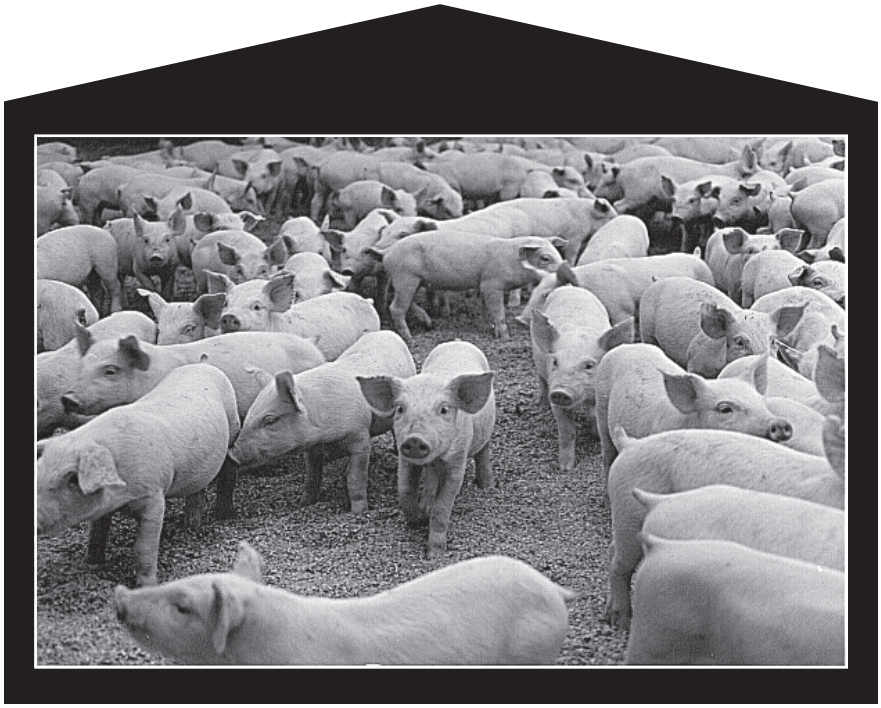
Designing Feeding Programs for Natural and Organic Pork Production



Jerry Shurson, Mark Whitney, Lee Johnston, Bob Koehler, Robert Hadad, and Dean Koehler

IN PARTNERSHIP...

The College of Agricultural, Food and Environmental Sciences

University of Minnesota Extension SERVICE

Authors

Jerry Shurson, Mark Whitney
Department of Animal Science, University of Minnesota, St. Paul, MN

Lee Johnston
West Central Research and Outreach Center, Morris, MN

Bob Koehler, Robert Hadad
Southwest Research and Outreach Center, Lamberton, MN

Dean Koehler
Vita Plus Corporation, Shakopee, MN

Contents

Tables

Introduction

This publication reviews nutrition and management practices that allow producers to raise pigs under natural conditions or in a manner that allows for organic certification. An extensive list of requirements for organic production of pork has been established and is discussed below. However, we know of no similar requirements for natural pork production. There is no legal or broadly accepted definition of natural. Consequently, individual marketing groups have established guidelines for the pork production that may be labeled natural. With no legal description of natural, one has difficulty defining this type of pork production. Natural pork production likely includes a ban on use of antibiotics and other synthetic growth promoters, possibly a ban on use of animal by-products in feeds, increased space allowances for animals, and use of other production practices thought to enhance animal welfare. Often, natural pork production has requirements quite similar to standards for organic production, but they are not quite as comprehensive. Producers interested in natural production of pork may wish to identify a group that markets natural pork and follow its standards. This publication focuses on nutrition and management requirements for organic pork production, but much of its content can be applied to production systems for natural pork.

Unlike natural pork production, there are extensive standards for organic production of pork. Several international and national groups have offered definitions for organic agriculture. Those definitions speak to environmental, social, and ethical goals and principles. Organic livestock production is defined and structured as a part of the whole farm ecosystem. The National Standards for Organic Agriculture published by the Canadian General Standards Board speaks to livestock production as follows:

> *"Provide attentive care that promotes the health and meets the behavioral needs of livestock. Organically raised livestock are managed to prevent disease and promote wellness through a combination of organically-produced diet, adequate housing, ethical animal husbandry, handling practices that minimize stress, and regular monitoring."*

United States National Organic Standards were announced by the USDA on December 20, 2000. The U.S. National Organic Standards are available on the National Organic Program website at www.ams.usda.gov/nop/, linked from the United States Department of Agriculture Agricultural Marketing Service. Feed manufactured for use in organic pork production can only contain ingredients from three categories:

1) agricultural products that were produced and handled organically,
2) nonsynthetic substances such as enzymes, probiotics, and others usually thought of as natural ingredients, and
3) synthetic substances that appear on the national list of Synthetic Substances Allowed for Use in Organic Livestock Production. Some ingredient use limitations for organic diets include:
    - No genetically modified grain or grain by-products.
    - No antibiotics, hormones, or drugs.
    - No animal by-products.
    - No grain by-products unless produced from certified organic crops.
    - No chemically extracted feeds (such as solvent-extracted soybean meal).
    - No synthetic amino acids.

Organically produced pork must carry the USDA seal for organic products to be sold as certified organic pork. A third party must certify that feeding and pro-

duction requirements listed in the U.S. National Organic Standards were followed to allow pork to carry the USDA seal. Certifying agencies have 18 months from the time the standards were announced to comply with these national standards. While not required by the national standards, some certifying agencies may institute more stringent rules for any producer seeking that agency's certification. Producers should be familiar with the national standards and in communication with their certifying agency to avoid practices that may disqualify them as certified organic.

Although the use of antibiotics or drugs is not allowed in animals that are sold to organic markets, this does not suggest that animal welfare be ignored if animals become sick or in need of medication. In fact, the National Standards on Organic Agricultural Production and Handling (2000) establish that a producer of organic livestock must administer vaccines and other veterinary biologics as needed to protect the well-being of animals in his or her care. When preventative practices and veterinary biologics are inadequate to prevent sickness, the producer may administer medications included on the National List of synthetic substances allowed for use in organic production systems.The ruling goes on to state that the producer must not withhold medical treatment from a sick animal to maintain its organic status. All appropriate medications and treatments must be used to restore an animal to health when methods acceptable to organic production standards fail. Livestock that are treated with prohibited materials must be clearly identified and shall not be sold, labeled, or represented as organic.

Corn-soybean meal based diets are typically used in midwestern pork production because of the abundant supply, high nutritional value, and competitive cost. Similar formulations are being used for organic production with organically-produced corn and soybean meal. However, the high cost and limited availability of organically-produced corn and soybean meal may preclude their use in some organic production systems. As a result, there is considerable interest in alternative ingredients to reduce cost and diversify crop rotations on organic farms. The high cost of organic grain and protein sources also suggests that producers explore the maximization of pasture contributions during months when grazing is practical. Nutrient contributions from pasture should be considered when formulating complete diets.

What Ingredients Are Allowed in Organic Diets?

Certified organic crops serve as the base feedstuffs for organic livestock nutrition. However, the use of some synthetic substances is allowed in organic pork production. Synthetic substances allowed under the National Standards on Organic Agricultural Production and Handling (2000) and non-synthetic substances may be used as feed additives and supplements. While not prominently stated in the National Standards, FDA-approved forms of vitamins and minerals are allowed in organic diets even though they may not be considered natural substances or appear on the national list of Synthetic Substances Allowed for use in Organic Production. Use of these ingredients in the formulation of organic diets may have economic and nutritional benefits.

Consult the national organic standards and your certifying agency for specifics on allowances during the period of conversion to organic status.

Synthetic Substances Allowed in Feeds for Organic Certification

Electrolytes without antibiotics – used to treat dehydration due to diarrhea in young pigs

Magnesium sulfate – used as a laxative agent for gestating and lactating sows

Milk replacers without antibiotics – used for disadvantaged, starving piglets but must not contain non-milk products or milk products from BST-treated cows

Copper sulfate – an inorganic copper source used for trace mineral supplementation

Vitamins – FDA approved synthetic vitamins used for enrichment or diet fortification. However, natural sources such as sprouted grains and brewer's yeast may be preferred by some certifying agencies.

Non-synthetic (Natural) substances allowed for use in organic livestock production

Citric acid – used to acidify baby pig diets

Bentonite – used as a pellet binder and may be effective in reducing adverse performance effects due to mycotoxin contamination of grain.

Calcium carbonate and calcium chloride – an inorganic source of supplemental calcium

Enzymes – derived from edible, nontoxic plants, nonpathogenic fungi, or nonpathogenic bacteria (It is not clear whether some forms of microbial phytase may be used to improve phosphorus digestibility of grain.)

Potassium chloride – used as a laxative agent for gestating and lactating sows

Potassium iodide – an inorganic iodine supplement

Non-synthetic, non-GMO yeast – a feed additive

Flavors – non-synthetic sources only and must not be produced using synthetic solvents and carrier systems or any artificial preservatives

Dried skim milk and dried whey – these ingredients can be used only if derived from organically produced milk

NOTE: Some of the above materials may be used only with permission from the certifying agency. In some certifying organizations, seaweed, kelp meal, natural rock powders, and molasses are preferred sources of trace minerals.

Documentation and Records

The Federal Organic Standard defines records as any information in written, visual, or electronic form that documents the activities undertaken by a producer, handler, or certifying agent to comply with the Act and regulations in this part. The records are to be kept as an audit trail that will allow for the tracing of the sources of animals, sources of feed and amounts fed, forage, feed supplements, treatments, medications, and animal health.

Documentation begins with birth or purchase of the animals. Specific information will include: date born, date purchased, date sold, date died, date bred, date farrowed, and date weaned. If animals are sold, list buyer's name. If the animal is to be slaughtered, then the date of slaughter, processor's name, and markets sold to must be listed. The medical documentation will include the diagnosis of diseases, date of treatment, medication and dosage used, time of withdrawal period, and copies of all medication labels.

Documentation of the feeding program requires listing diet formulations, feed ingredient sources, date of purchases, copies of ingredient labels, and locations where the feed is stored. For on-farm grown ingredients, records of seeding date, seeding location, organic certification of land used, date harvested, where processed, and storage facilities used are required.

The reason for such thorough records is to ensure that no co-mingling of non-organic livestock or feed ingredients occurs, allowable medications are identified, and that proper medical attention has been given to sick animals regardless of certification status. These records also give the farmer a paper trail to prove that his or her animals have been raised according to certified practices.

Challenges in Feeding Organically Raised Pigs

Managing pig health without antibiotics and animal-derived ingredients

Increase weaning age

Because traditional ingredients such as spray-dried porcine plasma, dried whey, and dried skim milk are not permitted in starter diets, pigs will likely need to be weaned no earlier than 28 days of age. After 28 days, the young pig's digestive system is mature enough to effectively digest cereal grain-based diets without adverse effects on health and performance. Some advisors recommend weaning at 35 days of age or more.

Implement high biosecurity procedures

Closed herds. To minimize the risk of disease transmission, maintain closed herds (with limited or no addition of animals from other farms). If replacement animals are obtained from outside sources, they should be isolated and kept in separate facilities (preferably off-farm) for 60 days and blood tested for undesirable pathogens. In closed herds, the use of artificial insemination eliminates the need for the introduction of new boars to the breeding herd for the production of home-grown maternal line females and to serve as terminal line boars. If establishing a new herd for organic production, breeding stock with high health status will prevent the depressed pig performance typically caused by diseases and parasites. Animals certified as SPF (Specific Pathogen Free) should be considered when populating new organic swine herds.

Traffic control. Visitor access to animal facilities should be restricted. Post signs telling visitors where to report. Delivery trucks, particularly those that visit other farms or slaughter facilities, should be thoroughly cleaned before entering animal areas. Producers need to implement procedures that prevent rendering trucks from entering areas around pig facilities. On-farm methods for disposal of swine mortalities eliminate the risks associated with rendering trucks entering the farm. On-farm methods include composting and incinerating. Limiting the contact of dogs, cats, birds, and wild animals with pigs will help eliminate the transfer of swine diseases.

Excellent sanitation. Keep facilities as clean as possible to minimize the concentration of pathogens in animal living areas. Dead animals should be disposed of using only approved disposal methods.

Provide the proper environment

Temperature, space, nutrition, and ventilation requirements of pigs must be met to minimize stress and the risk of disease.

Some practices to consider where appropriate and permitted are:

- **Pasture rotation** to minimize parasite load on pigs.
- **Farrowing** once per year, or twice per year in late winter and late summer (March/April & August/September in the midwest U.S.) to achieve a form of all-in/all-out production. Moderate climates allow greater flexibility in favorable outdoor or extensive farrowing. In some cases year-around farrowing can be used, with outdoor or extensive environments providing a measure of disease control.
- Use **standard vaccines and ivermectin** on sows not to be sold as organic (up to 3rd trimester).
- Use **organically approved substances** that may enhance health and performance:

  Diet acidification – Use in starter diets.

  Oligosaccharides – Pathogenic bacteria attach to dietary oligosaccharides instead of the surface of the pig's intestine. As a result, the oligosaccharide-bound bacteria are excreted from the pig before they can cause digestive and health problems.

  Enzymes – Supplemental enzymes that are matched to specific ingredients can improve growth rates due to improved nutrient digestion and absorption.

  Herbs – Limited information suggests that some herbs possess antimicrobial activity and have antiviral and antioxidative properties.

  Probiotics/Yeast – These products may provide alternatives to growth-promoting levels of anti-biotics in the diet. Unfortunately, beneficial responses have not been reported consistently under controlled conditions.

Guaranteeing no use of grain from genetically modified organisms (GMO) in swine diets

Given the popularity of GMO grains with crop producers and the potential for cross-pollination, it is nearly impossible to guarantee that organically-raised crops are absolutely free of GMO grain, which is prohibited in organic production. Grains certified to be produced according to the National Standards are considered organic and acceptable for use even if there are trace amounts of GMO present. The National Standards focus on certifying a process of production, not guaranteeing the purity of the product. However, some certifying agencies may have more stringent standards. If tougher standards are imposed, consider the use of other grain crops such as small grains which have very few if any GMO varieties available.

Diet formulation is more difficult without the use of animal or grain by-products

Several alternative feed ingredients can be grown organically and used in swine diets. The following is a summary of possible alternatives and a brief description of their contributions and limitations in swine diets. Approximate nutrient composition of these feed ingredients is provided in **Table 1**. Nutrient composition will vary depending on area grown, processing technique utilized, year-to-year variation, maturity of the plant, and many other variables. The best method to determine nutrient composition is to obtain representative samples of each feed ingredient and send them to a commercial laboratory for nutrient analysis.

Table 1. Nutritional comparison of potential ingredients to be used in an organic swine feeding system (1) (2)

Ingredient, %	DE (kcal/kg)	ME (kcal/kg)	CP (%)	Lys (%)	Ca (%)	P (%)	Fat (%)	Anti-Nutritional Factors(3)
Energy sources								
Barley, 6 row	3050	2910	10.5	0.36	0.06	0.36	1.9	
Barley, hulless	3360	3320	14.9	0.44	0.04	0.45	2.1	
Buckwheat	2825	2640	11.1	0.57	0.09	0.31	2.4	Fagopyrin, trypsin inhibitor, tannins
Corn	3525	3420	8.3	0.26	0.03	0.28	3.9	
Corn and cob meal	3043	2952	7.8	0.17	0.06	0.24	3.2	
Oats	2770	2710	11.5	0.40	0.07	0.31	4.7	
Oats, naked	3480	3410	17.1	0.47	0.08	0.38	6.5	
Rye	3270	3060	11.8	0.38	0.06	0.33	1.6	Trypsin inhibitors, ergot, soluble pentosans
Sorghum, grain	3380	3340	9.2	0.22	0.03	0.29	2.9	Tannins
Triticale	3320	3180	12.5	0.39	0.05	0.33	1.8	Trypsin inhibitors, ergot, soluble pentosans
Wheat, hard red spring	3400	3250	14.1	0.38	0.05	0.36	2.0	
Protein sources								
Alfalfa, dehyd.	2095	1885	19.6	0.90	1.61	0.28	3.3	Saponins, tannins
Canola(4)	4330	N/A(5)	21.7	1.20	0.39	0.64	39.7	Glucosinolates, tannins, myrosinase
Fababeans	3245	3045	25.4	1.62	0.11	0.48	1.4	Trypsin inhibitor, hemagglutinin, tannins
Lentil, seeds	3540	3450	24.4	1.71	0.10	0.38	1.3	Trypsin and chymotrypsin inhibitor, tannins
Peas, field	3435	3210	22.8	1.50	0.11	0.39	1.2	Trypsin inhibitor, hemagglutinin
Soybeans, full-fat	4140	3690	35.2	2.22	0.25	0.59	18.0	Trypsin inhibitor, urease, hemagglutinin, lectins
Soybean meal, mech. ex.	3789	3675	49.0	3.10	0.25	0.65	5.0	
Sunflower seeds (4)	N/A	N/A	17.3	0.65	0.21	0.60	37.9	

(1) Nutrient values presented on an as-fed basis.
(2) For limits on dietary concentration of individual ingredients see discussions of individual grains on pages 9–12.
(3) All cereal grains contain varying levels of phytate and may contain mycotoxins.
(4) Values obtained from Nontraditional Feed Sources for Use in Swine Production, P.A. Thacker and R.N. Kirkwood (eds.), 1990, Butterworth Publishers, Stoneham, MA. All other nutrient values obtained from NRC (1998, 1988).
(5) N/A = Not available.

Energy sources

Cereal grains serve as the major energy source in swine diets. They are high in carbohydrates (starch), palatable, and highly digestible. However, they are low in lysine (and other amino acids), vitamins, and minerals compared to the pig's requirement. Therefore, cereal grain-based diets must be supplemented with other ingredients to meet amino acid, vitamin, and mineral requirements for optimal health and performance.

Corn has the highest energy value of all cereal grains and is generally the most economical grain source in swine diets in Minnesota. Because genetically modified corn varieties are now grown widely under commercial conditions, unintended cross-pollination could occur with corn produced in compliance with organic standards. This cross pollinated corn is currently considered as organic since it was produced in a certified organic production system.

Corn and cob meal is a feedstuff that can be produced on the farm and incorporated into swine diets. It is low in energy compared to most other energy sources, and fits well in late finishing and gestation diets. Similar to corn grain, cross-pollination of non-GMO corn with GMO varieties may be a concern in some areas.

Wheat is equal to corn in feeding value and is very palatable if not ground too finely. However, it is usually a more expensive energy source than corn and as a result has not been used commonly in Minnesota.

Barley is higher in fiber and protein than corn. Because of its higher fiber content, the energy value ranges from 90% to 100% of corn. High quality barley can be an excellent grain source for swine diets.

Hulless barley contains more protein and less fiber than normal barley. Despite its higher nutritional value in relation to barley, performance of pigs is generally similar when fed either barley or hulless barley.

Oats, like barley, are higher in fiber and protein than corn, resulting in an energy value of approximately 80% of corn.

Naked oats (hulless oats) are much lower in fiber and higher in oil and protein content than oats. As a result, their digestible energy content is 30% to 35% higher than conventional oats. Hulless oats have a good balance of amino acids, with only lysine and methionine present in amounts insufficient to meet the pig's requirement. Hulless oats can support satisfactory growth performance when used as the sole grain source for grow-finish pigs, with almost no supplemental protein required. Although naked oats have been grown successfully in Canada and the northern regions of the U. S., disappointing yields are sometimes reported.

Grain sorghum is similar to corn in nutritional value and can completely replace corn in swine diets. However, specially developed bird-resistant varieties that are high in tannins have only 80% to 90% of the feeding value of corn. Grinding is essential for efficient utilization because this grain is small and very hard.

Buckwheat is most commonly grown as a grain for human consumption. The protein quality of buckwheat is considered to be among the best in the plant kingdom. However, buckwheat is relatively low in digestible energy compared to other grains due to its high fiber and low oil content. The other significant factor limiting the use of buckwheat in swine diets is the presence of the anti-nutritional factor, fagopyrin, which causes skin lesions and intense itching when pigs are exposed to sunlight. No more than 50% inclusion in grow-finish diets and 80% in gestation diets should be used. Avoid using buckwheat in starter and sow lactation diets.

Rye has an energy value intermediate to wheat and barley, and the protein content is similar to barley and oats. Although amino acid balance is similar to barley and wheat, its amino acid digestibility is 5% to 10% lower. Furthermore, rye is very susceptible to ergot, a fungus that reduces pig health and performance. Rye also contains several toxic anti-nutritional factors that reduce its nutritional value for swine. There is no limit on the amount of rye that can be fed to gestating sows, although an upper limit of 50% in grow-finish and 40% in lactation diets is suggested.

Triticale is a grain produced by crossing Durum wheat with rye. Very little triticale has been grown in the northern U.S. and Canada. Even though it has a digestible energy value similar to wheat, it is similar to rye in regard to the presence of several anti-nutritional factors and susceptibility to ergot.

Protein sources

Full-fat soybeans contain approximately 18% oil and are of the most value in diets for weaned pigs and lactating sows. Although research conducted at the University of Nebraska has shown that feeding diets containing raw (unheated) soybeans to gestating sows will produce satisfactory performance, soybeans must be heat-treated to be used successfully in all other production phases. Properly heat-treated soybeans are an excellent protein source for swine. Soybeans contain anti-nutritional factors including trypsin inhibitors, urease, and hemagglutinin. Trypsin inhibitors and urease can be destroyed by proper roasting or extruding

processes. However, overheating reduces amino acid digestibility and must be avoided. For optimal quality, soybeans should be roasted for 3 to 5 minutes with an exit temperature of 240 to 260 degrees F. The exit temperature for extruded soybeans should be 280 degrees F. Because soybeans contain 13% to 15% more energy than soybean meal, concentrations of other dietary nutrients must be increased to compensate for the lower feed consumption that naturally occurs when feeding high energy diets.

Mechanically-extruded soybean meal (non-solvent) can be produced as an organic substitute for conventionally manufactured soybean meal. Organically-produced soybeans can be mechanically extruded to produce a high-quality meal containing high protein and energy levels. Fat level of the meal may vary from 5% to10% depending on moisture content of the beans and efficiency of oil extraction during processing.

Field peas are grown primarily for human consumption, but they can effectively replace a portion of the grain and protein supplement in swine diets. The digestible energy content of peas is high and they are a good source of lysine. However, peas are low in methionine and tryptophan, which limits their use in most swine diets. Peas can be included in swine diets at up to 15% for starter pigs, 15% for sows, and can completely replace soybean meal in grow-finish diets. Peas also contain anti-nutritional factors including trypsin inhibitors and hemagglutinin, however, the level of these factors is generally not considered to be high enough to reduce performance. Many producers may choose to raise field peas in conjunction with barley as these two ingredients can be successfully incorporated into a swine feeding program.

Alfalfa's nutritional quality varies with stage of maturity, soil fertility, and methods of harvesting, handling, and storage. The more mature alfalfa is at the time of harvest (or time of consumption, if grazed) the lower its nutritional value for swine. Mature alfalfa is higher in fiber and lower in protein as compared to less mature alfalfa. The major factor that limits the nutritional value of alfalfa in swine diets is its low digestible energy content. Compared to cereal grains, alfalfa contains only half as much digestible energy. Alfalfa is a good source of most vitamins, and is an excellent source of vitamins A, E, and K. Alfalfa is high in calcium but has only moderate amounts of phosphorus. Therefore, diets containing alfalfa must be supplemented with phosphorus to maintain the desired 1:1 to 1.5:1 calcium:phosphorus ratio.

Alfalfa also contains saponins and tannins—anti-nutritional factors that reduce the growth rate of pigs. The use of alfalfa in weanling and young growing pig diets is not recommended due to its low energy digestibility, poor palatability, and the presence of anti-nutritional factors. Alfalfa fits better in diets for sows than for growing pigs. Sows have a greater capacity for fermentation in the hindgut that allows for greater fiber digestion and improved energy utilization. Furthermore, studies conducted at the University of Minnesota have shown increased litter size and lactation feed intake when sows were fed alfalfa haylage during gestation.

Canola is the primary oil seed crop produced in Canada. It contains 40% oil and 20% protein, making it a high energy, moderately high protein source. Canola can be effectively used at up to 15% in diets for all phases except for gestating and lactating sows, which should be limited to 10%. A large amount of commercial canola production uses GMO-derived seed, and therefore caution must be exercised to avoid the use of non-organically certified seed and potential for genetic drift, similar to corn.

Fababeans contain 24% to 30% protein and a digestible energy level intermediate between soybean meal and barley. Fababeans are low in oil content (1.5%) and the oil is high in unsaturated fatty acids. This makes it very susceptible to rancidity if the beans are

stored for more than one week after grinding. Fababeans contain several anti-nutritional factors including trypsin inhibitors, hemagglutinin, and tannins. For optimum nutritional value, fababeans should be roasted or extruded before feeding. Fababeans can be effectively added at up to 15% of starter diets, 20% of grower diets, and 15% of sow diets without adversely affecting performance.

Lentils are a poorer source of lysine, methionine, and threonine than peas. However, lentils can be included at up to 30% of the diets for swine as long as diets are carefully formulated to ensure adequate amino acid levels.

Sunflower seeds are high in oil (40%) and fiber (29%) and moderately high in protein (20%). Unheated sunflower seeds are more digestible than heated seeds. Upper limits of inclusion for sunflower seeds are up to 10% of the diet for weaned and grow-finish pigs, and up to 30% of the diet for gestating and 20% of the diet for lactating sows. As is the case with canola and corn, a large amount of GMO-derived sunflower seeds is used in commercial production, and therefore precautionary measures should be taken to ensure organic status.

Suggested Diets

Example diets for the growing pig, gestating sow, and lactating sow are provided in **Tables 2 – 7**. These diets have been formulated to provide complete nutrition for the animal, without forage or pasture supplementation, and serve as only a few examples of how many different ingredients might be used in various combinations for natural or organic pork production. The example diets are based on tabular values for total nutrient content of the selected ingredients and do not consider differences in nutrient digestibility of ingredients. Once one determines which ingredients will be used in a particular diet, final diet formulations should be calculated on a digestible amino acid and digestible phosphorus basis to ensure optimal pig performance. Diets have been provided for summer and winter (assuming 32° F environmental temperature). During the winter months, pigs will consume additional feed to meet increased maintenance energy requirements, and therefore a lower amino acid concentration is necessary in the feed to meet the pig's amino acid requirement for growth. A variety of feed ingredients can be incorporated into swine diets, but correct formulation is key to ensuring animals satisfy their nutritional requirements. Individual ingredients will vary somewhat from nutrient levels assumed in these example diets, and therefore sampling and nutrient analysis of these feedstuffs should be conducted prior to formulation. In addition, the pig's nutrient requirements will vary depending on genetics, environment, phase of growth, and age of animal. Producers should survey available ingredients that meet organic specifications, and then formulate diets utilizing those ingredients based on nutritional requirements for their operation and cost of nutrients supplied by the ingredients. Diets formulated to meet organic requirements may reduce performance as compared to traditional diets because of difficulties in meeting all nutritional needs. Producers are encouraged to use a diet formulation program or seek assistance from an experienced nutritionist when formulating diets.

Table 2. Early grower diet formulations for organic swine production, assuming no pasture supplementation (30 lb–75 lb pigs)

	Summer				Winter			
	1	2	3	4	1	2	3	4
Ingredient, %								
Barley	-	-	61.10	-	-	-	71.10	-
Corn	54.40	-	-	-	68.65	-	-	-
Oats, naked	-	73.30	-	-	-	83.70	-	-
Wheat	-	-	-	53.45	-	-	-	67.80
Canola	-	-	-	10.00	-	-	-	10.00
Peas, field	-	-	12.00	-	-	-	12.00	-
Soybeans, full-fat	42.40	-	-	33.50	28.00	-	-	19.00
Soybean meal, mech. ext.	-	23.50	23.70	-	-	13.00	13.60	-
Dicalcium phosphate	1.40	1.20	1.20	1.10	1.50	1.35	1.40	1.20
Limestone	0.80	1.00	1.00	0.95	0.85	0.95	0.90	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated nutrient composition								
ME, kcal/kg	3417	3362	3033(1)	3381	3373	3324	2956(1)	3313
Crude protein, %	19.4	24.0	20.8	21.5	15.6	20.7	16.9	18.4
Lysine, %	1.08	1.07	1.13	1.07	0.80	0.80	0.86	0.80
Calcium, %	0.73	0.76	0.75	0.75	0.74	0.76	0.74	0.76
Phosphorus, %	0.66	0.65	0.64	0.66	0.63	0.65	0.64	0.64

(1) Low energy density may result in slower growth and poorer feed conversion than desired.

Table 3. Late grower diet formulations for organic swine production, assuming no pasture supplementation (75 lb–125 lb pigs)

	Summer				Winter			
	1	2	3	4	1	2	3	4
Ingredient, %								
Barley	-	-	63.60	-	-	-	71.80	-
Corn	65.00	-	-	-	74.90	-	-	-
Corn and cob meal	-	26.50	-	-	-	26.50	-	-
Oats, naked	-	51.40	-	-	-	58.90	-	-
Wheat	-	-	-	61.15	-	-	-	72.10
Canola	-	-	-	15.00	-	-	-	15.00
Peas, field	-	-	20.00	-	-	-	20.00	-
Soybeans, full-fat	31.90	-	-	21.00	21.90	-	-	10.00
Soybean meal, mech. ext.	-	19.00	13.30	-	-	11.50	5.00	-
Dicalcium phosphate	1.25	1.25	1.25	0.90	1.35	1.25	1.35	0.95
Limestone	0.85	0.85	0.85	0.95	0.85	0.85	0.85	0.95
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated nutrient composition								
ME, kcal/kg	3392	3225	2980(1)	3377	3362	3205	2914(1)	3328
Crude protein, %	16.6	20.2	17.8	19.3	13.9	17.8	14.5	16.9
Lysine, %	0.88	0.88	0.94	0.88	0.68	0.68	0.74	0.68
Calcium, %	0.70	0.70	0.69	0.70	0.70	0.69	0.70	0.69
Phosphorus, %	0.60	0.61	0.61	0.61	0.60	0.59	0.62	0.59

(1) Low energy density may result in slower growth and poorer feed conversion than desired.

Table 4. Early finisher diet formulations for organic swine production, assuming no pasture supplementation (125 lb–175 lb pigs).

	Summer				Winter			
	1	2	3	4	1	2	3	4
Ingredient, %								
Barley	-	-	69.85	-	-	-	77.30	-
Corn	72.30	-	-	-	80.70	-	-	-
Corn and cob meal	-	53.00	-	-	-	53.00	-	-
Oats, naked	-	27.50	-	-	-	33.50	-	-
Wheat	-	-	-	69.05	-	-	-	79.00
Canola	-	-	-	15.00	-	-	-	15.00
Peas, field	-	-	22.50	-	-	-	20.00	-
Soybeans, full-fat	25.00	-	-	13.50	16.50	-	-	3.50
Soybean meal, mech. ext.	-	16.80	5.00	-	-	10.80	-	-
Dicalcium phosphate	0.75	0.85	0.75	0.45	0.95	0.85	0.75	0.55
Limestone	0.95	0.85	0.90	1.00	0.85	0.85	0.95	0.95
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated nutrient composition								
ME, kcal/kg	3388	3113	2932(1)	3357	3362	3097	2886(1)	3313
Crude protein, %	14.8	17.1	14.9	17.7	12.5	15.2	12.7	15.6
Lysine, %	0.74	0.74	0.74	0.74	0.58	0.58	0.58	0.56
Calcium, %	0.61	0.61	0.59	0.61	0.60	0.60	0.59	0.59
Phosphorus, %	0.49	0.50	0.51	0.51	0.50	0.48	0.50	0.50

(1) Low energy density may result in slower growth and poorer feed conversion than desired.

Table 5. Late finisher diet formulations for organic swine production, assuming no pasture supplementation (175 lb–250 lb pigs).

	Summer				Winter			
	1	2	3	4	1	2	3	4
Ingredient, %								
Barley	-	-	72.50	26.65	-	-	81.25	-
Corn	59.20	-	-	-	59.15	-	-	-
Corn and cob meal	-	72.20	-	-	-	72.10	-	-
Oats	20.00	10.00	-	-	25.80	13.75	-	20.00
Wheat	-	-	-	56.00	-	-	-	68.80
Peas, field	-	-	25.00	-	-	-	16.25	-
Soybeans, full-fat	18.30	-	-	15.00	12.50	-	-	8.75
Soybean meal, mech. ext.	-	15.30	-	-	-	11.55	-	-
Dicalcium phosphate	0.55	0.75	0.55	0.35	0.65	0.85	0.55	0.45
Limestone	0.95	0.75	0.95	1.00	0.90	0.75	0.95	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calculated nutrient composition								
ME, kcal/kg	3234	2959	2906(1)	3142	3176	2919	2880(1)	3093
Crude protein, %	13.7	14.3	13.3	16.0	12.3	12.9	12.2	15.1
Lysine, %	0.64	0.64	0.64	0.64	0.53	0.54	0.54	0.54
Calcium, %	0.56	0.54	0.55	0.54	0.55	0.55	0.55	0.55
Phosphorus, %	0.44	0.44	0.46	0.45	0.44	0.45	0.46	0.44

(1) Low energy density may result in slower growth and poorer feed conversion than desired.

Table 6. Gestation diet formulations for organic swine production, assuming no pasture supplementation. (1)

	Summer			Winter		
	1	2	3	1	2	3
Ingredient, %						
Barley	-	35.00	-	-	40.00	-
Corn	55.25	-	-	71.60	-	-
Corn and cob meal	-	-	-	-	-	66.75
Oats	25.00	-	-	20.50	-	-
Wheat	-	40.80	61.40	-	52.20	-
Alfalfa, dehydrated	-	-	10.00	-	-	-
Canola	-	-	15.00	-	-	12.50
Peas, field	-	15.00	-	-	-	-
Soybeans, full-fat	15.50	5.00	-	5.00	5.00	-
Sunflower seeds	-	-	10.00	-	-	18.10
Dicalcium phosphate	2.50	2.35	2.10	1.15	0.90	0.90
Limestone	0.75	0.85	0.50	0.75	0.90	0.75
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50	0.50	0.50	0.50
Calculated nutrient composition						
ME, kcal/kg	3130	3000	3180	3181	3038	3172
Crude protein, %	12.9	14.6	15.6	10.1	13.3	11.1
Lysine, %	0.59	0.62	0.57	0.38	0.45	0.38
Calcium, %	0.91	0.91	0.92	0.59	0.60	0.61
Phosphorus, %	0.79	0.80	0.79	0.51	0.53	0.52

(1) Assumes a feeding level of 4.5 lb/sow/day for summer and 7.5 lb/sow/day for winter.
Initial sow weight of 350 lbs, an additional 40 lb gestation weight gain, and expected litter size of 10 pigs.

Table 7. Lactation diet formulations for organic swine production. (1)

	Summer		
	1	2	3
Ingredient, %			
Barley	57.05	-	-
Corn	-	-	71.30
Oats, naked	-	67.90	-
Alfalfa, dehydrated	-	10.00	-
Peas, field	10.00	-	-
Soybeans, full-fat	29.00	-	-
Soybean meal, mech. ext.	-	18.50	24.50
Dicalcium phosphate	2.05	2.10	2.45
Limestone	0.90	0.50	0.75
Salt	0.50	0.50	0.50
Vit/TM Premix	0.50	0.50	0.50
Nutrient composition			
ME, kcal/kg	3045	3176	3330
Crude protein, %	18.5	22.6	17.9
Lysine, %	1.00	0.98	0.94
Calcium, %	0.91	0.91	0.91
Phosphorus, %	0.79	0.79	0.81

(1) Assumes no winter farrowing, unless sow and litter are housed indoors.

Forages in Swine Diets

Forages in the form of pasture, as part of a complete feed, or silage, can be used successfully in pork production. Prior to 1950, pasture was considered a vital component in most swine feeding programs because it provided vitamins, minerals, and unidentified growth factors. Forages may have special applications in diets for organic swine production. Forage species, maturity, growing conditions, and grazing habits of pigs all influence the nutritional value of the forage consumed. Unfortunately, there are few data available to estimate the quantity of forage consumed by pigs and the nutritional value of that forage. Consequently, most nutritionists give little or no nutritional credit to the forage when formulating diets for pastured pigs. Stored forage used in the diet or fed as silage can be analyzed for nutrient content. Nutrient content of the forage can be considered in diet formulation realizing that digestibility of those forage nutrients generally is lower than that of grains. Pork Industry Handbook (PIH-126), *Forages for Swine,* outlines some specifics on utilizing forages for swine. Some observations from that document include:

- Due to high fiber content and low energy density, forages have only limited use for young pigs (especially those weighing less than 40 pounds) and lactating sows.
- Forages are best utilized at an early stage of maturity.
- Pigs absorb more nutrients from forages after an adaptation period of at least two months.
- If forages make up more than 25% of the total diet, the crude protein content of the complete feed should be slightly higher than typical corn-soybean meal diets due to the lower protein digestibility of forages.
- When pastures are the forage source, pasture rotation should be used to prevent heavy parasite and bacterial contamination of pigs.
- Forages can be heavily damaged by grazing swine, especially with rooting in the spring and fall. Reduced stocking density will protect pastures and support greater persistence. Ringing of sow snouts can reduce damage, but ringing may be considered mutilation and may not be allowed under some market certification standards.
- Hogs on pasture may grow slower and require more feed per unit of gain due to high fiber intake and increased exercise compared with confinement-raised pigs.

Pasture Systems

Use of forages can lower costs of grain and protein supplementation. In the case of pasture systems, equipment and building costs decrease, resulting in lower fixed costs of production (PIH-13). If sows are bred in the late spring to farrow early fall, good quality forage can replace up to 50% of grain and supplement needs. One acre of good pasture can accommodate up to 8 sows for a season. During other seasons of the year, however, forage quality and availability will vary, and supplementation with corn and protein supplement will need to adjust to provide the necessary nutrients.

Available recommendations on stocking rates for grow-finish hogs on pasture vary considerably with soil fertility, pasture species, rainfall, and season impacting forage availability and quality. Available recommendations for pigs weighing less than 100 pounds are 15–30 pigs per acre and 10–20 pigs per acre for pigs weighing over 100 pounds. These numbers can be increased significantly with more intensive management such as rotational grazing. Grow-finish pigs on pasture are full-fed in most instances. However, some observations suggest limit feeding can be practiced with sufficient nutrient contributions coming from the

pasture. Research focusing on the nutritional contributions of pasture with current swine genetics and management is limited.

A sample pasture mix might consist of seedings for permanent, rotational, or annual pastures. The permanent pasture might contain seedings of bluegrass, white clover, orchardgrass, and alfalfa. The rotational pasture may include alfalfa, red clover, ladino clover, sweetclover, alsike clover, orchardgrass, bromegrass, and Timothy grass. An annual or temporary pasture could be made up of brassicas, rape, soybeans, cowpeas, fababeans, sudangrass, rye, oats, wheat, barley, field peas, and mixes of grass and legumes (Zeller, 1948). Example diets that have been presented do not assume pasture supplementation due to the wide variation in forage or pasture types used, and will therefore need to be adjusted based on nutrients provided from the pasture.

Literature Cited

Close, William H. 2000. Producing Pigs Without Antibiotic Growth Promoters. Western Hog Journal (Special Edition, Banff Pork Seminar 2000), Vol. 21, 4:29–30.

Edwards, Sandra A. 1999. Organic Pig Production. Proceedings-2nd Symposium on Swine Raised Outdoors. Concordia, Brazil, September 1999.

Froseth, John A. 1993. Peas in Swine Rations EB1738.

Jones, James R., Coffey, M. Terry, and Rea, John C. 1987. Principles of Balancing Swine Rations. Pork Industry Handbook (PIH-7).

Kephart, Kenneth B., Hollis, Gilbert R., and Danielson, D. Murray. 1990. Forages for Swine. Pork Industry Handbook (PIH-126).

Macey, Anne ed. 2000. Organic Livestock Handbook. Canadian Organic Growers, Inc., Box 6408, Station J, Ottawa, Ontario.

National Standards on Organic Production and Handling. 2000. Available at: www.ams.usda.gov/nop/. United States Department of Agriculture/Agricultural Marketing Service.

Nutrient Requirements of Swine. Tenth Revised Edition. 1998. Subcommittee on Swine Nutrition, Committee on Animal Nutrition, Board on Agriculture, National Research Council. National Academy Press. Washington D.C.

Plain, Ronald. 1998. Pork Production Systems with Business Analyses: The Two-Litter Pasture System (Farrow-to-Finish). Pork Industry Handbook (PIH-13).

Racz, V.J., and Bell, J.M. 1999. Feeding Peas to Swine. Pulse Canada. http://24.72.16.12/FeedPeas/feeding-Swine.htm.

Thacker, P.A., and Kirkwood, R.N. 1990. Nontraditional Feed Sources for Use in Swine Production. Butterworth Publishers, Stoneham, MA.

Wheaton, Howell N., and Rea, John C. Forages for Swine, Agricultural publication G2360-Reviewed October 1, 1993. http://muextension.missouri.edu/xplor/agguides/ansci/g02360.htm

Zeller, J.H. 1948. The Use of Forage in Feeding Hogs. Grass Yearbook of Agriculture. USDA.

Additional Resources

The Stockman Grass Farmer: The Graziers Edge. PO Box 2300, Ridgeland, MS 39158. 800-748-9808.

Quality Pasture: How to create it, manage it, and profit from it. Allen Nation. Green Park Press (A division of Mississippi Valley Publishing Corp. Jackson, MS). Managing Cover Crops Profitably, Second Edition. Sustainable Agriculture Network, National Agricultural Library, Beltsville, MD 20705-2351.

Building Soils for Better Crops. 2nd Edition. Magdoff, Fred and Van Es, Harold.

Appropriate Technology Transfer for Rural Areas (ATTRA). PO Box 3657, Fayetteville, AR 72702. 800-346-9140. Information on sustainable and organic production including livestock and marketing.

Minnesota Organic Farmers' Information Exchange (MOFIE): Connection to organic livestock producers

and research-based information of organic production. http://mofie.coafes.umn.edu.

Minnesota Grown Opportunities (MGO): Information on alternative crop and livestock production._www.mgo.umn.edu.

Certification Agencies Operating in Minnesota

California Certified Organic Farmers.
1115 Mission St., Santa Cruz, CA 95060
831-423-2263.

Farm Verified Organic. 5449-45th St. NE, Medina, ND 58467 701-486-3578.

Global Organic Alliance Inc., 3185 Township Rd. 179 PO Box 530, Bellefontaine, OH 43311
937-593-1232.

Iowa Department of Agriculture and Land Stewardship. Wallace State Office Building, Des Moines, IA 50319
515-281-5783.

Maine Organic Farmers and Gardeners Association. 283 Water St., 4th Floor, PO Box 2176, Augusta, ME 04338 207-622-3118.

Midwest Organic Services Association. PO Box 344, Viroqua, WI 54665
608-734-3349.

Oregon Tilth Inc. 1860 Hawthorn Ave. NE, Suite 200, Salem, OR 97303
503-378-0690.

Organic Crop Improvement Association., MN Chapter. 15075-225th St W. Jordan, MN 55353
952-492-3338.

Quality Assurance International, Midwest Office. PO Box 19117, Minneapolis, MN 55419
612-824-3404.

Washington State Department of Agriculture PO Box 42560, Olympia, WA 98504
360-902-1877.

Find more University of Minnesota Extension Service educational information at **www.extension.umn.edu** on the World Wide Web.

Additional copies of this item can be ordered from the University of Minnesota Extension Service Distribution Center, 405Coffey Hall, 1420 Eckles Avenue, St. Paul, MN 55108-6068, e-mail: order@extension.umn.edu or credit card orders at (800) 876-8636.

Produced by Communication and Educational Technology Services, University of Minnesota Extension Service.

07736-BU
2002