0.21	0.4
Wheat bran	980	15.5	4	10	0.1	1.16	0.34	0.56	0.41	0.25	0.17	1.43
Wheat, hard winter	1475	12.6	1.6	2.6	0	0.37	0.19	0.4	0.37	0.17	0.22	0.52
Wheat gluten, spray-dried	NA	74	NA	NA	NA	NA	NA	1.3	2.73	0.61	2.5	NA
Wheat middlings	1345	16.5	4.3	7.8	0.1	0.89	0.36	0.68	0.57	0.19	0.19	0.41
Wheat, soft winter	1495	11.4	1.6	2.3	0.1	0.36	0.18	0.36	0.39	0.27	0.22	0.58
Whey, dried	1400	13.3	0.8	0.2	0.9	0.76	0.73	0.94	0.89	0.18	0.19	0.49
Yeast, brewer's dried	1300	43.8	0.9	3	0.1	1.36	0.91	3.23	2.06	0.51	0.66	1.18

[a] Adapted from NRC (1988), Kansas Swine Nutrition Guide, Nebraska and South Dakota Swine Nutrition Guide, Swine Nutrition Guide from Prairie Swine Centre, Cromwell (1993).

[b] **These values are intended to be used as guidelines. Exact nutrient content of an ingredient is not constant, unless the ingredient is the result of a controlled industrial process (e.g. vitamins, trace minerals, crystalline amino acids, etc.).**

[c] Metabolizable energy

[d] NA means these values are not available for the ingredient.

[e] Amino acid levels were adapted from NCR-42 Committee on Swine Nutrition (1992).

premix rather than purchasing a supplier-developed premix, it is essential to include all desired vitamins, their level of inclusion, and the desired source.

Improperly written specifications can lead to undesirable products.

Suppliers want to see their customers succeed and are willing to help ensure producers request and receive the product desired. Problems such as those described in the following examples are likely to be avoided by communication with potential suppliers.

- For example, the source of vitamin E should be dl-alpha-tocopheryl acetate or d-alpha-tocopheryl acetate. If acetate is left off the end of the name and dl-alpha-tocopherol or d-alpha-tocopherol is used instead, the result would be an extremely unstable form of vitamin E with a short shelf life. A consequence could be a vitamin E deficiency. Another important point to remember is to specify international units (IU) instead of mg for vitamin E. For dl-alpha-tocopheryl acetate, 1 mg is equal to 1 IU. Due to higher relative bioavailability, 1 mg of d-alpha-tocopheryl acetate is equivalent to 1.36 IU. Specifying IU will allow either source of vitamin E to be used.

- Another example is vitamin K, which must be specified as menadione activity. Vitamin K specified at 800 units may result in the correct inclusion of 800 mg of menadione; however, it may also result in inclusion of 800 ansbacher units of vitamin K or the equivalent of only 0.64 mg of menadione.

Not all vitamins listed in Table 4 are added to all swine diets. Many nutritionists do not recommend the addition of pyridoxine, thiamine, or vitamin C to swine diets. Folic acid and biotin are often considered essential for sow diets, but questionable for other swine diets. Removing choline from the vitamin premix improves stability. Thus, choline is often added separately to the diet instead of as part of the vitamin premix, especially when extended shelf life is important.

The minimum inclusion level for vitamins must be listed on a toll-mill or supplier specification. Excess levels of vitamins are not detrimental to pig performance unless they are extreme. Cost of including extra vitamins in the premix will prevent excess levels from being added.

An antioxidant is often added to a vitamin premix. However, fat soluble vitamins that are susceptible to oxidation already contain an antioxidant making the need for addition of further antioxidants questionable. If added, the antioxidant and the desired level should be specified. The most common antioxidant added to vitamin premixes is ethoxyquin. The legal maximum level of ethoxyquin is 0.15% in complete feeds.

A carrier may be needed in the vitamin premix to improve stability, mixing, flow, and handling characteristics and to fill the remainder of the bag for the desired inclusion level. Carriers and diluents in premixes include: rice hulls,

limestone, soybean meal, ground corn, corn gluten meal, or wheat middlings. A mixture of rice hulls and calcium carbonate is a common carrier. When the proper oil binder is used, the physical properties of ground rice hulls allows binding of vitamins that are present in a fine powder form. Calcium carbonate is a low cost diluent that aids in flowability. A premix with a 10 lb inclusion rate may contain as much as 70% carrier. The same premix with a 4 lb inclusion rate may contain 25% carrier. Thus, selection of carrier is important to the characteristics and cost of the premix. If calcium carbonate is used as the primary carrier, the calcium from the carrier must be considered in formulation of the complete diet. A desired bulk density can accompany the specifications for the carrier. A specified bulk density will improve consistency of product and may help flowability of the premix through automated mixing equipment and bins. For example, a statement may be added indicating the carrier should provide a bulk density of 30 ± 5 pounds per cubic foot. Communicate with your supplier to arrive at an appropriate target.

Concentration or inclusion rate per ton of complete feed for the premix also must be determined. Smaller inclusion rates may reduce cost due to less carrier, fewer bags, reduced transportation expense, and reduced warehouse expense. However, the type of feed manufacturing system used by the producer or blender of the final complete feed must be able to accurately mix at the desired inclusion rate. Combined vitamins and trace minerals in a single concentrated premix will decrease the shelf life by reducing stability of the vitamins. Thus, if a producer uses a combination vitamin and trace mineral premix, the decreased vitamin stability must be considered when determining concentration or inclusion rate per ton of complete feed. Premixes should not be stored for more than 30 days to prevent loss of vitamin potency and to avoid unnecessarily tying up cash.

Feed grade mineral oil or a vegetable oil should be added at 1 to 3% to vitamin premixes as a binder to physically stabilize the premix. If mineral oil or another binder is desired in the toll-mill product, it should be indicated in the specifications. The level of oil binder to include in the premix depends on the amount (weight) of vitamins added in a powder form. The binder coats the carrier to allow the vitamins in a fine powdered form to adhere to the carrier to improve mixing and decrease the possibility of separation after mixing. The binder must be uniformly distributed on the carrier before adding the powders to the mix. The importance of proper mixing sequence is another reason to select a reputable supplier known to follow Good Manufacturing Practices.

Although not essential, many premix specifications stipulate a particle size for the final product. An example specification for particle size would be 99.5% should pass through a #14 U.S./Canadian screen.

Type and size of packaging should be included in a toll-mill specification. Multi-walled poly-lined paper bag are desirable for decreased oxidation of the vitamins to increase shelf life, though more expensive. Vitamin premixes can be bagged in other formats or delivered in totes (large containers for bulk lots).

Table 4. Nutrients Provided by a Vitamin Premix.

Nutrient	Units/lb	Most Common Sources
Vitamin A	IU	Vitamin A acetate (retinyl acetate)
Vitamin D	IU	Vitamin D_3 (cholecalciferol)
Vitamin E	IU	dl-a-tocopherol acetate, d-a-tocopherol acetate
Vitamin K (menadione)	mg	Menadione dimethylpyrimidinol bisulfite (MPB)
Vitamin B_{12}	mg	Cyanocobalamin
Choline	mg	Choline chloride
Niacin	mg	Niacinamide, Nicotinic acid
Pantothenic acid	mg	d-calcium pantothenate
Riboflavin	mg	Crystalline or spray-dried riboflavin
Biotin[a]	mg	Crystalline or spray-dried biotin
Folic Acid[a]	mg	Spray-dried folic acid
Vitamin C[b]	mg	Crystalline ascorbic acid
Pyridoxine[b]	mg	Pyridoxine HCl
Thiamine[b]	mg	Thiamine mononitrate

[a]Currently, these vitamins are frequently recommended to be added to sow diets only.
[b]Currently, these vitamins are frequently not recommended to be added to swine diets.

In toll-milling situations, the type of tags and labeling directions for the bags also should be provided. Self-adhesive tags glued to the bags are helpful to prevent losing tags and misidentification. The date of mixing, lot number, and mixing directions should be clearly marked on the tag to ease inventory management and product use. If your feed supplier is providing you with one of their recommended premixes, make sure you understand their coding of lot number and date of manufacturing.

Many farms use more than one vitamin premix. A main vitamin premix contains the major vitamins needed for swine diets. This premix is used at different inclusion rates depending on the vitamin requirements. The second premix contains the vitamins only needed for sow diets (biotin, folic acid, and high levels of choline). If the second premix for sows is used, cost can be dramatically reduced because these expensive vitamins are not fed to all pigs. Different combinations of vitamin premixes can be used to accomplish the same goal.

Trace Mineral Premix

Much of the discussion on vitamin premixes is applicable to trace mineral premixes. However, trace mineral premixes are not susceptible to oxidation making shelf life much less important. Antioxidants are not used and limestone is often used as the only carrier because of cost. Poly-lined bags are less important than with vitamins, but may be desired due to the heavy bulk density of trace minerals. Mineral oil is often added for dust control.

Sources of the trace minerals are as important as sources of vitamins.

For example, copper sulfate contains only 25.2% copper, but is 100% available. Copper oxide contains 75% copper, but recent research indicates that the copper is unavailable to the pig. Zinc and manganese also are less available in their oxide form (70%) than the sulfate form (100%). However, the oxide forms of these nutrients are much more concentrated and are often used to meet the trace mineral requirement due to a lower relative cost or ability to fit the premix in a smaller package.

Some sources of trace minerals also can contain different concentrations of the trace mineral. For example, zinc oxide can be purchased from different sources with concentrations ranging from 70 to 80%. The feed manufacturer can meet the custom nutrient specifications with any of these sources. However, if a custom formula is submitted to the manufacturer with actual amounts of zinc oxide to be included in the premix, the concentration of zinc oxide also needs to be specified to prevent misunderstandings.

Other possible sources of minerals, such as sequestered or chelated minerals, also are available for use in swine diets. Producers should work with a nutritionist to determine the mineral availability and cost-effectiveness of these mineral sources.

The FDA places restrictions on certain nutrients and ingredients.

As of September, 1996, the following restrictions must be followed. Selenium can not be added at levels greater than 0.3 ppm (270 mg in a ton of complete feed). Chromium picolinate can be used in swine diets at added levels no greater than 200 ppb chromium. When used in the diet, chromium is usually added separately from the trace mineral premix. The legal level for MPB (source of menadione) is 2 to 4 grams per ton of complete feed. Another source of vitamin K (Menadione sodium bisulfite complex or MSBC) is only allowed in poultry diets.

Some producers use a single vitamin and trace mineral premix to decrease the number of products needed to be handled in the feed mill. Disadvantages of a single premix include:

1. considerably shorter shelf life compared to storing vitamins and trace minerals separately; and
2. decreased flexibility in diet formulation which can lead to higher cost.

Losses of low stability vitamins, such as vitamin K, increase from 2 to 6 % per month in a vitamin premix without trace minerals to 30% per month in a vitamin premix with trace minerals.

Table 5. Nutrients Specified in a Trace Mineral Premix.

Nutrient	Units/lb	Most Common Sources
Copper	g	Copper sulfate, Copper chloride
Iodine	mg	Ca iodate, Ethylenediamine dihydriodide (EDDI), Potassium iodide
Iron	g	Ferrous sulfate
Manganese	g	Manganese sulfate, Manganese oxide
Selenium[a]	mg	Sodium selenite
Zinc	g	Zinc sulfate, Zinc oxide

[a]Maximum legal limit of supplementation is .3 ppm (270 mg in a ton of feed).

Base Mixes. A base mix is normally added at 50 to 100 lb per ton of feed. Base mixes are sometimes preferred by producers with on-farm mills for several reasons:

1. Fewer ingredients must be handled to mix all diets.
2. Base mixes can be used with more confidence in vertical mixers or older mills that may not accurately mix small additions.
3. Fewer potential errors occur in mixing due to fewer products.

A disadvantage is less flexibility to adjust vitamin, trace mineral or macro mineral levels in individual diets unless multiple base mixes or specific vitamin and(or) mineral premix additions are used.

In addition to the vitamin and trace minerals outlined in Tables 4 and 5, most base mixes also contain the calcium, phosphorus and salt (Table 6). The primary phosphorus sources include monocalcium phosphate (21% P and 15 to 18% Ca), dicalcium phosphate (18.5% P and 20 to 24% Ca), and defluorinated phosphate (18% P and 30 to 34% Ca). Due to the relatively low cost of salt and limestone, minimum and maximum values should be set for salt and calcium in a toll-mill specification. Synthetic amino acids are often added to the base mix to provide more uniform mixing of the amino acids when added to complete feed.

Suppliers often offer antibiotics or other drugs through their base mixes. If desired in a toll-milling situation, the antibiotic source and level should be specified. The feed manufacturer mixing the base mix often can use a more concentrated antibiotic than the producer, decreasing the amount of carrier or filler in the complete diet. Having the antibiotic mixed into the base mix helps ensure complete mixing of the antibiotic when added to the complete diet. If antibiotics are used in the base mix, greater care must be taken by the producer and(or) manufacturer to avoid carry-over to other products.

Table 6. Nutrients Provided in a Base mix.

Nutrient	Units/lb	Most Common Sources
Vitamins		As specified in Table 4
Trace minerals		As specified in Table 5
Calcium	%	Calcium carbonate, Monocalcium phosphate, Dicalcium phosphate, Defluorinated phosphate, other[a]
Available phosphorus	%	Monocalcium phosphate, Dicalcium phosphate, Defluorinated phosphate, other[a]
Sodium chloride	%	Salt
Amino acids[b]	%	L-lysine HCl, DL-methionine, L-threonine, L tryptophan[c]

[a] Meat and bone meal is often used as a source for calcium and available phosphorus.
[b] Amino acids may or may not be included in the base mix. When amino acids are included in a toll-milling specification, each individual amino acid and potential sources should be listed.
[c] Other products with a combination of amino acids or derivatives of amino acids also may be used as sources.

Mineral oil, vegetable oil, or a high quality animal-vegetable fat blend is often added at 1% in base mixes to help control dust. The desired level must be specified in toll-milling situations. Base mixes should be formulated to minimize the quantity of carrier needed to achieve the desired inclusion level in a complete ton of feed. However, a common mistake made when developing toll-milling specifications is formulating a grow-finish base mix with 55 lb of ingredients and specifying an inclusion rate of 50 lb. The specifications must allow sufficient room for all ingredients. Once the maximum level of calcium is met with limestone, another carrier, such as bentonite, corn, or wheat middlings could comprise the remainder of the base mix. Carriers such as corn or wheat middlings in a high mineral base mix can cause product separation.

Because base mixes contain vitamins and minerals in a concentrated form, the shelf life is considerably less for base mixes than for separate vitamin premixes.

Producers should use base mixes within 45 days of mixing to prevent excessive loss of vitamin potency, and to avoid unnecessarily tying up cash. If base mixes can not be used within 45 days, vitamins with relatively low stability (vitamin K) or moderate stability (vitamin A, D_3, and folic acid) may be added in higher levels to account for the calculated losses. This should be considered when developing toll-milling specifications.

Due to the relatively high inclusion rate, base mixes are handled in bulk by many producers. When purchasing in bulk, the manufacturer and producer must have the proper bins and augers to handle the base mix with minimal separation and bridging. Purchasing base mixes in bulk form will decrease the cost compared to buying base mixes in bags. If bagged, two different approaches can be taken. The first approach is to package as much base mix in a bag as possible to decrease cost of bags and bagging. The second approach is to ease mixing by packaging the base mixes in quantities used in a complete diet. For example, a grow-finish base mix may have a 60 lb inclusion rate, and thus, would be packaged in 60 lb bags. A sow base mix with a 100 lb inclusion rate may be packaged in two 50 lb bags. When requesting different size bags for different base mixes, the producer must realize this may increase the manufacturing cost. As discussed above, the type of bags and labeling requirements also should be clearly written on the specifications. If your feed supplier provides services with their base mix program, make sure you understand the intended use and obtain specific mixing directions for your operation.

Table 7. Nutrients Provided in a Supplement or Complete Diet.

Nutrient	Units/lb	Most Common Sources
Vitamins		As specified in Table 4
Trace minerals		As specified in Table 5
Calcium	%	As specified in Table 6, plus energy and amino acid sources
Available phosphorus	%	As specified in Table 6, plus energy and amino acid sources
Sodium chloride	%	Salt
Lysine	%	Amino acid sources as described in Table 2
Other amino acids[a]	%	Amino acid sources as described in Table 2
Metabolizable energy	Mcal	Energy and amino acid sources as described in Tables 1 and 2
Fat[b]	%	Animal fats or vegetable oils
Crude Fiber[b]	%	Energy and amino acid sources
Ingredients[c]	%	Specify ingredient source if desired
Moisture	%	All ingredients

[a]Levels of each essential amino acid or a ratio for each amino acid relative to lysine (% of lysine) should be specified. Major amino acids usually specified include: threonine, tryptophan, methionine, cystine, isoleucine.

[b]Fat and fiber levels may or may not be specified.

[c]Minimum or maximum should be listed for any specialty ingredients.

Complete Diets or Supplements.
Nutrients provided in complete diets or supplements are shown in Table 7. Nutrients provided from a complete diet or supplement include all those provided by a premix and(or) base mix, plus amino acids (protein) and energy.

Many manufacturers offer a variety of purchasing options for complete diets or supplement products. In addition to stock or custom diets, some suppliers will also toll-mill for producers.

To avoid confusion, vitamins and trace minerals, are usually specified as amounts added to the diet. Salt, calcium and available phosphorus are usually expressed as the amount in the total diet. Both minimum and maximum levels should be set for calcium and salt. Fat is usually specified as a minimum and crude fiber as a maximum. However, fat also may be specified as an added amount.

Comparing the energy level in various diets can be difficult.

The energy content of the diet can be expressed as digestible energy (DE), metabolizable energy (ME), or net energy (NE). Metabolizable energy is fairly common, however, the actual ME value of ingredients is variable and the value used by various suppliers can be quite different. Good communication between producers, suppliers, and any advisors is required to assure that the producer is well served. The producer, nutritional advisor, and feed manufacturer may want to agree to the appropriate terminology and energy values for the feedstuffs that will be used in the final diets.

Amino acids are equally complicated. Amino acids can be expressed as total, ileal digestible, or true available values. Total values are adequate in situations where diets are made up of only a few ingredients. In such a situation, maximum limits can be placed on ingredients with poor or variable digestibility. When diet composition changes often and variable byproduct ingredients are used in feed, it is best to express amino acids on a digestible basis.

Unfortunately, no "gold standard" exists for amino acid digestibility. The various methods used produce different answers.

Most systems do not have values for all ingredients and the amino acid digestibility for any given ingredient is not constant. However, ileal digestible values are used by many nutritionists. Reference for ileal and true availability values are provided in Chapter 2. These references are a guide that requires expert interpretation.

Nutrient specifications for the amino acids can be written in two ways.

1. An individual level for each essential amino acid (on a total or digestible basis) for every diet can be listed in the specification. If this method is used, specifications should include at least the following limiting amino acids in swine diets (lysine, threonine, tryptophan, methionine, methionine & cystine, and isoleucine).

2. An alternative method would be to use lysine as a reference amino

acid with other amino acid levels as a ratio relative to lysine. Using this method requires a specification for lysine as a percentage of the diet and a "proportion of lysine" specification for the other amino acids (on a total or digestible basis).

The desired amino acid ratio should be clearly written in the specifications in toll-milling situations. Unless desired for a specific reason, specifications for individual amino acids should be written as minimum standards. Within reason, excess amino acids are not detrimental to pig performance and setting a maximum may actually increase cost of the diet.

Besides agreement to general limitations for energy and protein sources, any minimum or maximum limitations desired for individual ingredients should be clearly written on the specifications for an individual diet. For example, 10% dried whey may be desired in a particular starter diet. The minimum level of 10% should be written in the specifications. If a particular source of dried whey or set of quality standards for the whey is desired, this also should be clearly outlined.

Ingredients, such as antibiotics or feed additives, also should be clearly specified along with inclusion rates.

Remember, feed-grade medications can only be added at their legal limit!

Feed manufacturers ***cannot*** include medications in the feed above the legal level, even with a prescription or upon the request of a producer. Feed medications are discussed in more detail in Chapter 11.

Selecting a reputable manufacturer will help avoid concerns with excessive moisture content. Most suppliers will not warrant a moisture content as ingredients rapidly equilibrate with the surrounding environment. However, a desired range in moisture content should be communicated with the supplier. Moisture levels in finished feed follow a seasonal pattern with highest levels occurring in cold winter months and lowest levels occurring in hot summer months. Examples of maximum desired moisture levels would be 12% for meal diets and 13% for pelleted or crumbled diets.

The desired particle size should be specified as a mean and a standard deviation as discussed in Chapter 4. The particle size can be specified on the grain portion of the diet or the complete diet. An example would be to specify a mean particle size of 600 to 800 microns with a standard deviation of less than 2.0.

Most feed manufacturers follow good manufacturing practices (GMP) to ensure proper mixing and adherence to medicated feed safety requirements. Thus, mixing instructions do not need to be included in the specifications. Form of the final diet can be specified as meal, pellet, or crumble. The size of the pellet also should be specified and appropriate for the animal to be fed (Chapter 4).

Packaging, bag type, and labeling should be specified in a toll-mill specification and are part of the cost consideration. If delivered in bulk, quantities and delivery schedule should be arranged on the

specification sheet or in an additional contract. Delivery costs are discussed in Chapter 8.

Checklist. When purchasing standard products from a supplier, the supplier is responsible for all aspects of his products. In addition to the items listed in the checklist below, a supplier can have a number of steps in his formulation, manufacturing, and perhaps delivery system to ensure quality.

If the producer enters into a toll-milling arrangement, they become responsible for a greater share of the quality control, particularly in the formulation steps.

The most common mistake made when writing nutrient specifications for complete diets is to forget a nutrient or another crucial step.

Specifications should be checked and rechecked using the following checklist to prevent mistakes. Review of final specifications is another area where open communications are important with the feed manufacturer. With open communications, the manufacturer can serve as the final reviewer for nutrient specifications to help correct any problems or discrepancies before the diets are mixed. However, added costs associated with this review may be passed back to the producer.

Checklist for toll-mill specifications.

—— All desired nutrients are listed

—— Levels for each nutrient are correct

—— Units of expressing each nutrient are correct

—— Source for each nutrient is clearly listed

—— Minimum and maximums for ingredients are listed if applicable

—— Sources of ingredients are listed if applicable

—— Desired carrier and bulk density is listed if desired

—— Antioxidant is included if desired

—— Oil binder and level are specified if desired

—— Particle size is specified

—— Packaging is specified

—— Labeling is specified

—— Delivery is specified

Chapter 4: Physical Form of the Diet

Cereal grains are the primary energy source in swine diets. The composition of the grain and how it is processed will influence its value to the pig.

Because feed represents 65 to 75% of overall production cost in a swine operation, improving the efficiency of feed utilization will have a tremendous impact on the cost of production.

Nearly all feed ingredients will be subjected to some type of particle size reduction. Particle size reduction increases the surface area of the grain thus allowing for greater interaction with digestive enzymes improving digestibility and feed efficiency. It also improves the ease of handling, and mixing characteristics. However, extremely fine grinding will increase the energy costs of feed processing and may result in feed bridging, dust problems, and increase the incidence of gastric ulcers. Other processing methods, such as pelleting, can also improve feed efficiency. The added cost associated with each processing method must be compared with expected improvements in feed efficiency.

Particle Size

Considerable confusion has existed concerning the optimum particle size of grain for use in swine diets. This is due in part to broad generalizations classifying dietary particle size. Typically, terms like fine, medium, and coarse have been used to define particle size. A more precise classification of particle size is based on the mean geometric diameter of particles measured in microns and the geometric mean standard deviation of the particles or their distribution (ASAE 1983). These measurements allow more precise definition and should be used to evaluate particle size of the ground grain.

Based on results from several experiments conducted over the past 10 years, a grain particle size of 700 microns is often recommended for all classes of swine including gestating and lactating sows. While the data demonstrates improved digestibility of diets with grain ground to less than 700 microns, problems such as energy costs, milling capacity, bridging, dustiness, and increased incidence of gastric ulcers suggest that 700 microns is an acceptable standard.

The decision on optimum grain particle size needs to include assessment of improvements in feed efficiency versus increase in milling costs and any other negative impacts (e.g. ulcers, handling characteristics, etc.). The data from many sources including Table 8, suggest a grain particle size of approximately 700 microns (with an acceptable range of 600 to 800 microns) to optimize both pig performance and milling efficiency. A smaller particle size may be used for pelleted diets in order to improve pellet quality, but may result in an increased incidence of gastric ulcers.

Table 8. Effect of Grain Particle Size on Apparent Digestibility and Feed Efficiency for Weaned Pigs (initial weight of 15 to 18 lb; approximate final weight of 50 lb).[a]

	Digestibility, %			
Particle Size (microns)	DryMatter	Protein	Energy	Feed/Gain
<700	86.1	82.9	85.8	1.74
700 to 1,000	84.9	80.5	84.4	1.84
>1,000	83.7	79.1	82.6	1.92

[a] Adapted from Ohh et al., 1983.

Particle Size Standard Deviation. Not only is overall mean particle size important for optimum feed efficiency, but the variability, measured by the standard deviation or range of particles around the mean, is also important. Most ground grain samples will have a standard deviation ranging from 1.8 to 2.4. A larger standard deviation indicates more variation in particle size.

Consistent particle size of ground grain may be more important for feed flow and handling characteristics than for pig performance.

However, reducing the standard deviation has been reported to slightly improve nutrient digestibility and reduce ulcers with feed ground to 800 microns or less (Wondra et al. 1995). Therefore, upper acceptable limits for particle size standard deviation should not exceed 2.25 for hammer mills and 2.0 for roller mills.

It is often suggested a mutually agreed upon reimbursement plan be developed for instances where purchased feed falls outside of established limits for mean and standard deviation of particle size. Samples for particle size analysis should be collected from the grain sources used in the diet. Most suppliers will not agree to terms based on measurement of a final feed product. Although the particle size of a complete diet can be measured, it can be subject to error due to variation in particle size of ingredients other than the grain sources. Measurement of particle size after pelleting is of no value.

Methods to monitor particle size are explained further in Chapter 5.

Methods of Reducing Particle Size. Particle size of grain can be reduced with a hammer mill or roller mill. Either mill can do a sufficient job of particle size reduction necessary for optimum pig performance. Hammer mills and roller mills have specific advantages and disadvantages some of which are listed below:

Hammer Mills

1. Easier maintenance
2. Higher horsepower
3. Process wider variety of materials
4. Greater range of particle size
5. Noisier
6. More dust
7. Greater capacity per size

Roller Mills

1. Requires re-grooving of rolls
2. Low horsepower
3. Use for small grains only
4. Narrow range of particle size produced
5. Quiet
6. Little dust produced when milling
7. Greater initial investment

Pelleted Feeds

Pelleting is one of the more common forms of feed processing after grinding. Pellets can be made of different lengths, diameter, and degree of hardness. The ingredients in the diet will influence the hardness of the pellet and pellet quality. When comparing performance of pigs fed either pelleted or meal diets, pigs fed pelleted diets are generally 5 to 8% more efficient. Some of the improvement appears to be the result of less feed wastage with pelleted feeds. Recent evidence suggests pelleting also improves nutrient availability and decreases dry matter and nitrogen excretion. Pelleting improves the value of high fiber feed ingredients more than low fiber ingredients due to the greater impact on handling characteristics. Therefore, the extent of improvement in feed efficiency by pelleting high fiber diets may be more than the expected improvement by pelleting a corn-soybean meal based diet.

When determining the value of pelleted feeds, the ingredient composition of the diet must also be considered.

Suggested Pellet Diameters. Limited research data is available evaluating the optimum pellet diameter for various classes of pigs. However, the following guideline is suggested:

Pig Weight, lb.	Pellet Diameter, in.
< 11	3/32 to 1/8
11 to 15	1/8 to 5/32
15 to 25	3/16 or less
> 25	1/4 or less

Pellet Quality. While pelleting feeds generally result in improved feed conversion, improperly pelleted feeds with a high percentage of fines may result in greater feed wastage, increased feeder management, and reduced feed intake. When considering pelleted feeds, some assurances must be made about pellet quality. In addition, pellets that are too hard may adversely affect pig performance, especially weanling pigs. Monitoring pellet quality as part of a quality control program for the producer is explained in Chapter 5.

Alternative Feed Processing Methods

The benefits in pig performance should outweigh the added costs of the processing if an alternative method is implemented.

There are several alternative feed processing methods. New methods are continually being developed to improve growth performance. Quality of the processing influences the economic competitiveness of each method.

Extrusion. Extruding is a process by which feed is pressed through constrictions under pressure. Extrusion can involve dry heat or steam preconditioning and injection into the extrusion cylinder. As the material is expelled, expansion takes place disrupting the starch granules. Raw soybeans are frequently extruded to denature the trypsin inhibitor and other anti-nutritional factors. Quality control during the extrusion process is critical for production of extruded soybeans to prevent over- or under-heating. Extrusion of complete feeds has resulted in variable effects on pig growth performance and may not justify its use under most circumstances.

Roasting. Roasting is the process by which an ingredient is heated to a desired temperature. Raw soybeans are sometimes roasted to denature the trypsin inhibitor and other anti-nutritional factors. Care must be taken to avoid overheating soybeans during processing. While roasted grains may take on a pleasant "nutty" aroma, little data is available to economically justify roasting grains or complete diets.

Micronizing. Micronizing is the heat treatment of an ingredient or feed by microwaves emitted from infrared burners. Mirconizing should not be confused with popping and the endproduct has a intact, flake-like appearance. Pig performance is not dramatically improved by micronizing cereal grains or complete feeds.

Expanding. Expanders or high-shear conditioners are relatively new to feed processing of swine diets in North America. Little information is available to demonstrate the effects of expanding swine diets on pig performance or pellet quality. As more data becomes available, economical evaluation of expanded diets can be conducted.

Steam Flaking. Steam flaking is widely used to process grains fed to cattle. Data would suggest that steam flaking grains does not result in economical improvements in pig performance.

Chapter 5: Quality Control Program

Preparation of swine feeds is a complex process involving several important steps that must be followed to enhance the probability for optimum pig growth performance and producer profitability. These steps include ingredient procurement, diet formulation, feed manufacturing, and delivery of the complete diet. Each of these steps can be further subdivided depending on a producers individual abilities and needs. Several or all of these processes are frequently handled by various components of the feed industry.

The feed manufacturing process requires a system of checks and balances to ensure that the final product is consistent with the original product description.

To ensure this consistency, a thorough quality control program needs to be developed and implemented based on the specific requirements of the producer. The quality control program should be mutually agreed upon with the feed manufacturer, especially in toll-milling situations. Producers should be aware that a thorough quality control program will cost conservatively between $0.25 and $3.00 per ton of finished complete feed. However, the quality control program is an essential investment that may result in a lower total cost of production due to improved feed quality.

Good Manufacturing Practices form the backbone of a quality control program.

Good Manufacturing Practices (GMP)

The FDA has established guidelines and standards for Good Manufacturing Practices (GMP) for the manufacturing of animal feeds that must be followed by all feed manufacturing facilities. Good Manufacturing Practices are designed to prevent feed contamination and to provide reasonable assurance that medicated feed additives are used properly. The function of GMP is to ensure a safe and residue free supply of food for human consumption. All parties involved with the manufacturing of medicated or non-medicated feed, whether at a commercial mill or on-farm must comply with the GMP.

In order to ensure that a supplier is following standard practices and using GMP, customers are highly encouraged to visit a suppliers production facility before placing orders. In addition, copies of all mixing records and a sample of each batch of completed feed or premix can be requested on designated shipments. Some companies do not allow copies of mixing records to leave their facilities. In many of these cases, the company will show the records to the producer if they come into the mill.

Because of the wide range in feed manufacturing needs, the individual steps in a quality control program will vary greatly. In this chapter, each step in an on-farm quality control program is discussed. For further information on

quality control programs, the Feed Quality Handbook from Elanco Animal Health and the series of Feed Manufacturing Bulletins from the Department of Grain Science and Industry at Kansas State University serve as excellent references.

Sampling

The success of any quality control program depends upon accurate and representative sampling.

Inaccurate and unrepresentative sampling yields meaningless laboratory results and compromises feed producer's credibility with suppliers. It is important to determine when to collect the sample, who is responsible, and how to retain duplicate samples. Visual inspection of a sample gives a cursory estimate of a products physical quality and may allow rejection of the product before it is unloaded. The cost of rejecting a shipment and impact of waiting for a replacement shipment must be considered. Communication between customer and supplier is needed to ensure mutual agreement of sampling procedure and responsibility. The principles of accurate sampling include frequency, location, and size.

Agreement on proper sampling techniques is one of the most important parts of the quality control program. The feed manufacturer usually retains a reference sample at the site of feed manufacturing. The producer may also obtain a sample using one of the acceptable sampling methods discussed in the following sections (probing an undisturbed bin or sampling from moving stream). The reference sample retained by the manufacturer and the sample obtained by the producer are both used in determining whether quality standards are met.

Sampling time. Samples should be obtained at delivery or prior to disturbing the delivery using prescribed sampling methods discussed in the following sections. Samples of complete feed delivered to the production site may be obtained during delivery by sampling from a moving stream while emptying the delivery truck or by probing the delivery truck prior to unloading. After unloading, the only acceptable method of sampling is probing the feed bin prior to running the augers. Running the augers will disturb the bin and prevent accurate sampling by mixing the feed with feed from a previous delivery. Feed samples taken at the feeder or from the bin after the auger has run and disturbed the bin are not adequate samples. Similarly, a single grab sample from the top of the feed bin is not an adequate sample.

Sampling frequency. The number of subsamples taken from a truckload of grain or a batch of complete feed is critical. A single sample from a truckload or rail car of an ingredient or complete feed is almost useless. Whether the final sample is representative and accurate is dictated by the size, number, and location of subsamples, and how the sample is subdivided. The minimum sample size is eight ounces per ton of product. Guidelines for the sampling tools, number of samples, location, and subsampling procedures follow.

Sampling tools for dry materials. The most common equipment used for sampling dry materials is the trier or probe. Triers are made in many sizes and of different designs, from small, 6-inch tapered seed probes to large double-tube, compartmentalized probes up to 5 feet or greater in length.

A 1 inch diameter double tube without compartments (a trier), is recommended for a bag sample. One end is open and the other end is tapered 3 inches to a point. The slot should be approximately 3/4 inch in width. A stainless steel, aluminum, or brass grain probe, 1 3/8 inches in diameter, 40 or 51 inches in length, without compartments is recommended for bulk truck load shipments.

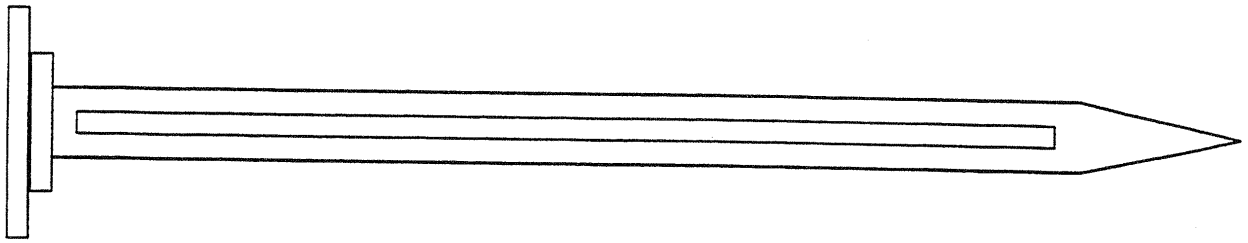


Figure 1. Bag Trier

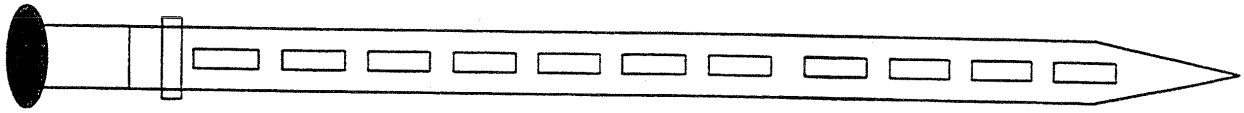


Figure 2. Grain Probe

Sampling a moving stream is easier, and possibly more accurate, but requires a commitment to receive the load. After unloading, rejection is impossible. Sampling from an unloading stream can be done manually or automatically. Manual samples can be taken with very basic or elaborate equipment. Pelican samplers are frequently used to sample materials flowing from a truck. Pelican samplers consist of a container approximately 18 inches long, 2 inches wide, and 6 inches deep, and it can be attached to a handle for sample collection. Grain farmers may be familiar with Pelican samplers as they are used by many grain elevators to sample incoming grain. A clean, one-pound can also may be used for sampling flowing materials. Passing the Pelican sampler or can across the width of a free-falling stream will yield an accurate sample. In sampling complete feeds or ingredients from a stream, care must be taken to ensure that at least eight to ten samples are collected and subdivided. These samples must be collected at even intervals throughout the unloading process.

Automatic samplers are an easier, but more expensive, alternative to manual sampling and are frequently found in conveying systems of large feed mills or where large quantities of ingredients are processed. Automatic samplers can be set to take samples at pre-selected intervals.

Sampling tools for liquid materials. For drums and small containers, a drum thief is typically used for obtaining samples. A drum thief is a glass or stainless steel tube 3/8 to 1/2 inch in diameter. The length will depend upon the size package to be sampled. One end is constricted by a short taper, not more than 1 inch long, to about 1/4 inch. The other end is constricted sufficiently so that it can be used as a finger valve (Figure 3).

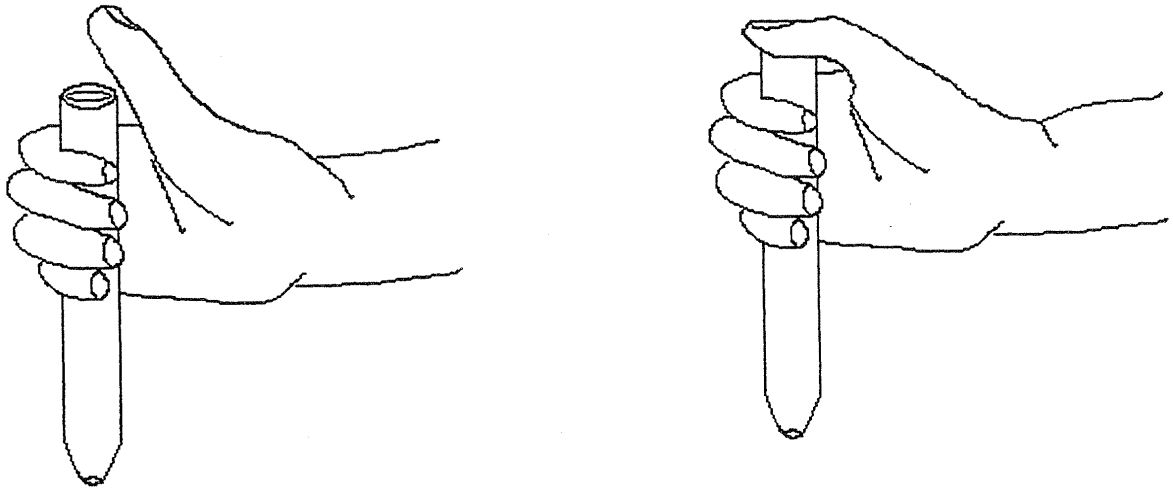


Figure 3. Drum Thief

For bulk tanks, a bomb or zone sampler can be used. These are tightly closed cylinders so constructed that a sample can be taken from any specified section of the tank. The bomb liquid samplers must permit taking a sample from within 1/2 inch of the bottom of the tank. The valves may be manipulated either automatically or by an attached cord (Figure 4).

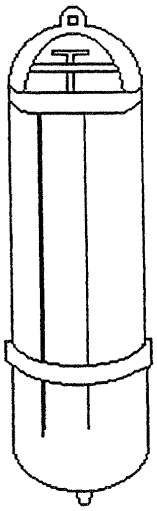


Figure 4. Bomb Liquid Sampler

Ingredient Sampling Procedures

Dry bulk ingredients. Samples must be taken from several locations and properly combined for analysis. As previously described, samples can be drawn during unloading, but rejection of the load is impossible at that point. When sampling from trucks, samples should be taken from the corners as well as the center of the truck.

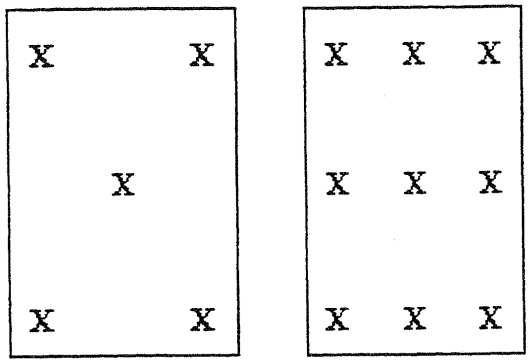
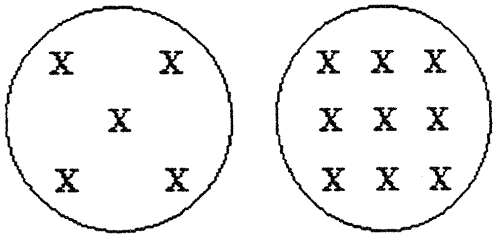


Figure 5. Example Sampling Locations for Trucks.

A similar pattern should be used when sampling grain or feed in bins. More samples need to be taken from grain if it has been stored for a long time, or if mycotoxins or moisture damage is suspected.



Feed or meal Whole grain

Figure 6. Sampling Locations for Feed and Grain Bins.

Bagged feed or ingredients. Samples should be obtained using a bag trier. Samples taken by hand, with a cup or with a dipper, are most common, but fail to provide the best possible sample. The bag should be laid horizontally and probed diagonally from end to end. If the lot contains 1 to 10 bags, all bags should be sampled. For lots with more than 11 bags, samples should be obtained from 10 randomly selected bags. Samples from each bag should weigh approximately 0.5 lb. Samples should be reduced and combined into a subsample for analysis.

Samples for mixer efficiency analysis. The sampling procedure for mixer analysis is slightly different than those procedures to make a composite sample of complete feed or ingredient. The objective of mixer analysis is to determine the coefficient of variation among at least 8 to 10 samples to determine if a batch of feed has been mixed properly. When sampling for mixer analysis, the samples should be probed from different areas in the mixer, or evenly sampled from the stream as the mixer is discharged. These steps should follow similar procedures and equipment used to collect a representative sample. However, the primary difference in sampling for mixer analysis is that the 10 individual samples are not pooled to make a composite sample. This procedure is described in more detail later in this chapter.

Sample reduction. In most cases, the composite sample of an ingredient or complete feed will be larger than needed for laboratory analysis and duplicate samples. Improper subdividing a sample after it is taken may present an even larger problem than obtaining the sample in the

first place. A consistent method of reducing the total sample to a suitable size for the duplicate working sample and retention sample is essential. The classic manual method for dry sample reduction is by quartering. First, the gross sample is completely mixed to obtain one representative sample. The mixing can be done in a bucket using a large spatula. The mixed sample is spread into an even layer on a flat surface and divided into equal quarters. Alternate quarters are selected and similarly quartered until the portions are reduced to the desired size for the two samples needed (one working sample for analysis and one retention sample). The quartering procedure is slow, cumbersome, and not practical for large manufacturers due to large sample size and large number of samples. Therefore, mechanical means are available to obtain representative portions from the gross sample.

For grain sample reduction, the standard divider for splitting grain samples is the Boerner Divider. This divider has been the official USDA Grain Sampling divider for many years and is standard equipment in grain grading stations. For complete feeds and(or) ingredients, subsamples also may be partitioned by a riffler. This device contains a hopper which is divided by a series of chutes that discharge in alternate directions.

How long should samples be kept? An excellent quality control program will collect and store samples from every purchased ingredient and diet. Even if not used for immediate analysis, samples should be maintained until at least the diet or entire lot of ingredient has been fed. If problems do occur with an ingredient or diet, retrospective analysis is impossible without a retained sample of the diets and each ingredient.

Schedules should be outlined to designate the length of time that retention samples should be held. Retention time will vary depending upon the rate of use and turnover of ingredients. It also will depend on the possibility of having negotiations over adjustment of purchase due to excess moisture, deficient protein, or other variance from specifications not extreme enough to cause rejection. Careful, detailed record-keeping is required during this process.

The appropriate retention time is a decision that each producer must make for their own operation. Sample retention time for feed manufacturers will vary from 90 days to 3 years. Typically, non-medicated feeds are retained for a shorter period than medicated feeds. If a producer ever has a drug residue at the processing plant, they will be assumed guilty by the FDA until proof of drug compliance from retained samples. Whatever retention time is selected, some system of storage must be established and maintained as a part of the receiving function. Storage conditions must be set and monitored to ensure that samples do not deteriorate within the time frame of their usefulness. High moisture samples should be frozen immediately after collection. Other samples should be stored in a cool, dry place in an air tight container. Optimal storage for feed samples would be in a freezer or refrigerator.

Labeling the sample. Sample identification is extremely important in a quality assurance program. Sample labels should at least contain the following information:

- date collected,
- unique sequence or assigned number,
- batch number and(or) ration number of the feed,
- analysis requested,
- name of the product, and
- lot number of product.

Samples should be labeled so they remain readable through handling and storage. The permanent record should include the method used (probe, trier, or automatically), the sample name, and number.

Packaging and shipment of samples. The sample packaging has a tremendous effect on the accuracy and usefulness of the assay. The following guidelines will help maintain the quality of a sample before and during shipping:

1. Samples must be protected from changes in moisture. Heavy plastic bags, whirl-pak bags, zip-lock bags, or plastic containers with lids work well for dry uniform feeds. Make sure all bags or containers are properly sealed. Don't use plastic containers if the feed is to be tested for pesticide residues, and never re-use pesticide containers. The use of paper bags is highly discouraged for storing feed samples, with the exception of samples collected solely for the screening of mycotoxins. Paper bags should be used for mycotoxin screening as they prevent the condensation of moisture and further proliferation of mold growth.

2. Minimize exposure to heat. Samples should be stored in a cool, dry place in an air-tight container. As mentioned earlier, high moisture samples should be frozen immediately after collection. Leaving a sample in a car or truck with the windows shut in the summer can cause rapid deterioration of the feedstuffs.

3. Perishable samples should be frozen and shipped on dry ice or blue ice early in the week, if possible, so that they will arrive at the laboratory on a week day. If dry ice is not available, use any of several overnight or second day delivery services. The key is to get the sample to the laboratory before it can deteriorate. Perishable samples would include high liquid byproducts, such as liquid whey or chocolate sludge.

4. Detailed written instructions for the laboratory indicating the type of ingredient and analyses to perform must be included. A range of the expected levels should be included for microingredients to help the lab determine which standards to use in their analysis.

Selection of Reference Laboratories

There are many fine commercial laboratories providing analytical services for the feed manufacturing industry. The reference lab should be mutually agreed upon between the supplier and producer. Once a lab is selected, consistent use of the same laboratory is recommended. Continual switching from one lab to another makes interpretation of results difficult due to lab-to-lab variation.

Price should not be the only consideration when selecting a laboratory.

In selecting a laboratory, the following things should be considered.

Qualification. It is important to find out to which professional associations laboratory personnel belong and which analytical techniques are used by the lab. Official methods are tested and approved by members of these professional organizations. Laboratory procedures are published by the associations. The lab selected should be Association of Official Analytical Chemists (AOAC) and American Association of Cereal Chemists (AACC) approved. Some membership affiliations to look for include: AOAC, AACC, American Chemical Society, American Oil Chemists Society, National Oilseed Processors Association, American Fats and Oils Association, National Institute of Oilseed Products, and American Feed Industry Association (AFIA). Also, check to see if the lab participates in check-sample programs provided by the Association of American Feed Control Officials (AAFCO), AFIA, AOAC, and other professional organizations.

The type of analysis used for various procedures should adhere to guidelines established by the organizations listed above. For example, Near-Infrared Reflectance (NIR) is adequate for dry matter and crude protein only. Some labs will use NIR as a quick test for other analysis, but these results usually are not acceptable for reference samples.

Service. Fast turn-around time can be important. Some labs can report results within three days after receiving the sample. However, a specific or short turn-around time request may incur additional cost. Specialized analyses may take longer. Many labs can report results via fax.

Cost. The most common proximate analyses (moisture, crude protein, crude fiber, crude fat, ash, and nitrogen-free extract) as well as some mineral analyses are not expensive and provide fairly reliable results. However, amino acid, vitamin, and drug assays vary widely in cost and potential analytical variation may render the results relatively useless. It would be advisable to check a price list for each procedure before selecting a particular nutrient analysis and laboratory. Providing a laboratory a range of expected nutrient values in a sample can frequently be helpful.

Payment for Analytical Procedures

A thorough and complete quality control program can add between $0.25 and $3.00 per ton of finished complete feed. These

costs are normally included in the price of purchased stock products. It is recommended the decisions on which analytical procedures are used, where they are conducted, and who pays for specific quality control procedures be agreed upon mutually. These agreements should be included in a contract signed by both supplier and customer in toll-milling situations. Several options are possible for determining who pays for analytical costs in such an arrangement.

Customer. In a situation where a customer is asking that the many services offered by a supplier be separated from the cost of the actual feed or ingredients, it is reasonable that the customer be responsible for all costs associated with a quality control program.

Joint Payment. A second option is to mutually agree upon specific assays for which the supplier would be responsible for the analysis and cost. A supplier also may agree to be responsible for a specific number of assays (for example, 12 crude protein analyses of a supplement or complete diet per year) over the duration of the agreement. When additional or different nutrients, or more frequent testing is requested, it should be the responsibility of the requesting party to pay for the analysis.

Supplier. The customer can leave the responsibility for quality control payment up to the supplier. Again, communication (verbal and written) will be essential so that all procedures and frequency are clearly understood by both parties.

Payment Based on Laboratory Results. Another method to determine payment relies on the laboratory results to determine who is responsible for payment. With this method, the supplier pays for the analysis when the laboratory results indicate the sample was outside the acceptable range. However, if the sample was within the acceptable range, the producer pays for the analysis.

Regardless of who is ultimately responsible for the costs associated with a quality control program, it is essential that the types and frequency of analytical procedures expected of the supplier be spelled out between the customer and supplier. This will prevent the confusion sometimes found when comparing toll-mill bids by preventing situations where one supplier includes analytical costs in a bid and a second supplier does not.

Permitted Variation in Laboratory Results

It is extremely important to understand that if a specific nutrient guarantee is not confirmed by a analytical procedure, that this is not entirely a result of an inferior product. Two of the largest and most important sources of possible error are representative sampling and analytical variation. To try to minimize possible error in analytical testing, a ***representative sample*** must be collected, subsampled, and stored. Therefore, the steps and procedures for sampling outlined earlier in this chapter should be followed. In addition, the Association of American Feed Control Officials (AAFCO) establishes definitions of feed ingredients as well as minimum and maximum nutrient levels for specific nutrients and ingredients. They also establish guidelines for variation of analysis of nutrient content within feeds or ingredients (Table 9).

These can be used as a reference point for determining acceptability of ingredients or finished products based on analytical testing. They are not intended to allow real deficiencies or excesses of the guaranteed ingredient, nor are they intended to cover sloppy work, poor sampling, or any deficiency in analytical or clerical procedures. The acceptable variation is established by AAFCO by sending the same sample to several different labs to determine the variation between results from each lab.

There are several key nutrients that do not have established permitted analytical variation allowances (such as amino acids). For these nutrients, the supplier and customer should mutually determine the acceptable allowances. Analytical variation allowances for feed medications can be found in the AAFCO (1994) Official publication.

Table 9. Permitted Analytical Variations (AV) Based on AAFCO Check Sample Programs.

Analysis	Determination Method[a]	AV%[b,c]	Concentration range
Moisture	934.01, 930.15, 935.29	12	3 - 40%
Protein	954.01, 976.05, 976.06, 984.13	(20/x + 2)	10 - 85%
Fat	920.39, 954.02, 932.02	10	3 - 20%
Fiber	962.09, 972.10	(30/x + 6)	2 - 30%
Ash	942.05	(45/x + 3)	2 - 88%
Pepsin Digest, Protein	971.09	13	
Total Sugar as Invert	925.05	12	24 - 37%
NPN Protein	941.04, 967.07	(80/x + 3)	7 - 60%
Calcium	927.02	(14x + 6)	0.5 - 25%
	968.02	10	10 - 25%
		12	< 10%
Phosphorus	946,06, 965.17, Auto Anal.	(3/x + 8)	0.5 - 20%
Salt	969.1	(7x + 5)	0.5 - 14%
Fluorine	975.08	40	ppm
Cobalt	968.08	40	ppm
Iodine	934.02, 935.14, 925.56	40	ppm
Copper	968.08	25	0.03 - 1%
		30	< 0.03%
Magnesium	968.08	20	0.01 - 15%
Iron	968.08	25	0.01 - 5%
Manganese	968.08	30	0.01 - 17%
Potassium	975.03, 925.01	15	0.04 - 8%
Zinc	968.08	20	0.002 - 6%
Selenium	969.06	25	ppm
Sodium	a.a.	20	0.2 - 4%
	ICP	15	0.2 - 4%
Vitamin A	974.29	30	1200 -218,000 IU/lb
Vitamin B_{12}	952.2	45	
Riboflavin	970.65, 940.33	30	1 - 1500 mg/lb
Niacin	961.14, 944.13	25	3 - 500 mg/lb
Pantothenic Acid	945.74	25	4 - 190 mg/lb

[a] Method Reference fare from 15th Edition, AOAC Official Methods of Analysis.

[b] X = % Guarantee (Example: For a 10% Protein Guarantee AV% = (20/10+2) = 4% of Guarantee. This means the low AV is 4% of 10 or 0.4.

[c] Analytical Variances as derived from the AAFCO Check Sample Program. The ± signs have been removed from the AV table. The table denotes a true analytical variation and not a tolerance. They apply both above and below the guarantee and are equally correct.

Ingredient Quality Guidelines

Visual inspection of purchased ingredients and diets. Because it is often difficult or impossible to reject unloaded ingredients, an initial visual inspection of feed ingredients is recommended. The person responsible for receiving, inspecting and logging in ingredients should know what to look for when inspecting incoming ingredients. Individual mills and large operations may have written "tolerances" for incoming ingredients. However, some judgment is required of the person who accepts incoming shipments. In addition to training, a library of ingredient samples that meet inspection standards is helpful in visual inspection. The following is a list of some of the more common reasons for rejection.

Bulk ingredients or complete feeds. Bulk ingredients include supplements, base mixes, premixes, or individual ingredients. Desirable qualities include:

- Color typical of product— uniform throughout the load.
- Clean, characteristic smell.
- Free-flowing, non-sticking, no wet spots.
- No evidence of heating— off color, warm to the hand, dark germs in grains.
- Reasonable particle size distribution for the product.
- Consistent texture and overall appearance.
- No dirt, mold, sticks, metal objects, sand, gravel or other foreign material.
- No evidence of rodent or bird contamination, or insect damage.

Undesirable qualities that may be cause for rejection include:

- Discolored or off-color material.
- Clumps, moldy spots or "set-ups".
- Musty, moldy or "off" odors.
- Wet spots or hot spots.
- Excessive fines or coarse material.
- Excessive foreign material.
- Evidence of rodent or bird contamination, or insect damage.

Bagged ingredients or complete feed. Bagged ingredients may include supplements, base mixes, premixes, and some specialty ingredients. Desirable qualities include:

- Clean, characteristic smell.
- Content and composition agree with label.
- No evidence of heating.
- No evidence of torn or broken bags.
- Dry— no evidence of having gotten wet.
- Product in bag has not "set-up" or hardened.
- No evidence of bird or rodent contamination, or insect damage.

Undesirable qualities include:

- Discolored or water-damaged bags.
- Hard, set up bags.
- Moldy, musty or "off" odors.

Grains. Grain is subject to a great deal of variation. Moisture content, protein, and test weight will be most critical as indicators for determining grain quality. Foreign materials and presence of molds or other contaminants caused by improper storage should also be noted. A moisture tester and a black light (for aflatoxins) can be practical means for on-farm or commercial mill testing of grain quality. If the initial screen indicates mycotoxin contamination, further analysis should be conducted to determine concentration of specific mycotoxins. Home-raised grains should be sampled and tested as new bins or "fields" are used to manufacture feeds.

It is sufficient to test for protein and moisture content. Due to the high cost of analysis ($70 to $150/sample), and relatively low amino acid content, lysine and other amino acids need not be regularly tested in grain unless the grain is a specialized variety being used specifically for a high amino acid content. With purchased grain, each shipment should be tested until quality is assured. Test weight, moisture, broken and damaged kernels, and foreign material should also be determined on purchased grain as they are useful in determining if the grain meets trading rule specifications as governed by the National Grain and Feed Dealers Association. Care must be taken to ensure that quality standards and expected nutrient levels are met. If growing or storage conditions promote a cause for suspicion, grain should be analyzed for mycotoxins each time the source (bin or supplier) changes.

Soybean meal. Soybean meal is the most common protein source for swine diets. Standards are established for protein, fiber, moisture, and calcium by the National Oilseed Processors Association. The purchaser is entitled to price adjustments should these criteria not meet set standards. However, this price adjustment does not happen automatically. The producer must have the soybean meal analyzed and request a price adjustment. When purchasing a new load, request an official sample and ask the company for a written description of the content. Then send the sample to a refereed analytical laboratory approved by the National Oilseed Processors Association for analysis. If analysis indicates the sample is outside the guaranteed level of the processor, a claim should be filed for a price adjustment. The claim must be filed within 30 days of shipment of the soybean meal from the processor. You may decide to take a duplicate sample for analysis when it is unloaded. However, only the reference sample will be recognized by the processor for price adjustments. Every load should be tested for protein and dry matter content. In addition, calcium should be tested periodically and whenever changing suppliers. Other protein sources also are variable in nutrient content and should be analyzed for protein content as an indicator of amino acid content.

Dried whey, fish meal, and spray-dried blood products. Because these ingredients are often added to baby pig diets, excellent quality is essential. Samples should be tested for protein, dry matter, calcium, and phosphorus periodically and whenever changing suppliers. By using specified definitions established by AAFCO (1994) such as "edible grade" dried whey, "menhaden" fish meal, and "spray-dried" blood products, some inferior quality products can be avoided. Many producers specify certain companies as the source for specialty products due to known quality from past experience. If a supplier has alternatives to these specifications, it is reasonable to request to see test results or other evidence that substantiates the equivalence of such products.

Dicalcium phosphate and calcium carbonate. A common problem for producers using premixes or specifying customer formula feeds is formulating their diet using monocalcium phosphate (15 to 18% Ca and 21% P) and buying dicalcium phosphate (20 to 24% Ca and 18.5% P). Always check feed tags and ingredient labels. Calcium carbonate should be visually checked for particle size and dicalcium or monocalcium phosphate should be periodically tested for calcium and phosphorus.

Complete supplements, base mixes, and vitamin and trace mineral premixes. These should be checked periodically for certain nutrient content (see Tables 12 and 13). Generally, this will include screening for two to four nutrients and rotating the nutrients checked with each batch. Base mixes and premixes should be checked with every change of supplier and then periodically, (every one to two months). Base mixes should be tested for calcium, phosphorus, a vitamin (alternate), and a trace mineral (alternate). In addition, a complete mineral analysis (Ca, P, Fe, Zn, Mn, Cu, and NaCl) is recommended once per year.

If the base mix contains specific amino acids, the level of the particular amino acid should be tested with every change of supplier and then periodically. Premixes also should be checked with every change of supplier and then periodically. One fat soluble (alternate) and one water soluble (alternate) vitamin should be checked for vitamin premixes and one trace mineral (alternate) should be checked in trace mineral premixes. Experts recommend checking the more expensive nutrients, such as protein, phosphorous, vitamin E, and riboflavin. Vitamins should be analyzed within two weeks after receiving the product due to the potential degradation over time.

Fats and oils. Rancidity may be the biggest problem with fat and oil sources. If questionable, check for free fatty acids and MIU (moisture, impurities, and unsaponafiable material). Free fatty acids should be less than 15% and MIU should be less than 2%. When storing fats or oils, it is suggested that they be stabilized with an antioxidant, such as ethoxyquin, BHT, or BHA. Rules, as set forth by the American Fats and Oils Association, govern the purchase of fats and oils.

Complete diets. A stringent quality control program on all incoming ingredients and processing needs to be followed by a check of the final product. Periodically checking diets on a rotational basis is a good way to double check your on-farm system. Analyses should be conducted for moisture, protein, and possibly calcium, phosphorus, and salt.

If complete feeds are purchased, a sampling program is recommended including a periodic basic feed test of dry matter, crude protein, calcium, and phosphorus. Particle size and pellet quality (as appropriate) should also be monitored on a regular (weekly or monthly) basis. Fat and fiber levels also can be monitored as an indication of the energy content of the diet. Because of the variation in analysis and difficulty to discriminate between added and total vitamin and trace minerals, vitamin and trace mineral testing of complete diets is not recommended on a regular basis. However, some producers obtain samples of base mix or premix from the feed manufacturer for vitamin and mineral testing.

Sampling base mixes or premixes is most common for producers using toll milling. When sampled, premixes and base mixes should be tested as discussed above. Finally, samples should be taken, either at the mill or upon delivery, of every batch of complete diet. Regular testing is not done on every batch; however, sampling will provide a reference for later analysis if needed. The sample also provides the opportunity for visual analysis of the feed upon delivery.

Monitoring Particle Size

Particle size should become a routine measure incorporated into the quality control program. Based on the tonnage processed per year, particle size should be analyzed (sieve test) at least every 400 to 600 tons of feed processed. It is highly encouraged to retain samples of grain ground to different particle sizes to facilitate visual inspection of particle size. If you notice whole kernels or even half kernels, these can be indicators of a hole in a screen or worn hammers or rollers. Several commercial laboratories analyze particle size for mean and standard deviation. Shaker-screen testers have been developed and appear to provide accurate results on mean particle size. These may be stationary on site, or portable. If pelleted complete feeds are purchased, it is essential to collect particle size samples from grains before pelleting in order to ensure accurate results.

The greatest effect of particle size is on feed efficiency. Several experiments have measured the effects of grain particle size on pig performance. Feed usage increases about 1.2% for every 100 microns above the particle size goal (Goodband et al., 1995). For example, if feed/gain for 700 micron feed is expected to be 3.0 based on the equation, and particle size increases to 1,100 microns, projected feed efficiency would be 3.14 or 4.8% higher. The exact impact of particle size on feed efficiency will depend on several factors, including the energy level of the diet, age and weight of the animal, and grain source.

Producers also may want to specify a minimum particle size for the grain to reduce some of the handling problems and stomach ulcers associated with small particle size. Variation in particle size also is a concern to be addressed. Ulcers and feed bridging has been attributed to small particles. A maximum standard deviation in particle size or maximum percentage under a certain micron size (such as 300 microns) can be used to minimize variation.

Accurate Weights and Measures

Inaccurate weighing is a major source of error for most swine producers manufacturing their own feed. Commercial feed manufacturers are obligated by law to regular validation of the accuracy of scales being used to manufacture and deliver feed and feed ingredients. Similarly, producers should regularly validate the accuracy of scales being used in complete feed or ingredient delivery and manufacturing. Regular checks of scale accuracy are a smart economic investment, as well as critical for properly mixing diets. Accurate, validated scales prevent overuse of expensive feed ingredients in feed manufacturing and the potential for having underweight delivery of ingredients or complete feed. The Department of Agriculture is responsible for validation of commercially used weights and measures in most states. Several scale companies regularly service and check privately used scales for a fee.

Regular measurement of ingredient density and subsequent adjustment of proportioning equipment is critical for producers using a mill which relies on volummetric measurement rather than weight. Volummetric mills should be checked and adjusted as necessary on a weekly basis and with every change in ingredient source.

Mixers and Mixing

Feed mixer design and mixing time. Feed systems normally use three types of mixers: vertical, horizontal, or rotating drum. Different types of mixers require different amounts of time to thoroughly mix feed (Table 10). The various mixers also have different abilities to mix small quantities of ingredients (minimum inclusion rates). These values are offered as guidelines. Mixing time refers to the time required to obtain an adequate mix after the last ingredient is added to the mixer. Manufacturer recommendations should be consulted and individual mixers should be tested for appropriate mixing times. If smaller inclusion rates are desired than recommended, these products should be mixed thoroughly into a larger volume before being added to the mixer.

Table 10. Typical Mixing Times and Minimum Inclusion Rates for Mixers.

Mixer Type	Mixing Time, min	Minimum Inclusion Rate, lb/ton
Horizontal ribbon	4 to 5	0.5
Horizontal paddle	4 to 5	0.5
Vertical, single screw	12 to 15	20
Vertical, double screw	8 to 10	10
Rotating drum	5 to 10	2

Horizontal mixers with either paddles or ribbons typically require about 4 to 5 minutes to get below the recommended 10% coefficient of variation. A general recommendation is to increase mixing times if fats or other liquids are used in the formulation. Both ribbon and paddle horizontal mixers can be used to incorporate much higher levels of liquids (like oil) into feed than a vertical mixer. Generally speaking, ribbon mixers are a better choice than paddle mixers for mixing swine feeds.

The vertical mixer is composed of an upright tank, usually round, with one or two vertical augers in the center to mix the feed. Smaller, less costly mixers are usually of the vertical type. Vertical mixers usually will require approximately 15 minutes for optimum feed uniformity. Generally, single-screw vertical mixers require longer mixing times than twin-screw mixers; however, there appears to be a great deal of variation in mixing time of vertical mixers. If the mixer has a single elevating screw and is in good mechanical shape, it will usually take 12 to15 minutes to arrive at a uniform blend after the last ingredient is added. A twin screw design may reduce mix time to 8 to 10 minutes.

Portable grinder mixers fall into the same category as single-screw vertical mixers and require at least 15 minutes to adequately mix a batch of feed. However, too many producers gauge mixing time by how long it takes to

drive the tractor and portable mixer to the first feeder or bin after the mixer is filled. To ensure proper mixing, document and use a consistent mix time.

Rotating drum or "cement" mixers also have been shown to be effective in adequately mixing feed and typically require 5 to 10 minutes mixing time. There are two types of rotating drum type mixers. Single action rotating drum mixers blend feed in the same way that cement mixers mix concrete. Double action rotating drum type mixers have a screw-type conveyor in the center of the drum to move feed materials back and fourth in the mixing process.

Mixer performance testing. Mixing efficiency is another term for feed uniformity or how thoroughly a batch of feed is mixed. Mixers should be checked for proper mixing times when they are first installed, then updated periodically as screws, augers, and paddles become worn. This can be once every year or two, depending on tonnage mixed.

The testing procedure involves taking at least 10 individual samples from a single batch of feed and analyzing each sample for a specified nutrient content. Salt is typically used for the analysis because it is relatively easy and inexpensive to test; however, other nutrients can be used. Drugs are not appropriate components for evaluating mixer efficiency due to the cost of analysis and analytical variation associated with most drug assays. If the variation in salt content between the 10 samples is greater than 10%, then the feed has not been mixed properly. Many commercial feed manufacturers will not accept variation of greater than 5%, especially manufacturers of base mixes and premixes. Mixer performance testing consists of two parts— sampling and sample analysis.

The first step in mixer testing involves collecting representative feed samples. This process depends on the type (horizontal versus vertical) and design of the mixer. For example, it is difficult to collect a representative sample directly from a vertical mixer using a grain probe. So, collecting samples at evenly spaced intervals during mixer discharge is recommended. Samples can be taken from the spout end of portable grinder-mixers or near the discharge point for a stationary vertical mixer. Horizontal mixers are usually accessible from the top which permits sample collection directly from the mixer using a grain probe. Samples should be drawn from 10 pre-designated, equally spaced locations around the mixer or at even intervals during mixer discharge. It will be helpful when interpreting data to identify the location or time sequence by numbering the sampling bags from1 to 10.

Feed samples must be collected at intervals over an extended period to determine the optimum mixing time. For example, a horizontal mixer can be evaluated for optimal mixing time as follows:

- Run the mixer to two minutes, stop the mixer and collect 10 representative samples from predetermined, equally spaced locations.
- Run the mixer two more minutes, stop the mixer, and collect ten samples from the same locations as the previous sampling.
- Repeat this process for ten minutes (five sampling times).

Since it is difficult to collect samples directly from vertical mixers, a sampling scheme will involve separate batches of feed that have different mixing times. It

is important to perform this test using the same feed ration and same sequence of ingredient addition to the mixer. The 10 samples should be sent to a commercial laboratory to be tested for the reference ingredient (usually salt). The average salt concentration and variation between samples are calculated to determine a single coefficient of variation. A fact sheet (MF-1172) from the Department of Grain Science and Industry at Kansas State University and the AFIA Feed Manufacturing Handbook explains this procedure in more detail. A guideline from the KSU publication to help interpret results of a mixer test is described in Table 11.

Table 11. Interpretation of Mixer Tests.

Coefficient of Variation	Rating	Corrective Action
< 10%	Excellent	None
10 - 15%	Good	Increase mixing time by 25 - 30%
15 - 20%	Fair	Increase mixing time 50%, look for worn equipment, overfilling, or sequence of ingredient addition
> 20%	Poor	Possible combination of all the above. Consult extension personnel or feed equipment manufacturer

Other factors affecting mixing efficiency. A common misconception is that overmixing or unmixing can occur if feed is mixed too long. There is little information to support this concept; therefore, there is little chance for problems to occur if feed is mixed slightly longer than recommended. As a rule, run your mixer for the required mixing time, then shut it off until you're ready to unload the feed. There's no point in running it any longer, since the feed will not become more uniform and you'll just be wearing out your mixer.

Over-filling the mixer. Very often to save time, producers try to mix more feed than a mixer is designed to handle. This common practice seriously limits the action of the mixer by creating "dead zones". As a result, adequate feed mixing may not take place, even if the mixer is allowed to run for extended periods of time. Paddles should emerge 2 to 3 inches above the level of the feed in a horizontal mixer, whereas vertical mixers should have at least 8 to 12 inches between the top of the screw housing and the top of the mixing chamber. Underfilling a mixer to less than 50% of capacity also can result in an unsatisfactory mix.

Worn equipment. Worn paddles, ribbons, and screws also contribute to increased mixing times. Wear on screws and their housing in vertical mixers will reduce mixing action. Because most of the wear will occur at the bottom of the mixer, this will limit the amount of feed

that can be lifted. A rule of thumb is that if the diameter of the screw is reduced by 1/2 in., then you should increase mixing time by 5 minutes.

Build-up on mixer. Build-up on ribbons or paddles from adding fats or oils and milk products can also interfere with mixing action. Mixers should be cleaned to prevent reduced mixer performance. Fat is often added after the feed leaves the mixer in some commercial mills due to the problem with build-up when fat is added into the mixer. The method of fat addition to the mixer also can influence the amount of build-up. If fat enters the mixer at too high a rate or volume, it may adhere to the mixing equipment prior to being adequately blended into the feed.

Mixer RPM. Low revolutions per minute will limit mixing action in both horizontal and vertical mixers. Horizontal mixers should be turning at 30 to 40 RPM, where as single-screw vertical mixers operate in the 200 to 300 RPM range.

Measuring mixing efficiency on purchased diets. Mixing efficiency also can be measured on purchased complete diets. The same procedures would be followed as explained previously for measuring mixing efficiency of farm manufactured feeds. Equally spaced samples can be taken during unloading or a probe can be used to obtain equally spaced samples from the delivery truck. A coefficient of variation of less than 10% should be used as the standard to ensure adequate mixing.

Sequencing ingredients and feeds. The order or sequence in which ingredients are added to a mixer can significantly affect mixer efficiency.

The ideal sequencing of ingredients into the mixer is:

1. half of the ground grain,
2. protein source,
3. micro ingredients, and
4. half of ground grain.

If this is not possible or feasible, an alternative sequence for charging a mixer is:

1. protein source,
2. microingredients, and
3. ground grain.

If fat is added to the mixer, the rest of the diet should be completely mixed without the fat (dry cycle) and then mixed the required time again after the fat is added (wet cycle). When added at the mixer, fat should be sprayed into the flowing feed to minimize build-up on the mixing equipment.

In sequencing production of medicated feeds with withdrawal times, proper flushing procedures must be followed. After the medicated feed is processed, the next feeds produced should be those for pigs furthest from market, (as in the order: nursery, grower, then finisher).

Pellet Quality

When pelleted complete feeds are purchased, a pellet durability test can be periodically conducted to determine the percentage of fines. Low durability pellets with excess fines are the normal concern. However, care must also be taken to ensure that pellets are not scorched or too hard. Hard pellets are a concern with very young pigs, especially when the pellet size is larger than desired. Scorching of pellets is a greater concern with diets containing high levels of milk products due to potential browning of the milk products denaturing the protein. Over-heating also can destroy a portion of the vitamins in the diet.

A pellet durability test provides an indication of pellet hardness and durability. Samples for this procedure should be collected as pelleted feed is discharged into the producer's bulk bins or by probing the bulk bin prior to running the feed handling system. Samples should be taken at the bulk bin instead of the feeder. The supplier should not be held liable for pellet quality if the customer has an inadequate feed handling system or if feed must be transferred from bin to bin. Normal deterioration in pellet quality is expected between the bulk bin and the feeder.

Due to the limited amount of data, an appropriate pellet quality standard is difficult to establish. Open communications between the supplier and producer is essential to establish guidelines for pellet durability as measured by a pellet durability test or as the percentage of fines in the product delivered to the bulk bin. Appropriate reimbursement schedules should also be developed for when quality standards are not met.

Laboratory Analysis Schedules

As a producer assumes responsibility for mixing their own feed, quality control is vital. A stringent and tough quality control program will avoid the use of inferior ingredients. Quality control programs will vary based on the size of the operation and tons of feed used. However, following are example programs indicating the type and frequency of items to check. These are only examples and each item may be checked more or less frequently, although short-cutting a quality control program greatly reduces its effectiveness. The appropriate schedule for a particular enterprise should be determined in consultation with those familiar with nutrition and feed manufacturing.

The example schedules presented in Tables 12 and 13 are for producers using a base mix, or premix program, respectively. Each table lists the various ingredients to be sampled and the corresponding analytical procedures to be conducted. Please refer to the earlier section on ingredient quality guidelines for specific information about each of the analyses. These schedules are based on the approximate feed usage of a 500 sow, farrow-to-finish operation that would be receiving bulk ingredients (either soybean meal and base mixes or premixes) at 4 to 6 week intervals. The periods listed in the tables would correspond to the frequency of deliveries (ex. months for monthly deliveries). The frequency of sampling and analytical testing may vary based on the frequency and quantity of materials received. For example, a larger customer might be sampling 2 or 3 loads of soybean meal per month, but still receive base mixes at 6 week intervals.

To assist in determining what nutrients to analyze, it is helpful to remember the major contributing nutrients provided by an ingredient. For example, vitamin premixes do not need to be checked for protein content. In addition, it may be advisable to analyze the more expensive nutrients as they may be included closer to their minimum guarantee. Vitamin D may represent less than 1% of the cost of a vitamin premix and is very expensive to analyze, whereas vitamin E may represent 30% of a premix's cost and is less expensive to analyze. Finally, the cost and permitted analytical variation of an analytical procedure should be a consideration. The analysis of vitamin B_{12} is one of the more expensive analytical procedures with a permissible variation of 45% (see Table 9).

Table 12. Example Laboratory Analyses Schedule for a Base mix Program.

Period	Ingredient	Analyses	Approximate Cost
1	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Starter Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
		Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
	Ground grain	Particle size	$10.00 - 15.00
2	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Sow Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
3	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Finish Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
4	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Grower Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
5	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Sow Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
		Choline or Biotin ($53 to $58 each)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
6	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Starter Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
7	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Grower Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
	Ground Grain	Particle size	$10.00 - 15.00
	Mixer test	Mixing Efficiency	$20.00 - 25.00
8	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Finish Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
9	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Grower Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
		Niacin or Riboflavin ($40 to $47 each)	$47.00 - 60.00
	Grain	Visual and test weight (others as indicated by visual)	
10	Soybean meal	Basic Feed test (DM, CP, Ca, P)	$12.50 - 20.00
	Sow Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
11	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Finish Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
12	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Starter Base mix	Individual minerals (Ca, P, Cu, Mn, Zn, Fe, Na)	$12.50 - 25.00
	Grain	Visual and test weight (others as indicated by visual)	
Other	Soybean meal	Crude protein and dry matter on every load	$10.50 - 12.00 each

[a] Every ingredient should be visually inspected and sampled. Approximate cost is for analysis only and does not include the cost of sampling, processing, and shipping samples to the lab.

Table 13. Example Laboratory Analyses Schedule for a Premix Program.

Period	Ingredient	Analyses	Approximate Cost
1	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Trace Mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
		Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
	Ground grain	Particle size	$10.00 - 15.00
2	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
3	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
4	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
		Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
	Ground Grain	Particle size	$10.00 - 15.00
5	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
6	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
7	Soybean meal	Basic Feed Test (DM, CP, Ca, P)	$12.50 - 20.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
		Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
	Ground Grain	Particle size	$10.00 - 15.00
8	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Vitamin E or A ($55 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
9	Soybean meal	Crude protein and dry matter	$10.50 - 12.00
	Trace mineral mix	Individual minerals (Cu, Mn, Zn, Fe, Na)	$10.50 - 25.00
	Vitamin Premix	Niacin, Riboflavin, or B12 ($40 to $63 each)	$63.00 - 70.00
	Sow add pack	Choline or Biotin ($53 to $58)	$58.00 - 70.00
	Grain	Visual and test weight (others as indicated by visual)	
Other	Soybean meal	Crude protein and dry matter on every load	$10.50 - 12.00 each

[a] Every ingredient should be visually inspected and sampled. Approximate cost is for analysis only and does not include the cost of sampling, processing, and shipping samples to the lab.

Producers should provide the lab with as much information as possible to reduce sample preparation time and to prevent redoing analysis. Information should include expected analytical values and chemical form (for example, EDDI, calcium iodate, or potassium iodide for iodine). Producers also should be aware of the chemical form of laboratory results. For example, choline can be reported as choline or choline chloride. Consult with the laboratory or a nutritionist for clarification if needed.

Even if samples are not used for immediate analysis, visual inspection should be done and samples should be taken from every incoming ingredient and complete diet. Visual inspection will identify many problems and help in their prevention. As explained above, retrospective analysis of problems that may or may not be feed related is impossible without reference samples in storage.

Using the Analytical Data

The critical step in a quality assurance program is to implement and use the information provided by the visual inspections and analytical data. These records can provide important historical information about your operation's feeding program. Correct information management will assist in:

1. detecting ingredient or product variation,
2. evaluating suppliers,
3. determining the discount for substandard products,
4. fine-tuning feed rations,
5. explaining animal performance problems, and
6. meeting FDA GMP (if mill is registered).

A simple way to utilize information involves recording lab results in table form (either by hand or on a computer spread sheet program). Columns in the table should include the date material was received, lab number assigned to the sample, ingredient supplier, and assay results. Separate data sheets could be kept for each ingredient or product. These results should be regularly compared with specifications to ensure suppliers are supplying ingredients or products that meet or exceed quality criteria. Calculated nutrient composition can be compared to analyzed values and variation between suppliers can be determined over time.

Recourse

Many producers feel they have little or no leverage with large suppliers when they insist on products that meet the agreed upon purchase specification. Smaller producers should not be intimidated into accepting inferior quality ingredients. Custom, trading rules, and law afford smaller producers the same remedies as major feed manufacturers. If ingredient quality does not meet the agreed specification, contact the supplier. If there are differences in opinions, have an independent third party serve as a referee. The following options are other possible avenues for the buyer.

Rejection. Physical inspection, prior to unloading, is important. If the inspection identifies any of several objectionable characteristics, the delivery should be rejected. Many problems with ingredient quality can be determined by visual inspection of bulk

or bagged ingredients when they are received. In other cases, ingredient quality or quality of the finished feed must be determined through a laboratory analysis, and a reimbursement schedule should be established. Similarly, if subsequent independent analysis confirms that a rejected shipment was within specification, the producer may be expected to bear any costs associated with the rejected shipment.

Deficiency claims. Some trade association rules establish claims mechanisms for resolving quality disputes. If the buyer's analysis of the destination sample or official sample indicates a quality deficiency, the buyer can file a quality adjustment claim. The filing period is usually thirty days from the date of delivery. Methods for calculating the claim amount are stated in the trading rules. If the seller's analysis is different from the buyer's analysis, the seller may deny the claim, negotiate the settlement (often an average of the origin and destination analyses), or a retained portion of the origin sample may be sent to a mutually agreed upon referee laboratory. Concerns should be expressed whenever deficiencies are detected, if only to emphasize the buyer's commitment to receiving quality products.

Negotiation. When trading rules do not apply to a given situation, negotiation with the supplier is an option to find an equitable solution. Most suppliers have a sincere desire to retain their customers and are willing to negotiate to find a solution equitable to both parties. As one purchasing group indicated, they learned that predetermined penalties for deficiencies of particular nutrients by assay do not nurture an environment of good will with suppliers. If a shortage is detected, they now ask for an explanation and a proposal for compensation. For example, a formulation error in a vitamin premix resulted in a settlement that reimbursed the group for the shortage plus a 50% penalty.

Changing Vendors. In most areas, there is usually more than one supplier for any ingredient. If, after a reasonable number of analyses, a feed producer finds they are not receiving the quality or service expected they should find another supplier. The producer should communicate the reason for their decision to their original supplier to improve the product quality, pricing, and services provided.

Consideration of penalties. Should nutrient analysis of manufactured feed products or ingredients fall outside the permitted analytical variation, customers and suppliers have several options for determining compensation. Reimbursement is an issue that needs to be openly communicated between customer and supplier before a business relationship is established. There are three options for establishing reimbursement including mandatory penalties established by the producer, reimbursement schedules provided by the supplier, and mutually agreed compensation.

1. Mandatory penalties can be established by the producer and presented to the supplier prior to the purchase of ingredients or feeds. An example would be a set dollar per unit discount if specified nutrient specifications

fall outside guaranteed levels (with consideration of permissible assay variation).

2. Some suppliers have predetermined, published guidelines for compensation if an ingredient does not meet specifications. Soybean meal manufacturers frequently publish schedules for price adjustments if the protein content of the soybean meal is below the permitted analytical variation of the guaranteed protein content.

3. In cases where there is no predetermined reimbursement schedule, one may be mutually agreed upon by both the customer and supplier. One possible method might simply involve asking the supplier for an explanation for the deficiency and a proposal for compensation. This might include the price differential between the deficient nutrient level and the guaranteed level and possibly some additional compensation based on an allowance for the change in pig performance during that period. While it is relatively easy to calculate the cost differential between deficient and guaranteed nutrient levels and determine a price, calculating differences in pig performance are much more difficult. These calculations can be helped by accurate records to allow calculation of when batches of ingredients were used in complete feeds, the number of animals fed diets with the deficient ingredients, and how long the animals were fed the deficient nutrients. In addition, biological pig performance records can be used to try to approximate changes in pig performance or applying results of research trials to determine a relative percentage change in pig performance.

Regardless of the type of reimbursement schedule, communication between both customer and supplier is essential and an agreement needs to be completed before ingredients or completed feeds are purchased.

Product liability. A supplier is liable when a person or their property is injured by a product they purchase or use. The theory behind product liability is that a supplier should be responsible when a product does not perform to expected standards. There are three legal bases for product liability claims: breach of contract, negligence, and strict liability. Breach of contract involves disputes to a product warranty, either explicit or implied. Negligence occurs if a manufacturer has made a mistake and this results in harm or injury to a customer's livestock. Finally, strict liability refers to a product that may be unreasonably dangerous. For example, a supplier would be liable if a swine premix with high levels of copper sulfate were sold for use in sheep diets. To avoid product liability, a strict quality assurance program should be in use. In addition, a customer can ask a supplier for evidence of their product liability insurance. A typical level of product liability insurance covers at least $1,000,000 per occurrence. However,

some suppliers choose other levels of liability insurance or self insurance. Producers should discuss insurance with their supplier and come to agreement on the level of insurance maintained by the supplier.

Arbitration

Arbitration is a method of resolving legal disputes without going through the traditional court system. It is intended to decrease the costs and time involved in legal disputes. A neutral third party hears both sides and renders a binding decision. An arbitration clause is often included in contracts between producers and feed manufacturers. This clause stipulates the legal aspects of the arbitration agreement. The legal aspects should include: the state of jurisdiction, method for selecting arbitrators, party responsible for notifying arbitrator, and payment of fees for the arbitrator. Arbitration laws vary by state, but a common type of arbitration clause shown below. Underlined portions indicate items that must be tailored to your situation in negotiation between the supplier and producer.

> "It is agreed by the parties that any dispute arising under this contract that cannot otherwise be agreed upon shall be submitted to arbitration upon written request of either party. Binding arbitration will be in accordance with the appropriate arbitration law for the state, unless both parties agree that such procedure is inappropriate for the matter of controversy. Arbitration shall be initiated by either party notifying the other party in writing and requesting a panel of 3, 5, or 7, arbitrators from the American Arbitration Association. The arbitrator will be selected by alternative removal of one name from the panel by each party commencing with the party requesting the arbitration until one name remains. The remaining individual shall be the arbitrator for the dispute. The party requesting arbitration shall notify the arbitrator who shall hold a hearing(s) within 30, 60, 90 of the notice. The decision or award of the arbitrator shall be made in writing within 30 days after conclusion of the hearing(s). Judgment on the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. All fees for arbitration will be divided equally between the parties."

An arbitration clause is meant to decrease the cost and time involved in legal disputes. Open communication of concerns should be the first step with any problem to prevent the need for arbitration or further legal recourse.

Chapter 6: Pricing Basis

There are many considerations when purchasing feed. It is hard to identify the most important factor because many of the factors are intertwined. However, price is a critical component of feed purchasing decisions.

Feed companies offer more localized and customized services to farmers than in the past. This is partially due to the increasingly critical management decisions farmers must make and because of the increasing complexity of production practices. Therefore, service also can be an important component of purchasing feed, but it is important for producers to realize what they are paying for because not all producers need the same services.

In spite of the increased role non-price factors play in the modern marketing process, price remains an important element in the feed purchasing decision.

Methods Used to Set Prices

The method feed processors or suppliers use in setting prices will determine the price producers ultimately pay. Thus, a brief discussion of how agribusinesses set prices is included here so that producers can understand the entire marketing and pricing process. Prices charged by agribusinesses are generally set using one of the following approaches:

1. Cost-based
2. Buyer-based
3. Competition-based

Cost-based pricing. Cost-based pricing, also referred to as cost-plus, consists of adding some mark-up to the cost of producing, processing, and(or) delivering a product or service. Prices based on costs are not necessarily optimal from an efficiency standpoint because they are set without regard to competition and demand for the product or service. However, this method is popular because:

1. it is relatively easy for sellers to establish prices,
2. prices tend to be similar if all firms use this method, and
3. prices established in this manner are often considered to be fairer to both buyers and sellers.

The mark-up above cost can be calculated by using a fixed rate, percentage markup, percentage margin, or a combination of these. A fixed rate markup is a stipulated dollars and cents charge per unit of product (a common method in the early stages of production). Markup charges are often set by leading firms and adopted by others. Variations are seldom found; thus, charges often become identified as a customary fee or charge. Percentage markup is a fixed percent of the incoming cost of a product (a common method at the upper wholesale and retail stages of production). Percentage margin, or marketing margin, is a percentage of sales price which is charged for marketing. If percentage (marketing) margin is 20%,

incoming cost is calculated to be 80% of selling price. For example: if incoming cost is $200 per ton and marketing margin is 20%, then selling price is $250 per ton ($200 / 0.80). A combination markup would involve a fixed rate as well as a percentage markup. This method might be used when a seller faces considerable variability in the cost of one or more of the inputs. Even though costs between firms may be similar, it is still possible for a range of prices to exist within an industry. This is because different sellers may use different costs (such as total cost, total variable cost, average total cost, average variable cost, or marginal cost) for their pricing decisions.

Buyer-based pricing. Buyer-based pricing is based on the principle that prices are set to reflect the buyer's perceived value of the product or service as opposed to the seller's costs. This method is also referred to as demand-oriented pricing because prices are set according to the buyer's demand for a product or service. Non-price variables are used by the seller to build up the perceived value in the buyer's minds. Companies that overestimate the buyer's demand will overprice their products and their products will sell poorly. On the other hand, companies that underestimate buyer's demand for their products will under-price their products. These products sell extremely well, but they produce less revenue than they would if price was raised to the perceived-value level.

From a resource allocation standpoint, buyer-based or demand-oriented pricing is very efficient. However, this method requires the seller to have knowledge of the elasticity of demand for their products and to have some control over the price of their products. Sellers also have to recognize that as buyers' demand or perceived value for a product decreases, prices will also have to decrease to prevent losing market share.

Competition-based pricing. Competition-based pricing can occur in the form of going-rate pricing as well as sealed-bid pricing. In going-rate pricing, prices are primarily set based on competitor's prices with little attention paid to seller's costs or demand. Going-rate pricing is popular in oligopolistic industries (few sellers).

When businesses bid for jobs, competition-based pricing is common in the form of sealed bid-pricing. With sealed-bid pricing, prices are set on expectations of how competitors will price rather than on a rigid relation to seller's costs or buyer's demand. In other words, prices are determined or set to meet the competitor's price and not to preserve a cost markup. In recent years there has been an increasing trend for sealed-bid pricing in the feed industry.

Other factors. Other factors that can affect how agribusinesses set prices are customs, buyer's perception of quality, industry structure, and the firm's objectives. Some prices become customary because they are established and observed over a long period of time with little or no change. An example of customary prices might be a charge for processing feed. Once a price becomes

customary, sellers often find it difficult to increase price without great resistance from buyers. Because of this, sellers may have to change their product or service in order to change its price.

Some businesses recognize the price of their product can affect buyers' perception of its quality (some believe you get what you pay for). Because of the perception that price and quality are directly related, relatively high cost products are associated with high quality. Therefore, price can be important to a business from both a revenue standpoint as well as from an image (product and company) standpoint.

Another factor that affects the prices set by businesses is the competitive structure of the industry (oligopolistic vs. many sellers). Competition-based pricing often exists when there is a high level of competition (large number of sellers) within an industry. On the other hand, an oligopolistic industry with few sellers will tend to use cost-based and buyer-based pricing because they have more ability to control the prices they charge.

Pricing decisions by agribusiness managers will be affected by a pricing objective. Possible alternative price policy objectives can be achieving a target return, stabilizing prices, maintaining market share, or maximizing profits.

Adjustments to Prices

Once the basic price levels are set using one of the previously mentioned methods, companies will often adjust this price to account for various customer differences and changing situations. Some of the different price adjustment strategies used by sellers are:

1. Discount pricing and allowances.
2. Discriminatory pricing.
3. Geographical pricing.

Discount pricing and allowances. Cash discounts are a common way of discounting price. Cash discounts are price reductions to buyers who pay their bills promptly. For example, "2/10, net 30," means payment is due within 30 days, but the buyer can deduct 2 percent from the cost by paying the bill within 10 days. A cash discount serves the purpose of improving the sellers' liquidity (cashflow position) and reducing credit collection costs and bad debt. See Chapter 9 for more information on terms of payment.

Quantity discounts are price reductions to buyers who buy large volumes. Quantity discounts can be offered because sellers typically have a lower cost associated with processing and delivering large volumes. The discounts may be offered on a non-cumulative basis (on each order placed) or a cumulative basis over time.

Quantity discounts provide an incentive to buy more from a given seller rather than buying from multiple sources.

Discriminatory pricing. Discriminatory pricing, also referred to as a variable-price policy, occurs when sellers sell similar amounts to similar buyers at different prices. Sellers may do this to gain the business of certain buyers. By law (Robinson-Patman Act), the price differentials to different customers must be justified on the basis of cost. However, when volumes purchased and delivery sites vary, cost differentials can generally be documented because of the lower cost of manufacturing and delivering large volumes.

Geographical pricing. Geographical pricing adjustments are used by sellers to determine how to set prices for buyers in different locations of the country. Different forms of geographical pricing are FOB origin pricing, uniform delivered pricing, zone pricing, base-point pricing, and freight absorption pricing.

FOB origin pricing means goods are placed free on board a carrier, at which point the title and responsibility pass to the buyer, who pays the freight from the plant to the destination. FOB pricing simply means the buyer is responsible for shipping costs.

Uniform delivered pricing is the opposite of FOB. The same price plus an average shipping cost is charged to all buyers regardless of their location (also referred to as "postage stamp pricing"). With uniform delivered pricing, buyers near the mill subsidize those further away since all buyers pay the same price.

Zone pricing is basically a combination of FOB and uniform delivered pricing. All buyers within a geographical zone pay the same price. Buyers in zones the furthest away from the mill pay more than those in the nearby zones.

With base-point pricing, the seller designates some city as a basing point and charges all buyers the freight from the city to the buyer location regardless of the city from which the product is actually shipped. In this case, the buyer is paying a "phantom shipping cost". There is no law against base-point pricing. However, several court cases found this method of pricing illegal under the Robinson-Patman Act. Freight-absorption pricing might be used by sellers anxious to increase business or sales with a particular customer or area. In these instances, sellers might be willing to absorb some or all of the freight charges to generate business. Freight-absorption pricing is typically used for market penetration and to maintain market share in increasingly competitive markets.

Managing Price Risk

Since feed represents a large proportion of the cost of finishing pigs, setting the price of feed ingredients in advance can help producers manage input price risk. Because it is often not practical or feasible to buy large quantities of feed in advance and store it until needed, setting the price in advance will typically involve some type of contracting.

Another advantage of buying or pricing feed in advance is that it can reduce the time committed to feed purchasing, leaving the manager with more time to concentrate on production. The following is a list of some of the tools or strategies managers can use for purchasing feed ingredients and(or) manufactured feed products.

1. Cash purchases.
2. Forward basis contracts.
3. Formula price contracts.
4. Options contracts.
5. Futures contracts.
6. Forward cash contracts.

The types of risk management tools available will depend on the commodity or feed ingredient being priced.

As a general rule, fewer risk management tools are available as an ingredient is further processed.

For example, producers purchasing corn can use futures contracts, options contracts, forward contracts, or other methods to manage price risk. However, cash purchases and forward contracts might be the only alternatives available when purchasing a base mix or complete diet.

Cash purchase. A cash purchase strategy simply means buying feed as needed. This is the simplest feed purchasing strategy, but it also involves the most price risk. Using this strategy a producer will benefit when prices are decreasing, but they will be hurt when prices are increasing. If production is relatively constant throughout the year, this method of purchasing feeds will result in paying the average price for the year. However, some managers may feel that by locking in prices in advance at some times of the year and making cash purchase at other times, they will be able to pay less than the average price for the year.

Forward basis contract. A forward basis contract locks in the difference between the cash price and the futures price (basis) for a commodity. The price that will ultimately be paid is essentially "tied" to the futures price with a basis contract. This type of contract will only be available for ingredients whose prices can be directly hedged in the futures market, or whose prices can be cross hedged using the futures market. Cross hedging is when a commodity not traded on the futures market is hedged using a closely related commodity that is traded on the futures market. Hedging the price of grain sorghum using the corn futures price is an example of a cross hedge. Because a basis contract only locks in the difference between cash and futures prices, a significant amount of price risk still exists. Therefore, this tool or strategy will do little to reduce price risk. However, when used in combination with hedging in the futures or options market it can be very effective for reducing price risk.

Formula price contract. A formula price contract is similar to a basis contract in that it ties the buyer's price to some predetermined factor(s) or price(s) as opposed to a futures market price. This strategy is similar to the basis contract, in that only a relationship between two prices is locked in, eliminating only a portion of the price risk. An example of a formula price contract is when a supplier's price is the average of several local elevator's prices

on any given day. In this case, the formula price is directly related to local conditions and indirectly related to the futures market price.

Options contracts. Purchasing call options is a strategy that can set a price ceiling for ingredients. However, this strategy is only available for commodities that can be hedged, or cross hedged, in the futures market (as in corn, grain sorghum, wheat, oats, soybeans, soybean meal, soybean oil). This method is attractive because it allows the producer to pay the lower amount if prices decrease while locking in a price if they increase. While option contracts can be used to manage price risk, they do not reduce basis risk unless used in conjunction with a basis contract.

Futures contracts. Hedging in the futures market reduces the risk of prices rising in the future, but does not lock in the basis level. Thus, this strategy can be a good risk management tool because it eliminates much of the price risk. However, it can only be used for those ingredients that can be hedged, or cross-hedged, in the futures market (such as corn, grain sorghum, wheat, oats, soybeans, soybean meal, soybean oil). An advantage of using the futures market to lock in prices compared to cash forward contracts is they typically allow prices to be set further out into the future (15-18 months). Producers can hedge in the futures market on their own working with a broker or through suppliers that offer a hedge-to-arrive contract. A hedge-to-arrive contract operates in the same manner as hedging with a broker; however, the supplier offering the hedge-to-arrive contract is responsible for the margin calls.

Forward cash contracts. Forward cash contracts basically eliminate all input price risk because a firm price is established at the time the contract is negotiated. Because this locks in the price of the major input, breakeven prices can be projected with some certainty. This alternative may be the only risk management tool available for special ingredients, premixes, base mixes, supplements, and complete diets. An advantage of forward contracts is that the terms of the contract are negotiable; whereas, the terms of a futures or options contract are specified. Therefore, producers with good negotiation skills may find it advantageous to use forward contracts compared to futures contracts. Forward cash contracts also may be available for many different quantities; whereas, futures contracts are only available in 1,000 or 5,000 bushel increments.

Producers have several alternatives for managing price risk for the feed they purchase.

It is also important to realize that no one strategy or alternative will always be the best. Risk management strategies such as forward basis contracts, formula price contracts, and forward cash contracts are also methods of securing a future supply of the product from a supplier by requiring them to deliver the product at the contracted basis or price during the specified delivery period. Strategies such as options or futures contracts generally will not result in delivery of the actual product. For these reasons, producers may want to use different strategies at varying times and for different ingredients.

The strategies used for managing input price risk will depend on the financial condition of the operation.

For example, a highly leveraged operation may need to reduce price risk as much as possible even if it means paying a slightly higher price. On the other hand, an operation with low debt that does not have cash flow problems may be able to use feed purchasing strategies that involve more price risk.

Considerations When Setting Or Negotiating Prices

This chapter has discussed methods agribusinesses use for setting and adjusting prices. This is useful information for producers to know because it can help them do a better job of negotiating prices when they purchase feed. This final section is intended to discuss some of the important factors to consider when setting or negotiating prices. These factors include volume discounts, payment policy, pricing basis, and delivery. Delivery is discussed in detail in Chapter 7.

Volume discounts. Volume discounts have become very popular because they can help sellers lower their costs and plan production. Many purchasing groups have been organized to take advantage of volume discounts offered by sellers. The following are some questions buyers might ask sellers with regard to volume discounts.

- Do you offer volume discounts?
- Is volume based on tonnage, total value, or combination?
- Is volume based on single, cumulative purchases, or both?
- Does it matter if purchase is for an individual or a group?
- If group purchased, is delivery to centralized location or individual operations?

Volume discounts are available because they help feed suppliers lower manufacturing, marketing, and delivery costs. Diet requests, such as multiple physical form options, multiple drug options, and multiple custom mixes, cause short manufacturing runs and dramatically increase manufacturing costs. A good relationship and communication between the customer and supplier can increase awareness manufacturing costs to help reduce them.

Payment policy. Some businesses offer discounts if payments are made within a certain time frame. Others may not have a discount policy, but they might have a longer grace period before interest or finance charges are added. An attractive price might not be as good as it initially appears if high interest charges or short repayment periods are added. It is important for buyers to inquire about the payment and credit policy before making any purchases (see Chapter 8 for more information on payment terms).

Pricing basis. While it is unrealistic to assume a seller will explain specifically how they set price, buyers should ask about pricing from a risk management standpoint. The following are some questions buyers might ask sellers with regard to pricing so they can make informed risk management decisions.

- Do you offer a formula price contract, and if so, how are prices determined?

- Do you offer a forward price contract?
- Can I lock in the price of some ingredients without pricing all ingredients?
- How far into the future can I lock in prices?
- Is there a minimum volume for locking in price?
- Is a deposit required to lock in a price?
- Can I purchase feed ingredients myself and have them shipped to you for processing? How will shrink be handled in this situation?
- Are you willing to bid on my specifications?
- What is the processing fee structure for ingredients I deliver to your mill?

Chapter 7: Freight Responsibility and Terms of Delivery

Delivery can significantly affect the cost of feed and production performance measures such as gain and feed efficiency.

Buyers should not overlook the importance of the delivery of purchased feeds. Because the delivery of feed is so important, buyers should discuss and(or) negotiate the terms of delivery with their feed supplier prior to purchasing feed.

Buyers need to know the sellers freight delivery charges prior to purchasing feed. When the price of purchased feed is quoted FOB, a buyer is directly responsible for the cost of freight to the specified delivery point. FOB pricing means goods are placed free on board a carrier, at which point the title and responsibility pass to the buyer, who pays the freight from the plant to the destination. The supplier might make the delivery in their trucks or an independent trucker may be used, but either way there is a specific delivery charge added to the purchase price. With FOB pricing, the freight delivery charge is a direct cost and is known with a high degree of certainty.

It is important for buyers to realize that even if feed is not purchased FOB, they are paying the delivery cost indirectly because there is a definite cost to the supplier to make delivery.

Suppliers may include the actual cost of delivery to individual buyers into the cost of their feed, or they might add an average cost of delivery on to the price of feed for all buyers.

If a supplier charges for delivery based on actual costs, as opposed to averages, then it is important for buyers to know these charges and how they are determined. Factors that will affect delivery charges will be the distance from the mill, load size, number of stops, number of bins per stop, biosecurity requirements, and lead time required. Flexibility for timing of delivery and batch sizes affect the cost of delivery. In general, the cost of delivery will increase when producers have rigid delivery times. Producers unable to order batch sizes matched to the delivery capability of their supplier also will increase the cost of delivery.

It is important for buyers to be somewhat flexible with respect to delivery so the benefits of good pricing decisions aren't offset by high delivery costs.

If the supplier bases delivery charges on average costs, buyers close to the mill will essentially be subsidizing buyers further away from the mill. If this is the case, buyers close to the mill may be able to negotiate for delivery charges below the normal rate.

In addition to the cost of delivery, buyers need to know what the supplier can and will do from a delivery standpoint. The following are some questions buyers might ask suppliers with regard to their delivery policy and capabilities:

- What is lead time required before delivery can be made?
- Do you have a minimum load size?
- Is there a maximum number of bins per stop or per site for each load?
- What is the number and size of compartments in your trucks?
- What is your policy or procedure for maintaining biosecurity?
- Are there times or days when delivery cannot be made?
- Do your delivery capabilities change seasonally?
- What can I do to help you reduce your delivery costs?
- What are normal delivery days and holidays observed?
- What are normal delivery hours?

As mentioned previously, suppliers also have an interest in negotiating terms of delivery with potential buyers.

Suppliers will not want to commit to a feed and(or) delivery price if they do not know what they are getting into.

The following are some questions suppliers might want to ask potential buyers with regard to making deliveries.

- Are the roads to the delivery site(s) capable of handling delivery trucks in varying weather conditions?
- What is your expected volume and frequency of purchases?
- What lead time will you give us before expecting delivery?
- Do the conditions of your facilities represent any safety hazards?
- What biosecurity or other special requirements are there for deliveries?
- Do you have multiple sites where delivery will be made?
- Will there be somebody present when deliveries are made, and if not, what will be done for proof of delivery?
- Can bin sizes and deliveries be matched to the capacity of compartments in our trucks to maximize feed hauled with each trip?
- What is the unloading capacity of your system?

When the buyer arranges for the pickup of feed, the buyer is responsible for the condition of the truck. It should be free of contamination, holes, leaks, moisture, and so on. To prevent contamination, the buyer or trucker cannot be allowed to haul non-feed items with the feed.

Delivery of purchased feed is important from both a cost and production standpoint. Buyers need to inquire about the freight delivery charges so they can evaluate the total cost of ingredients or feed purchased. Buyers also need to find out what the delivery capabilities of suppliers are to make sure feed can be delivered where and when it is needed. Similarly, suppliers need to ask buyers questions with regards to conditions of roads and facilities to assure they will be able to make deliveries in a timely and safe manner.

Chapter 8: Terms of Payment

When buyers negotiate with suppliers on the many factors mentioned in this manual pertaining to feed purchases (specifications, quality, price, delivery, etc.), they also need to discuss the supplier's payment policy. Many agribusiness firms will have some type of credit policy; however, it should not automatically be assumed that is the case. In addition, even though a seller may have a credit policy, the payment terms can vary considerably between firms and within firms for different purchases. This section discusses terms of payment as they relate to both cash and credit purchases.

Even though most suppliers may have some type of credit program, there may be some suppliers that use a cash payment policy only. This may be done so they can better manage their cash flow situation or because of the cost of selling on credit. In some instances, suppliers may have a credit program for some buyers while requiring other buyers to purchase on a cash payment basis. Buyers restricted to cash purchases generally are those with a poor payment record or new buyers without a past history with the supplier.

The main instruments that will be used by a supplier with a policy of cash payment only will be a draft before shipment or cash on delivery (COD). Draft before shipment simply means the supplier requires payment before the product will be shipped or manufactured. Draft before shipment may also be referred to as cash in advance (CIA). Cash on delivery simply means payment is expected and due upon delivery and that no credit is being extended.

As mentioned previously, many agribusinesses offer buyers some type of credit program for purchases of inputs. Some of the reasons suppliers might offer credit purchases are the following:

- Provide customers with a convenient and simple way of financing purchases.
- Promote sales and meet competition.
- Promote increased sales to reduce per unit fixed costs.
- Earn additional revenue from finance charges a customer pays to obtain credit.

Typically, the major reasons for offering credit will be to maintain or increase sales and as a convenience to buyers and not to earn revenue from finance charges.

Suppliers normally do not offer credit to compete with lending agencies, rather it is offered as a service for customers and to maintain market share.

Some suppliers also may offer credit for inputs and(or) capital investments for items other than their products and then require the buyer to purchase inputs from them. For example, a feed company may be willing to finance facilities if the buyer agrees to purchase feed from the company for the duration of the facilities loan. While this can provide much needed

capital, especially for somebody with limited borrowing capacity, it is important that buyers fully evaluate the total cost of the credit as they would evaluate and compare the cost of other inputs.

The costs of offering credit from the suppliers standpoint can be divided into direct and indirect costs. Direct costs vary directly with the number of credit accounts and the volume of credit extended. Direct costs include items such as supplies (forms, stationary, envelopes), postage, collection costs, bad debts, and interest. Interest cost will either be the cost of money the supplier is borrowing or the opportunity cost of not collecting the money at the time of the purchase and investing it in an alternative use. Indirect costs are those costs that are incurred as a result of extending credit, but do not vary proportionately with the volume of credit extended. Examples of indirect costs are time spent in credit appraisal and billing, additional employees and any special office equipment or computer programs needed.

While producers do not necessarily need to be concerned about costs to the suppliers for offering credit, they need to keep in mind that there is a cost associated with offering credit. If credit rates are significantly below other lenders, buyers may want to make sure the difference is not being made up on the price of their products and services. Truth in Lending legislation was enacted by the federal government requiring dealers and other financial institutions to disclose the details of their credit arrangements so that the customer can compare the cost of credit from different sources. However, agricultural businesses are exempt from the requirements of the Truth in Lending legislation in most states. Therefore, producers may need to request the details of credit offered by suppliers in order to compare credit costs. Buyers should keep in mind that even if credit costs are slightly higher from an input supplier compared to other lending agencies, the added convenience and flexibility may justify the higher cost.

The types of credit instruments typically used by agribusiness firms are the open book account and the promissory note. The open book account is the credit instrument used most often. In this arrangement, the value of the products or services sold on credit to each buyer is recorded and evidenced by sales invoices, delivery receipts, or shipping tickets. Billing occurs on a regular basis (monthly, weekly, etc.) and interest is charged on accounts that are not paid in a timely manner. The security interest or liens, a supplier has when open book credit accounts are used, will depend on state laws and thus vary from state to state. A promissory note is the buyer's written promise to pay the seller a definite sum of money at a specified time and may be secured or unsecured. A promissory note is a much more formal structured type of credit purchase because payment dates and amounts are specified at the time of the purchase. Along with the credit instrument, the collection policy of the seller will be important in evaluating the cost of credit to a buyer.

Factors Determining the Cost of Credit

Cash discount rate. The reduction in the price of the input, if any, if the bill is paid within a specified number of days after the purchase date or by a certain date in the month following the purchase. The cash discount rate may be specified in percentage or absolute terms. For example, a cash discount rate may be quoted as either 2% or $10 per ton of the purchase price. Cash discounts typically will range from 1 to 5% with 2% being common. An example of a cash discount might be the following: deduct 2% from the purchase price if paid by the 10th of May for purchases made in April. Not all sellers offer a cash discount.

Cash discount period. The time between the purchase date and the date on which the buyer must pay in order to receive a discount. Cash discount periods might range from 0 to 30 days. If the cash discount period is zero, this means a buyer would have to make payment at the time of the purchase in order to receive any cash discount.

Account due period. The number of days between the purchase date and the date when full payment is due. If referred to as the account due date, this is simply the date when full payment is due.

Finance charge rate. The penalty or interest rate the buyer must pay if the amount is not paid by a specified date. The finance charge may also be referred to as a late payment charge. The finance charge commonly ranges from 1 to 1.5% per month on the unpaid balance, but there is a considerable amount of variability in this charge between sellers. Therefore, it is important for buyers to know what the charge is and when it is imposed. Buyer's also need to be aware if there is a minimum finance charge and(or) the amounts of late payment penalties.

Finance charge period. The number of days between the purchase date and the date the finance charge is imposed. This is commonly referred to as the "grace period".

Determining Value of a Discount. A cash discount serves the purpose of improving the sellers' liquidity (cashflow position) and reducing credit collection costs and bad debt. Cash discounts are price reductions to buyers who pay their bills promptly. For example, a cash discount for many businesses is 2 percent for cash payment within 10 days. The term "2/10, net 30," means payment is due within 30 days, but the buyer can deduct 2 percent from the cost by paying the bill within 10 days. This cash discount can be converted to an equivalent annual interest rate using this formula:

Equivalent annual interest rate =

$$\frac{\text{(cash discount rate x 365)}}{\text{(account due period - cash discount period)}}$$

Example of 2/10, net 30:

$$\frac{(2 \times 365)}{(30 - 10)} = 36.5\%$$

In this case, buyers will pay a charge equal to 36.5% annual interest if they pay in 30

days rather than paying in 10 days to get the cash discount. If a cash discount is offered, it will usually be to the buyer's advantage to accept the cash discount if there is not a cash flow problem. The equivalent annual interest rate is greater than the return the funds would otherwise earn. If cash flow is a problem, the funds can be borrowed from other sources for less than the equivalent annual interest rate. It can be seen that the discount rate, discount period, and account due period all affect the equivalent annual interest rate; thus, buyers should consider all of these when evaluating cash discounts offered by sellers. Following are examples of some common cash discount rates, discount periods, and account due periods.

- 10 days net 30 days
- 2% 10th prox net 30th prox*
- $3 per ton 15 days, net 45 days
- 2% 30 days net 60 days
- No discount, net 60 days

(* prox is the abbreviation for proximo, meaning "occurring in the next month.")

If a seller is extending credit through the use of a promissory note, additional information or variables that also apply include:

Note issue period. The number of days between the purchase date and the date the note is issued. If a note is not issued at the time of the purchase, the difference between the purchase date and the date the note is issued would be similar to the finance charge period (grace period) mentioned above.

Interest rate. The annual percentage rate charged on the note from the time the note is issued until the end of the payment period.

Note payment period. The number of days between the note issue date and the date when it is due. The length of the note payment period will depend on what is being financed. Short-term inputs such as feed will generally have relatively short-term payment periods as well.

Credit information requirements. In addition to the above collection policy information, Truth in Lending regulations require non-agricultural dealers to provide the following information on the monthly statement for open-end credit arrangements (open book account). Agriculture producers should request similar information to evaluate credit cost. Additional information is required for installment plans and credit other than open-end.

- Annual percentage rate (APR).
- Unpaid balance at the start of the billing period.
- Amount and date of each extension of credit and identification of purchased items.
- Payments made by a customer and other credits (returns, rebates, and adjustments).
- Rates used to calculate finance charge and range of balances to which they apply.
- Unpaid balance on which finance charge was calculated.
- Closing date of the billing cycle and unpaid balance at that time.

Summary

Credit offered by suppliers can be a good source of capital for buyers from a cost and convenience standpoint.

However, because of the cost of providing credit incurred by suppliers, suppliers may discontinue credit sales for customers with large unpaid balances. Because of this, buyers should not assume they will always be able to "buy on credit". The credit policies and terms will vary considerably between suppliers so it is important for buyers to compare the cost of credit between sellers.

The cost of credit may look relatively low compared to other credit sources if its cost is subsidized by the price of the supplier's products and(or) services. Similarly, the cost of credit may appear high if it is subsidizing other services. Buyers need to consider all aspects of their purchase (price, credit, services) when making their purchasing decisions.

Services can be an important component of purchasing feed, but it is important for producers to realize what they are paying for because not all producers will need the same services.

Chapter 9: Biosecurity for Feed Purchasing

Biosecurity is defined as the measures taken to prevent the introduction of infectious disease pathogens. Therefore, methods of purchasing and delivering feed and feed ingredients to exclude pathogens are important components of a farm biosecurity plan. As with any disease control procedure, biosecurity measures are a cost. However, the cost must be balanced against the potential economic impact of the introduction of a pathogen.

Biosecurity for Feed Ingredients

The risk of transmitting infectious disease through feed ingredients is relatively low. At the current time, there is little documented evidence of feed-born transmission of pathogens other than *Salmonella spp.* It also should be noted that the most common species of salmonella causing clinical disease in swine is *Salmonella choleraesuis*. However, this species is rarely isolated from feed. Other swine pathogens potentially transmitted by feed include the foot and mouth virus and swine vesicular disease. Fortunately, the United States is free of these two diseases and it is unlikely they would contaminate US feed ingredients.

Risk of feed-born pathogens is greatest from protein sources of animal origin. However, many of these ingredients have excellent nutritional characteristics that make them cost effective additions to swine diets. Protein sources of animal origin should be relatively free of pathogens because they receive a heat treatment process that should destroy most known swine pathogens. The most common source of pathogens in these ingredients is improperly following the procedures for heat treatment or recontamination after the heat treatment. For example, using the same truck to deliver meat and bone meal and to haul raw material or personnel that work in both the raw material receiving and the finished product load out areas.

Risk of feed-born pathogen transmission may also affect ingredient usage depending on the type of pigs being fed. For example, a higher risk of infection may be tolerated in an all-in/all-out barn containing terminal-cross finisher pigs because the potential loss will be confined to that group of pigs. However, if the finisher contains gilts to be used in the breeding herd, even low risks may not be acceptable. The risks would not be tolerated because an infection of animals in that group could transmit the pathogen to the sow herd and it's progeny. This example illustrates the importance of communication to the feed manufacturer or ingredient supplier of the relative risk of disease transfer and the potential economic implications.

Controlling feed-born pathogens. Procedures to minimize the risk of feed-born pathogen transmission include purchasing ingredients from manufacturers that follow Good Manufacturing Practices (GMP) and have a regular microbial

testing program. Producers should require products sourced from ingredient suppliers following Food and Drug Administration (FDA) specified Good Manufacturing Practices (GMP). Most reputable manufacturers of ingredients with a pathogen risk have a regular microbial testing program to protect their clients. Producers should not hesitate to request results of salmonella testing on any protein sources of animal origin (such as meat meal, meat and bone meal, blood meal, animal plasma). If the ingredient supplier is unable or unwilling to provide these results for each lot of ingredient purchased by the producer, the producer should consider alternative ingredient suppliers.

In addition, if the risk of pathogen transmission is high, an individual producer should institute microbial testing. Feed processing procedures, such as pelleting and extrusion, that subject the feed to a heat treatment also will reduce the risk of feed born pathogens. Surveys have indicated that meal feeds are more likely to be contaminated with *Salmonella spp* than pelleted feeds. One problem with testing is that products may be 100% free of *Salmonella spp* or other pathogens at the time of initial processing, but may be exposed to pathogens during transport, handling, bagging, or storage. A product that does not culture pathogens at the time of processing may culture pathogens 30 days after processing and handling, even under the best of conditions. Guidelines are available from the American Feed Industry Association (AFIA) for salmonella control.

If the producer is purchasing complete feed or obtaining ingredients from their feed supplier, the supplier may have a microbial testing program for specific ingredients as part of their quality control program. Clear and open communications between the swine producer and feed supplier may minimize the need for producers to repeat this effort.

Biosecurity for Feed and Ingredient Delivery

As with feed ingredients, there has been little documented association between feed delivery and pathogen transmission. The logistics of feed and ingredient delivery make changing of driver clothing, frequent disinfection of vehicles, or observing down time away from other swine difficult to implement on a practical basis. Therefore, consider all feed delivery personnel and vehicles as having potential for carrying pathogens but with a relatively low risk of transmitting them. Recommended guidelines for feed delivery biosecurity are listed in Table 14.

A well defined written policy for biosecurity of feed delivery should be instituted and communicated to the feed or ingredient supplier. This policy should specify the desired procedures for delivery and exact locations for delivery so that delivery personnel do not enter facilities.

The relative risk for the transmission of swine pathogens is low from feed, feed ingredients, or feed delivery.

However, implementing simple biosecurity measures will further decrease the risk.

Table 14. Biosecurity Guidelines for Feed Delivery.

- Feed bins and ingredient storage areas should be located so delivery vehicles and personnel never have contact with pigs or swine facilities.
- Delivery personnel should be instructed never to enter the swine facilities.
- Delivery vehicles should be dedicated solely for the hauling of feed or feed ingredients.
- Delivery personnel should be instructed to avoid contact with live animals, carcasses, and(or) manure.
- Trucks should not be driven in areas where they will be in contact with swine manure.
- Trucks should be kept clean and be disinfected if in contact with swine manure or carcasses.
- Make feed deliveries to higher-health status locations on Mondays or first thing in the morning.

Chapter 10: Feed Additives— Use of Medication in Feeds

Feed additives are used in swine diets to improve the pig's feed efficiency, promote faster gains, or prevent or treat disease. Proper manufacture of medicated feeds is important for safe and effective use. The FDA requires minimum production standards, called Current Good Manufacturing Practices (CGMPs) for all medicated feed manufacturers, including pork producers with on-farm mixing operations. Live animals are considered unprocessed food. Therefore, the FDA will use the food provisions of the Federal Food, Drug, and Cosmetic Act to enforce the use of medication in food producing animals.

Feed medication usage should be done in consultation with a veterinarian. Information on available drugs, indications for their usage, dosages, withdrawal times, and labeling requirements are available in the *Feed Additive Compendium*. Feed manufacturers and veterinarians refer to the *Feed Additive Compendium* as a source of information on feed grade drugs used in livestock. Producers should have open communications with their feed supplier and veterinarian to be updated on feed medication changes as listed in the *Feed Additive Compendium*. Table 15 includes a partial listing of feed grade medications, dosages, and withdrawal times.

Before using or producing medicated feeds, producers should understand the terminology used with different medications. First, a medicated feed is any manufactured or mixed feed that contains drug ingredients intended to promote growth or feed efficiency or to cure, mitigate, prevent, or treat diseases of animals other than man. Medicated products (feeds or ingredients) are categorized as Type A, B, or C. The main difference between the three types is the concentration of the drug as described below:

- Type A— The most concentrated form of a medicated feed additive. It usually consists of the drug source and a carrier and can be used to manufacture another Type A medicated article or a Type B or C medicated feed.
- Type B— A medicated feed containing an animal drug and a substantial amount of nutrients (vitamins, minerals, or other nutritional ingredients). At least 25% of the Type B medicated feed must be nutritional ingredients.
- Type C— A medicated feed that is intended to be a complete feed. This feed is made by diluting a Type A, B or C product.

Drug ingredients used to make the Type A medicated article or Type B and C medicated feeds are divided into two groups:

- Category I— Drugs for which no withdrawal period is required at their lowest continuous feeding level.
- Category II— Drugs that require a withdrawal period at the lowest feeding level or are regulated on a "no-residue" basis.

Registered vs. Nonregistered Feed Mills. The significance of these different categories for drugs and medicated feeds is their use in explaining the difference between a registered and nonregistered feed mill. If a mill wants to purchase and use a Category II drug in a concentrated form (Type A), they must be registered and receive approval from the Food and Drug Administration as a medicated feed establishment. Nonregistered mills can use any Category I, Type A, B or C medicated article or feed and Category II, Type B or C medicated feeds. Registered mills are subject to regular inspection by the FDA to ensure adherence to CGMPs. While not regularly inspected by the FDA, nonregistered mills can be inspected to confirm registration status of the mill, to follow up on a report of a drug residue, or for other appropriate reasons. Also, the feed control office in your state may conduct routine inspections to determine compliance of your facility with applicable CGMPs that are required by the FDA. Most on-farm feed mills are non-registered mills. Operators of on-farm mills must keep abreast of current rules and regulations, especially concerning the production of medicated feeds.

An important point should be noted that licensed veterinarians, feed manufacturers, and lay persons may order, produce, or use drugs in medicated feeds **ONLY:**

- If approved by FDA.
- In the manner as they were approved.
- As labeled.
- As provided by a form FDA-1900, where applicable

NOTE: No persons (licensed veterinarians, feed manufacturers, or lay people) have "extra-label" drug use provisions for adding drugs to medicated feeds.

Table 15. Partial List of Approved Medications and Withdrawal Times for Swine (June, 1996).[a]

Drug	Trade name	Withdrawal Period
Apramycin	Apralan	28
Bacitracin	BMD, Bacitracin zinc	0
Bambermycin		0
Carbadox	Mecadox	70
Chlorotetra-cycline	Aureomycin, CTC	0
Lincomycin hydrochloride	Lincomix	
	20 or 40 g	0
	100 or 200 g	6
Oxytetra-cycline	Terramycin, OTC	
	< 500 g/ton	0
	500 g/ton	5
Oxytetra-cyline plus	Neo-terramycin	
	< 140 g/ton	5
	140 g/ton	10
Sulfamethazine	Aureomix 500 Tylan 40 Sulfa-G	15
Sulfathiazole	CSP-250, CSP-500, Aureosol	7
Tiamulin	Denagard	
	10 g/ton	0
	35 g/ton	2
	200 g/ton	7
Tylosin	Tylan	0
Virginiamycin	Stafac	0
Anthelmintics		
Dichlorvos	Atgard	0
Fenbendazole	Safegard	0
Hygromycin B	Hygromix 8	15
Ivermectin	Ivomec	5
Lavamisole hydrochloride	Tramisol	3

[a] A more complete listing including cautionary statements and indications for use appears in the *Feed Additive Compendium*. **Approved medications will change over time. The *Feed Additive Compendium* is a reliable source for updates on approved medications and withdrawal times. Contact your supplier for further information on feed medications available.**

Veterinary Feed Directive

A new system of feed medication usage is available. The new system will be termed Veterinary Feed Directive (VFD). The VFD will only be used for new veterinary therapeutic feed drug approvals. Usage of a VFD will require a veterinarian-client-patient relationship. Once the relationship has been established and the veterinarian and producer determine that the drug is the most appropriate to use, the veterinarian fills out a VFD form. The VFD form indicates the identity of the animals, directions for usage and withdrawal times, and the total amount of drug needed. The producer then uses the form to purchase medicated premix and(or) feed from the medication supplier. Only the amount of drug to treat the animals specified on the form can be purchased. The forms will be monitored by FDA to assure compliance with the guidelines for use.

All swine producers and feed manufactures should follow CGMPs and guidelines outlined in the PORK QUALITY ASSURANCE℠ LEVEL III℠ program to ensure that safe residue-free pork is produced.

Who is Responsible for Violations?

The swine producer is ultimately responsible for all violations.

The responsibility can be passed up the feed processing chain if fault lies at another level; however, ultimate responsibility lies with the producer. Penalties may include condemnation of swine carcasses, seizure of feed products, and/or criminal prosecution.

When violations occur due to feeding a properly mixed and formulated diet in an incorrect manner, the producer is responsible. When the violation is the result of feeding an improperly mixed or formulated diet, responsibility may be shifted to the manufacturer of the final feed product fed to the pigs. The manufacturer may be a swine producer or feed supplier. If improper formulation is the result of improperly mixing or formulating the premix or base mix including the drug, the manufacturer of the concentrated drug, premix, or base mix may become responsible.

Detailed records are needed to determine the cause for violations and whether the responsibility should be shifted to another party.

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Vitamin Premix Specification Form

Name: _____

Company: _____

Address: _____

City, State, Zip: _____

Phone: _____

Date: _____

Date Needed: _____

Product name: _____

_____ Quantity, lb.

_____ Package size, lb.

Use level, lb./ton Sow diets: _____

Nursery diets: _____

Grower diets: _____

Finisher diets: _____

Price quote desired (circle one): $/lb. FOB

$/lb. Delivered

Nutrient	Units	Guaranteed Potency per lb. of Premix	Sources
Vitamin A	IU		
Vitamin D	IU		
Vitamin E	IU		
Vitamin K (menadione)	mg		
Vitamin B_{12}	mg		
Choline	mg		
Niacin	mg		
Pantothenic acid	mg		
Riboflavin	mg		
Biotin	mg		
Folic Acid	mg		
Vitamin C	mg		
Pyridoxine	mg		
Thiamine	mg		
Carrier			
Oil	%		

The following points must be followed unless approval for changes have been made:

a Guaranteed to stay free-flowing, lump free, non-dusty and packaged in multi-wall, poly-lined paper bags.

b The final moisture level will be less than 10% and 99.5% product will flow through #14 U.S./Canadian screen.

c Bulk density will be 30 ± 5 lb per cubic foot. Please notify me if oil level or carrier cause a flow problem.

d All bags must be labeled with tags. Tags should include date of manufacture, lot number, guaranteed analysis, inclusion rate, and proposed use of the product.

Trace Mineral Premix Specification Form

Name: _____

Company: _____

Address: _____

City, State, Zip: _____

Phone: _____

Date: _____

Date Needed: _____

Product name: _____

_____ _____

Quantity, lb. Package size, lb.

Use level, lb./ton Sow diets: _____

Nursery diets: _____

Grower diets: _____

Finisher diets: _____

Price quote desired (circle one): $/lb. FOB

$/lb. Delivered

Nutrient	Units	Guaranteed Potency per lb. of Premix	Sources
Copper	g		
Iodine	mg		
Iron	g		
Manganese	g		
Selenium	mg		
Zinc	g		
Cobalt	g		
Carrier	%		
Oil	%		

The following points must be followed unless approval for changes have been made:

a Guaranteed to stay free-flowing, lump free, and packaged in multi-wall, poly-lined paper bags.

b All bags must be labeled with tags. Tags should include date of manufacture, lot number, guaranteed analysis, inclusion rate, and proposed use of the product.

Base mix Specification Form

Name: _____

Company: _____

Address: _____

City, State, Zip: _____

Phone: _____

Date: _____

Date Needed: _____

Product name: _____

_____ _____

Quantity, lb. Package size, lb.

Use level, lb./ton Sow diets: _____

Nursery diets: _____

Grower diets: _____

Finisher diets: _____

Price quote desired (circle one):

$/ton FOB $/ton Delivered

Form desired (circle one):

Bulk Bagged, lb./bag____

Amino acids	**Units**	**Guaranteed Potency per lb. of Base Mix**	**Sources**
Lysine	%		
Methionine	%		
Threonine	%		
Tryptophan	%		
Minerals	**Units**	**Guaranteed Potency per lb. of Base Mix**	**Sources**
Copper	g		
Iodine	mg		
Iron	g		
Manganese	g		
Selenium	mg		
Zinc	g		
Cobalt	g		
Calcium (Minimum) (Maximum)	% %		
Available phosphorus	%		
NaCl (Minimum) (Maximum)	% %		

Vitamins	Units	Guaranteed Potency per lb. of Base Mix	Sources
Vitamin A	IU		
Vitamin D	IU		
Vitamin E	IU		
Vitamin K (menadione)	mg		
Vitamin B_{12}	mg		
Choline	mg		
Niacin	mg		
Pantothenic acid	mg		
Riboflavin	mg		
Biotin	mg		
Folic Acid	mg		
Vitamin C	mg		
Pyridoxine	mg		
Thiamine	mg		

Other	Units	Guaranteed Potency per lb. of Base Mix	Sources
Carrier			
Oil	%		

Specialty Ingredients	Units	Guaranteed Potency per lb. of Base Mix	Sources
	%		
	%		
	%		
	%		

The following points must be followed unless approval for changes have been made:

a Guaranteed to stay free-flowing, lump free, and non-dusty. When requested in bagged form, base mix will be packaged in multi-wall, poly-lined paper bags.

b The final moisture level will be less than 10% and 98% product will flow through #20 standard sieve.

c When bagged, all bags must be labeled with tags. Tags should include date of manufacture, lot number, guaranteed analysis, inclusion rate, and proposed use of the product.

Complete Diet or Supplement Specification Form

Name: _____

Company: _____

Address: _____

City, State, Zip: _____

Phone: _____

Today's Date: _____ Date Needed: _____

Weight range of pigs: _____

Product name: _____

Quantity, lb. _____ Package size, lb. _____

Price and forms desired (circle one in each row):

1) $/ton FOB $/ton delivered

2) Bulk Bagged

3) Meal (Particle size:_____) Pelleted

If pelleted, pellet size:_____ max fines,%_____

Amino acids	Units	Guaranteed Potency per ton	Sources
Lysine	%		Amino acid sources as agreed[a]
Other amino acids	%	Ideal ratio as agreed[b]	Amino acid sources as agreed[a]
Other	**Units**	**Guaranteed Potency per ton**	**Sources**
Metabolizable energy	Mcal		Energy sources as agreed[a]
Fat (Minimum)	%		
Crude fiber (Maximum)	%		All ingredients
Moisture (Maximum)	%		All ingredients
Added minerals	**Units**	**Guaranteed Potency per ton**	**Sources**
Copper	g		
Iodine	mg		
Iron	g		
Manganese	g		
Selenium	mg		
Zinc	g		
Cobalt	g		
Calcium (Minimum) (Maximum)	% %		All ingredients
Available phosphorus	%		All Ingredients
NaCl (Minimum) (Maximum)	% %		

Added vitamins	Units	Guaranteed Potency per ton	Sources
Vitamin A	IU		
Vitamin D	IU		
Vitamin E	IU		
Vitamin K (menadione)	mg		
Vitamin B_{12}	mg		
Choline	mg		
Niacin	mg		
Pantothenic acid	mg		
Riboflavin	mg		
Biotin	mg		
Folic Acid	mg		
Vitamin C	mg		
Pyridoxine	mg		
Thiamine	mg		

Specialty Ingredients	Units	Guaranteed Potency per ton	Sources
	%		
	%		
	%		
	%		

The following points must be followed unless approval for changes have been made:

a If additional forms are not attached with minimums and maximums for amino acid and energy sources, guidelines in Tables 1 and 2 of NPPC Feed Purchasing Manual will be followed. Previous agreement must be met before using any ingredient not included in the list. Indicate which values are being specified (check one): total_____, ileal digestible_____, or true available_____.

b The following ileal digestible amino acid ratios will be used to determine minimum levels for other amino acids relative to lysine: threonine_____; tryptophan_____; methionine_____; cystine_____; isoleucine_____.

c Guaranteed to stay free-flowing and lump free. When requested in bagged form, diet will be packaged in multi-wall, poly-lined paper bags.

d When bagged, all bags must be labeled with tags. Tags should include date of manufacture, lot number, guaranteed analysis, inclusion rate, and proposed use of the product.