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G88-892 Mixing Quality Pig Feed (Revised July 1992)

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Mixing Quality Pig Feed

Pig feed quality problems and mixing recommendations are covered here.

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Feed ingredients represent over 60 percent of the total cost of farrow-finish pork production and 65-70 percent of the variable expenses. Attention to quality preparation, in addition to purchasing decisions, is a component of feed ingredient cost management. Errors in formulation, misuse of feed mixing equipment, use of poor quality feed ingredients or lack of a quality assurance program can have costly consequences.

Quality Problems

Surveys show feed quality problems are common in the pork industry. Often the crude protein, calcium and phosphorus levels in on-farm mixed pig feeds do not match those needed for optimum performance and profitability. Pork producers can optimize performance and profitability by achieving nutrient levels in pig diets similar to those presented in the publications *Swine Diet Suggestions (EC 92-210)* and *Specification Feeding Growing-Finishing Pigs (NebFacts 92-917),* available at county extension offices.

Under certain conditions, molds in feed may produce toxic substances called mycotoxins. Proper grain storage and handling is important in reducing mycotoxin contamination. Recommendations for managing stored grain are presented in *NebGuides G84-692, G85-760,* and *G86-790*. Depending on which mycotoxin is present in the feed, pigs may experience reproductive or feed intake problems. For more information on mold toxins see *NebGuide G87-850, Understanding Mold Toxins*.

Vitamins in contact with minerals over a prolonged period of time in a hot and humid environment are likely to lose potency, possibly resulting in vitamin deficiencies and poor pig performance. If vitamins and minerals are combined in one premix, they should be used within 30 days of purchase. Vitamin and trace mineral premixes should be stored in a cool, dry and dark place. Stabilizing agents (BHT or ethoxyquin) also are helpful in maintaining premix quality.

Feed Mixing Recommendations

- **Correct formula--**Producers who use commercial supplements, base mixes and/or vitamin-trace mineral premixes, generally have mixing instructions available on the feed tag. **Mixing instructions should be followed precisely for best results**.

  Sometimes including alternate grains (wheat, barley, etc.) in the diet becomes economical, but mixing instructions are not provided. In these instances it is best to consult the manufacturer of the supplement, base mix or premix you are using or your local cooperative extension office. Example diets for all classes of pigs are presented in *Swine Diet Suggestions (EC 92-210)*.

- **Weigh feed--**There is no substitute for weighing feed ingredients when mixing diets. Scales help you be consistent and accurate as you mix feed. They ensure that ingredients are included in the diet in the proper proportions. Furthermore, scales provide more accurate data for calculating feed efficiency and feed cost/lb of gain.

  Some types of on-farm feed mixing equipment, however, are not designed to weigh feed ingredients. It is essential that equipment that measures feed on a volume basis be calibrated frequently to account for changes in bulk density (test weight) and flow characteristics of feedstuffs.

  For example, the bulk density of soybean meal and commercial supplements can range from 37 to 50 lb/cu ft. Likewise, the bulk density of grain and vitamin and trace mineral premixes varies. Unless the mixing equipment is calibrated periodically, variations in the nutrient content of diets could be large and affect performance and profits.

  Check the bulk density of a new supply of any ingredient if you mix feed by volume. Simply obtain a container (about 1 cu ft in size) that can easily be struck off with a straight edge, then weigh it on a reliable set of scales. Changes in bulk density are easily detected by keeping a record of the exact weight of each ingredient required to fill the container level full. A good rule of thumb is to recalibrate the mixing equipment for all diets containing an ingredient in which the bulk density changes more than 5 percent.

  Some producers use results from a laboratory feed test to calibrate their mixing equipment. This practice does not always result in properly balanced diets and is not recommended (see *Pork Industry Handbook Factsheet #94* for a simple method of calibrating volumetric mixers).

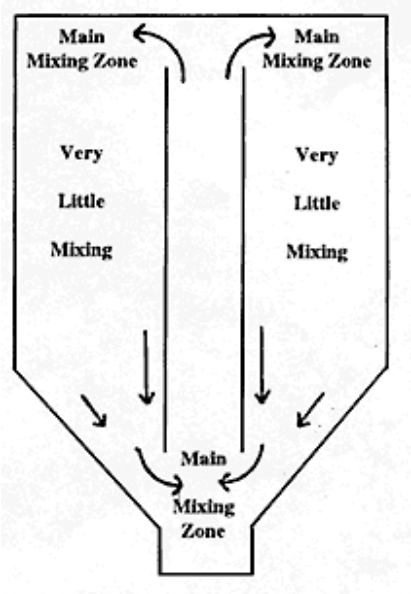

Figure 1. Vertical mixer feed flow pattern and main mixing zones (adopted from Wilcox and Unrak, 1986).

Mixing times--Turning the mixer off too soon after the last ingredient is added results in uneven blending of ingredients. A vertical mixer is essentially a holding bin with a vertical screw in the center. Mixing of ingredients is limited to the lower and top ends of the screw (*Figure 1*). Because the screw can move only a fraction of the total amount of feed in the mixer at one time, about 15 minutes is necessary to adequately mix the ingredients after the last ingredient is added to the mixer. Feed ingredient segregation will not occur even if mixing times exceed 15 minutes. Horizontal and drum mixers should run for 5 to 10 minutes after addition of the last ingredient.

Wear on the screw, ribbons, and paddles of mixers significantly reduces mixing action, and increases the mixing time required.

- **Overfilling mixer**--Sometimes mixers are overfilled which results in inadequate mixing. Keep the quantity of feed in the mixer within manufacturer-suggested levels.

- **Sequencing**--The order in which ingredients are added to the mixer affects the time required to obtain an adequate mix. Add at least one-half of the grain or all of the supplemental protein to the mixer prior to adding other ingredients. To reduce chances of carcass drug residues, mix medicated feeds first, followed by a feed for pigs weighing less than 125 lb. Mix the intended drug-free feed last.

- **Premixing**--Some ingredients such as feed additives, crystalline amino acids, and vitamin and trace mineral premixes represent less than 2 percent of the diet (40 lb/ton). Ingredients representing such small quantities are difficult to mix adequately into the complete diet unless, for example, they are premixed with ground corn or soybean meal before being added to the mixer. Generally when using vertical screw mixers, ingredients should be premixed if they represent less than 2 percent of the diet (40 lb/ton). For horizontal and drum mixers, ingredients representing less than 1 percent (20 lb/ton) of the diet should be premixed prior to being added to the mixer.

- **Ingredient segregation**--Segregation is the separation of one or more ingredients, or a portion of an ingredient, from the rest of the mix. The problem may occur during transport of the feed from the mixer to the feeder. The major factors involved in segregation are particle size, shape, and density.

  Producers can reduce segregation problems by processing grain so it is comparable in size to other ingredients in the batch. For optimum results, finished pig feed should have an average particle size between 750-800 microns. From a practical standpoint, using a 3/16" to 3/8" screen in a hammermill gives the best overall results. Well-designed and maintained roller mills also will adequately process grain for pigs. Avoid processing the grain too finely as it may cause gastric ulcers, increased dustiness, and bridging in bins and feeders.

- **Clean the mixer**--Several pounds of feed remain in the bottom of most vertical screw mixers after they are "emptied." This residual feed will contaminate the following batch of feed unless the mixer is thoroughly cleaned. *Cleaning the mixer after making medicated feed is an important step in avoiding carcass drug residues*.

Laboratory Use Recommendations

Laboratories are an essential component of a feed quality assurance program. The following recommendations will help producers best allocate time and money when using a laboratory.

- **Who should test?**--Anyone who derives a significant portion of their income from pork production and strives to remain competitive should test feed and feed ingredients. The effort needed for testing depends on how finished feed is obtained.

  With complete feed (a feed made according to the manufacturer's specifications) there is no need to spend a great deal of time and money testing. Most feed manufacturers rigorously test ingredients and finished products, plus state regulatory officials check complete feeds at random for label compliance.

  If feed is made on the farm or is custom mixed (according to your specifications), a more extensive feed testing program is necessary. Many custom mixed feeds are not checked by regulatory officials, and the custom mixer may not have an adequate feed quality check program. Producers have total responsibility for feed made on their farm.

- **What to test for**--Generally, avoid routine tests for vitamins, trace minerals (zinc, iron, etc.), amino acids, and medications. Those analyses are costly and less accurate than tests for other feed components. Money is better spent monitoring major nutrients like protein, calcium, and phosphorus. *Table I* lists suggested analyses for finished feeds and ingredients.

Table I. Suggested analyses for finished feeds and ingredients.

Item	*Suggested Analysis*
Finished Feeds	
	Moisture, crude protein, calcium, phosphorus, and diet particle size
Ingredients	
Grain[a]	Moisture, crude protein, lysine (high-lysine corn only)
Soybean meal	Moisture, crude protein
Soybeans	Moisture, crude protein, urease (if cooked)
Dried whey	Moisture, crude protein, ash, salt
Custom premixes and	Biotin or choline (sow diets only),
base mixes	vitamin E, phosphorus, crude protein if crystalline lysine added
[a]Consider mycotoxin screen when drought conditions persist, storage problems are suspected or certain abnormalities are observed in animals.	

Suggested frequencies for analysis of finished feeds and ingredients are detailed in *Table II*. The best schedule for a given operation will depend on several factors. If, for example, feed is manufactured without scales and/or more than one employee and feed supplier is involved, a higher testing frequency than shown in *Table II* is recommended. Consider testing feed and ingredients more often if quality problems are discovered. If feed is custom mixed, ask the manufacturer about their testing program and adjust accordingly. Analyze diets less frequently than shown in *Table II* if test results match expectations.

Table II. Suggested frequency of analysis for finished feeds and ingredients.

Item	*Frequency of Analysis*
Finished Feeds	
Purchased complete	Every 40th batch
Supplement-based[a]	Every 30th batch
Base mix-based[b]	Every 25th batch
Premix-based[c]	Every 20th batch
Ingredients	
Homegrown grain and soybeans	At harvest and again every three months
Purchased items (soybean meal, grain, whey, etc.)	Every third load

[a]A supplement contains protein, calcium, phosphorus, salt, trace minerals, and vitamins.
[b]A base mix contains calcium, phosphorus, salt, trace minerals, and vitamins.
[c]A premix contains trace minerals and vitamins.

The risk of not producing the quality of feed intended is greatest with base mix or premix-based diets, so they should be monitored most frequently. Major feed quality problems can occur easily when low inclusion products like these are used by people who are not feed manufacturing experts.

By testing a combination of ingredients and finished feeds, producers can quickly spot a wide range of possible feed quality problems. Plus, it is easier to solve a quality problem in finished feeds if individual ingredients have been analyzed.

- **Laboratory services**--Several commercial laboratories, and some feed suppliers and universities will test feed. The names and addresses of some are presented in *Table III*

Table III. Commercial analytical laboratories serving Nebraska.[a]

Midwest Laboratories, Inc.
13611 B St.
Omaha, NE 68144
(402) 334-7770

Department of Agronomy
Soil and Plant Analytical Laboratory
139 Keim Hall
Lincoln, NE 68583-0916
(402) 472-1571

Inter-American Laboratories
P.O. Box 94
West Hwy 30
Cozad, NE 69130
(800) 658-3146

Olsen Agricultural Laboratory
210 East First
P.O. Box 370
McCook, NE 69001
(308) 345-3670

Romer Labs Inc.
P.O. Box 2095
Washington, MO 63090
(314) 239-3009

Servi-Tech Laboratories
1602 Park West Drive
P.O. Box 169
Hastings, NE 68901
(402) 463-3522

Triple S Laboratories
Box 678
Loveland, CO 80537
(303) 667-5671

Ward Laboratories, Inc.
4007 Cherry Avenue
Kearney, NE 68848
(308) 234-2418

Woodson-Tenent Laboratories
3507 Delaware - P.O. Box 1292
Des Moines, IA 50305
(515) 265-1461

[a]This list is for information only and does not imply endorsement of the labs listed nor a discredit to any lab inadvertently omitted from the list.

- Contact laboratories before submitting feed samples to find out the types of analyses available, how much each analysis costs, what sample size the lab prefers, and how long it will be before results are available. If a base mix or premix is to be analyzed, be sure to alert the laboratory to the expected concentration of the nutrients being checked. Some laboratories may not be equipped to accurately measure nutrients at concentrations normally found in base mixes or premixes.

  Laboratory fees are variable. One reason for the difference is that some laboratories perform analyses in duplicate--they analyze a portion of a sample twice and report the average. Most laboratories, however, perform one analysis per sample submitted. Producers can be more confident in test results when the tests are duplicated, so use a laboratory with that policy when accuracy is of utmost importance, such as settlement of claims.

- **Sampling**--Poor sampling techniques result in an inaccurate and misleading test report. The sampling technique will be most accurate by using a grain probe; it allows deep penetration into feeders, bags, and other containers while sampling. If a probe is not available, use your hand or a cup on a pole.

  Here are some guidelines for proper sampling.
  - ***Finished feeds****:* Sampling from feeders gives the best assessment of the overall feed preparation program (mixing and handling procedure, ingredient quality, etc.). Take a sample from at least one out of every two feeders, inserting the probe at two different locations. If you use your hand for sampling, be sure to insert your arm to elbow depth to obtain a sample. When sampling directly from the mixer or unloader, grab 10 single handfuls of feed per ton at various intervals as the feed is unloaded.

  - ***Bulk ingredients:*** Insert the probe at 8 to 10 different locations in the truck before unloading, or grab 10 single handfuls per ton as ingredients are loaded into storage.

  - ***Bagged ingredients:*** Obtain .5 to 1 pound samples from each of 7 to 10 bags. A grain probe works best.

  Collect the samples in a clean 5 gallon bucket or similar container and mix thoroughly. Scoop out two 1-lb samples and seal each in individual, clearly marked and dated containers. Heavy plastic bags, plastic containers with lids and clean, wide mouth jars are excellent for storing samples. Submit one sample to the laboratory and keep the other in the freezer until the analysis is complete. When testing grain for mycotoxins, collect a 20-lb sample, mix it, then take out two 5-lb samples (keep one

and send the other to the lab). A larger sample increases the chances of finding mycotoxins.

Producers who buy soybean meal and want restitution for possible quality problems should have the official sample (taken by the processor and available upon request) analyzed, instead of a sample collected by the producer. Even though testing a sample the producer collects identifies problems no one may have been aware of, it is not recognized as official under current soybean meal trading rules.

- **Interpreting results--**Even if the feed sampled was made to perfection, there are errors in sampling and laboratory analyses that at best can only be minimized. These errors can cause differences in nutrient levels between what the laboratory reports and producer expectations. Generally there is no need for concern as long as analyzed nutrient values are not greatly different from the calculated nutrient content of the diet. **Comparing analyzed values to the calculated nutrient content of the diet is an essential step in understanding laboratory results**.

  Simply calculate the nutrient content (crude protein, for example) of finished feeds from the diet formula, appropriate feed labels, and nutrient contents of ingredients. The accuracy of the calculations will improve by using the analyzed nutrient contents of the ingredients in the diet (crude protein values for grain and soybean meal, for example). It will be necessary to use "book values" for some items such as the calcium and phosphorus content of grain to finish the calculations because actual test results on these nutrients probably will not be available. A good source of expected nutrient contents for many ingredients is *Swine Diet Suggestions (EC92-210)* available at extension offices.

  When reviewing laboratory results, use the "as-fed," "as-is," or "as-received" values, **not** the 100 percent dry-basis values.

  How much difference can there be between calculated and analyzed values before concluding there is a feed quality problem? The normal amount of variation associated with sampling and laboratory analyses is shown in *Table IV*. Using the calculated or expected nutrient contents of a diet or other manufactured products, a normal range of values can be calculated. For example, assume the calculated crude protein content of a grower pig diet is 16 percent. To allow for normal sampling and laboratory variation, define the normal range of acceptable crude protein levels to be between 15.5 and 16.5 percent.

  (16% x .03 = .48 or .5%; 16% - .5% = 15.5%; 16% + .5% = 16.5%).

Table IV. Analytical variations in nutrient analyses.[a]

		Example	
Nutrient	*Variation*	*Calculated level*	*Normal range*
Crude protein	+ 3%	16%	15.5 to 16.5%
Lysine	+ 10%	.7%	.63 to .77%
Calcium	+ 22%	.65%	.51 to .79%
Phosphorus	+ 12%	.50%	.44 to .56%
Zinc	+ 20%	100 ppm	80 to 120 ppm

[a]Adapted from Association of American Feed Control Officials, 1992.

If analyzed values fall within the normal range (between 15.5 and 16.5 percent in the example), no

further action is necessary. However, if the level of all or any one of the nutrients fall outside the normal range and proper sampling procedures were used, submit a portion of the retained sample to the same laboratory for a repeat analysis. If the results from the second analysis also fall outside the normal range, a feed quality problem may exist. Problems could be the result of a poor formula, improper mixing and handling procedures, or nutrient variation in ingredients.

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