

NUTRITION AND FEEDING



In the feeding of pigs, the main objective is to produce piglets from breeding animals, and subsequently meat from these piglets, with the maximum efficiency and productivity.

Feeding represents about 80% of the total cost of producing pigs. Therefore use feeds efficiently and economically in order to make profit. Use cheaper, lower grade feed stuff and supplement with more nutritious feeds. Provide feed requirements according to the different categories of pigs and the condition e.g. piglets, weaners, growers, pregnant sows and sows, suckling piglets.

Fortunately, pigs can survive on a variety of feeds ranging from commercial feeds (very expensive option), root tubers to pastures with quite good performance with optimum supplementation. While feeding, you (the farmer) should achieve the basic nutrient requirements of the particular age group of the pig.

Before introduction of pigs into the rearing system (pigsty), you should mobilize large feed reserves to ensure uninterrupted feeding of the animals so that the intended objective is achieved.

Generally a pig has no definite time for feeding. Piglets are habitual nibblers and eats in small quantity throughout the day. However, pigs are fed twice or thrice a day with the following computed feed:

Age	Quantity
1-2 Months	0.5 kg per day
2-3 Months	1.0 kg per day
3-4 Months	1.25 kgs per day
4-5 Months	1.5 kgs per day
5-6 Months	2.0 kgs per day
Boar and Pregnant Gilt	2.5 kgs per day

But what is a feed?

A **feed** is food given to domestic animals in the course of animal husbandry.

Uses of Pig Feeds

- ❖ **Growth:** Mainly an increase in size of bone, muscle and skin cells.
- ❖ **Maintenance:** Energy for normal animal activities and repair of worn body tissue.
- ❖ **Reproduction (Gestation):** Growth and development of unborn pigs, from mating to farrowing.
- ❖ **Milk Production (Lactation):** Producing milk requires a high-level feeding of quality feed.
- ❖ **Fattening:** Formation and deposition of fat tissue under the skin, around muscles and in the body cavity.

Basic Rules of Pig Nutrition

Nutrition and feeding provide an important tool for management manipulation in the control of disease. The quality of the feed, its methods of presentation and the amounts of feed provided are part of the disease prevention process.

Below are some of the nutrition rules you can adopt on the farm:

Rule 1: Outdoor pigs need more than just pasture to survive.

- ❖ While it is true that pigs love rooting in and eating pasture, they cannot survive on pasture alone. They need a balanced ration usually based on cereal grain. Pigs are monogastric (single stomach) animals and are inefficient digesters of fiber (only 50% efficiency).
- ❖ Diets based on pasture are high in fiber. Pasture quality can change quickly. Pigs unused to pasture diets can take 2 months to adjust. Most of this adjustment is due to changes in the size

of the large intestine and changes to micro flora in the gut. The more fiber in the diet the lower the digestibility.

- ❖ Young pigs do not have the gut capacity to eat enough pasture to get their nutrient requirements for growth, health and well-being. Pasture should be 10% or less of their daily intake for best results. Mature dry sows may cope with 50% of their diet comprising of good quality pasture but they need a balanced ration as well. Lactating sows should be fed to appetite with a grain based ration.
- ❖ Pigs on a pasture based diet have a reduced dressing percentage due to the increased gut volume for fiber digestion.

Rule 2: Cereal grains must be processed - cracked, rolled or soaked – for efficient digestion by the pig.

Pigs will eat whole grain but this will pass straight through and show in the manure. Grain that is processed is more easily digested by the pig and there is less feed wasted. The recommended particle size for pigs is 0.7mm or 700 microns.

Use of hammer mills or roller mills breaks the grain to smaller particle size and increases the surface area available to the digestive enzymes in the gut. Soaking softens the grain and it is broken to smaller particle size when the pig chews the grain. Soaking is inefficient for large numbers of pigs, and there is the added risk of mycotoxin development. (Mycotoxins are toxins produced by molds.)

Pelleted feed has a fine particle size suitable for easy digestion by the pig. However pellet size can vary so be sure the pellets are not too large for young pigs to eat. If you can see whole grains or parts of grains in the pig manure then you are wasting feed.

Rule 3: One diet does not suit all pigs – Match Feed to Need.

Pig feeds and diets are assessed on the amount of lysine and DE (digestible energy) that they provide for the pig. Piglets, weaners and growing pigs have higher lysine and energy requirements compared to mature pigs. First lactation gilts, older lactating sows and dry sows all have different lysine and energy requirements. Pigs housed outdoors may have additional energy requirements (up to 15% extra) depending on weather conditions and exercise.

Larger scale commercial piggeries will feed specific diets to their weaners, growers, finishers, gilts, dry sows and lactating sows – usually 6 different diets. Small scale piggeries with only a few sows are

usually unable to be this specific. However there is benefit in targeting the pig groups that benefit most from matching feed to need. These groups are the weaners and growers and the lactating sows and gilts.

A small scale producer needs to consider the age at which the pigs are sold. If all pigs are sold as weaners then a lactating sow diet will suffice for all pigs, with a top dressing of milk powder as the creep feed for suckling pigs. If pigs are grown out to the porker/grower weight then introduction of a grower diet for the weaners and growers would benefit those pigs.

If you are using pelleted feed then you need to make sure the pellet size is suitable for all pigs in the group. Meal or mash is preferable but you need feeders or troughs to reduce waste. If feeding wet feeds then cleanliness is important as stale moist feed is a good substrate for molds and mycotoxins which can make pigs sick or worse cause their death.

Rule 4: Feed a balanced ration – consult a pig nutritionist for diet formulations

A balanced ration and diet formulation is part of the process of matching feed to need. Different feed ingredients contain different amounts of amino acids and energy and have differing digestibility so they may not be suitable for all age groups of pig. Some feed ingredients may have restrictions on amounts that can be included in a ration due to their effects on palatability, their digestibility, fiber content or cost. A pig nutritionist can provide you with a diet formulation that supplies a balanced ration for your pigs.

There are several companies that supply vitamin and mineral premixes, and most provide a feed formulation service. It is recommended that you utilize this service. If you feed your pigs a balanced ration you enhance their health and well-being. Pigs that receive an inadequate diet are more susceptible to health and reproductive problems.

You can purchase ready mixed pig feed directly from quality feed mills. This is the easiest way to start when feeding pigs.

Consult a nutritionist as well as a vet if you have herd health or reproductive problems – these may be due to dietary deficiencies. Review your diets summer and winter or whenever the ingredients list or conditions change.

Rule 5: Water should be available at all times and readily accessible for all age groups.

- ❖ Water intake is correlated with feed intake and should be available at all times.
- ❖ Piglets start drinking water before they are weaned so water should be accessible to them as well as the sow. Lactating sows seek water at night as well as during the day even in cold weather.
- ❖ Water still needs to be available even if you are liquid feeding especially in hot weather as the liquid feed is not always available and pigs can still be thirsty.
- ❖ Aim for a cool water supply 18-20°C. Supply lines should be buried or insulated particularly if they are black poly pipe outside in the full sun; otherwise the water is hot and undrinkable when it is most needed.
- ❖ If using nipple drinkers match water pressure to age group – 0.5 liters/min for piglets and weaners, 1.0 liters/min for growing pigs and dry sows and 2.0 liters/min for lactating sows.

Rule 6: Do not feed prohibited substances (swill) to pigs.

You must not feed meat, meat products or anything that has been in contact with meat (such as table scraps or restaurant waste) to pigs. The use of Dry Stock Feed Meals based on meat, blood, bone, feathers or a combination of such products, is only allowed if the meal has been produced according to standards relating to Hygienic Rendering of Animal Products.

It is possible to keep pigs on a vegetarian diet but you are advised to consult with a pig nutritionist to develop a balanced ration.

Rule 7: Check for hazardous substances in feed – some weed seeds and some plants are poisonous to pigs.

Always ask for a vendor declaration with all feed deliveries.

Keep feed samples of all feed deliveries for 6 months. Label well and store them in a vermin free environment. Keep delivery dockets and batch numbers of all feed ingredients.

Do not feed 'OFF' Feed to pigs – look for molds, moisture, heat, odor, excessive dust, odd color or unusual ingredients. Use mycotoxin inhibitors in pig feed to reduce effects of unseen mycotoxins. Mycotoxins are toxins produced by molds on feed. There are several types. Some can cause vomiting, some can cause reproductive problems such as abortions and some can cause death in pigs.

Be aware of the plants growing on your farm – some are toxic to pigs. Some will cause death in a short period of time after ingestion (for example the seeds of the White Cedar tree) while for others the effects can be more gradual (Patterson's Curse, Common Heliotrope, Bracken Fern).

Detailed Daily Feed Requirements

- ❖ **Dry/pregnant Sows and Gilts:** Dry sows and gilts give 2.5/kg day of sow and weaner meal. Give extra 1kg/day one week before serving gilts and sows and one week after service. Give lactating sows 2.5 kg/day of sow and weaner meal for maintenance and 0.25 kg/day extra for each piglet being suckled.
- ❖ **Boars:** Give boars 2.0 kg/day. If the boar is regularly used give it 2.5 Kg.
- ❖ **Piglets:** Give creep pellets i.e. 0.5 - 1.00 kg/day from day 7 up to weaning time (21 days) per piglet. The feed should be mixed with sow and weaner meal the last one week before weaning.
- ❖ **Feeding of Growing and Finishing pigs:** - Pigs weaned at 3 - 5 weeks of 11 - 13 kg body weight should continue being fed on the starter diet until they reach 18 kg live weight. Pigs weaned at 7 weeks or older may be switched gradually to sow and weaner diet. For growing or finishing pigs all ration changes should be made gradually. If this is not possible the feeding level of the new diet should be low until the pigs become accustomed to it.

Where post-weaning scours are a major problem, restricted feeding during the first week after weaning may reduce the incidents of scours.

For treatment in case of an outbreak of scouring, medication through drinking water is preferable since sick pigs go off feed.

Traditional Pig Feeds

Feeds should meet the animal's needs for maintenance, growth and reproduction.

Good pig feed contains sufficient energy, protein, minerals and vitamins. Several feeds like maize bran, broken maize, wheat bran, millet rice bran, brewers waste, cassava meal, sweet potatoes, vegetable culls, molasses, fruit culls, sugar cane bagasse, bakery waste and forages are some of the traditional pig feeds that can be found in Uganda.

However, be careful not to use feeds from contaminated sources where you may introduce a disease like African swine fever into your herd. Also do not feed pigs with moldy feeds like spoilt bakery wastes because they are toxic.

Distillery waste is much appreciated in the traditional pig husbandry, especially for fattening pigs. It is advisable however, not to give this high valued feed to pregnant and lactating sows and to piglets and weaners because of the alcohol contents in the waste.

Below is a table of the most traditional foods fed to pigs.

	<p>Rice Bran: is very suitable for pig feeding. It contains 11% protein and can be used as the main ingredient. Rice bran can be mixed with other feeds to 30 - 45%. Rice bran can be kept no longer than 1 month because it can become moldy.</p>
	<p>Broken Rice: is very suitable for pig feeding. It can be mixed with other feeds up to 15 - 20%. Broken rice contains about 8% protein.</p>
	<p>Maize: is a very good animal feed. It contains up to 65% carbohydrates and 9% protein. It can be mixed and cooked with other feeds, but not more than 40% in the mix ration</p>
	<p>Maize bran: Maize bran is a by-product of various maize processing industries, including starch and ethanol production, and the production of maize-based foods. While maize bran theoretically consists of the bran coating removed in the early stages of processing, the maize bran sold for livestock feeding is usually a mixture of the bran fraction and other by-products and is, therefore, a very loosely defined product of highly variable composition.</p>

	<p>Soybeans: is a crop which has a high nutritional value and is very good for pig feeding. It contains 38% protein (very high). It should be dried, milled or well-cooked in combination with other feedstuff like rice bran, broken rice and maize.</p>
	<p>Wheat Bran: A by-product from the manufacture of flour, containing mainly the grain husks. It therefore has a high fiber and low energy value, but it is a useful source of phosphorous. It can also be a useful remedy for constipation in farrowing sows.</p>
	<p>Root Crops: are being used for pig feeding, they can be mixed with other feeds up to around 10 - 20% (never more than 30%). First it should be peeled and washed and then sliced, dried and ground before use. It should not be fed to pigs as raw cassava with the skin, because of toxic substances. The sliced and dried cassava can be kept longer.</p>
	<p>Fruits: Fruits damaged during transportation, storage and handling are used as supplementary feeds for pigs by boiling and mixing with other feeds such as rice bran, broken rice and maize. They can also be given fresh. Suitable fruits are: Banana, papaya, apple, pear, melons etc.</p>



Vegetables: Vegetables damage during transportation, storage and handling are used as supplementary feeds for pigs by boiling and mixing with other feeds such as rice bran, broken rice and maize. They can also be given fresh. Suitable vegetables are: cabbage, lettuce, spinach, morning glory, sweet potato vine, cola-cassia (needs boiling), pumpkin, guards, water hyacinth etc.



Sweet potato vine and tubers: Surplus potatoes or those graded unsuitable for the human market can be utilized as pig feed. The fleshy tuber provides an excellent source of energy, protein, essential vitamins and minerals. The precise nutritional value will depend on many factors including variety, season, tuber size and yield level. The starch in the raw potato is resistant to the digestive enzymes of the pig, and much of it is fermented by the gut micro flora, resulting in reduced energy availability. Cooking the potato improves its energy value by 40% but it is not always economic because of the fuel costs involved. Cooking improves the palatability of potatoes.



Green Soya bean plant: A reach source of vegetable protein.



Pumpkin: Pumpkin is a good source of the vitamin B group, while a large proportion of these vitamins is lost during the preparation of the protein concentrate and isolates.

Traditional Feed Processing

Different feeds are mixed and boiled to make the pig feed more palatable. There are 3 types of traditional processing:

- Mixing all different feeds together (rice bran, broken rice, crushed maize and soya, dried legume leaves, etc.) in proportion and giving it directly to the pigs.
- Cooking the different raw materials together to improve digestibility and to break- down toxins from some feeds as raw maize and soya grains, beans, kitchen waste, forage crops, etc.
- Food Waste Feeding to Swine is also commonly known as Garbage Feeding or Swill. Food waste or garbage fed to swine must be cooked and sterilized properly.

Feeding Alcohol Distilling Residues

Local alcohol can be made from millet, rice, maize, sweet potato, banana, etc. Most popular for pig feeding is distillery wastes from millet. It should be mixed with other feeds such as rice bran and broken rice/maize grids. Distillers' residues can be fed to fattening pigs, but not to pregnant or lactating sows. The following mixing ratio is commonly used in combination with distillery waste; Rice bran/Wheat bran (2 kg), broken rice (1 kg), and Distillers' residues (5-10 kg) and other locally available agricultural by-products.

Utilization of sun-dried on-farm generated poultry litter as a feed resource for growing-finishing pigs

Poultry litter includes excreta, bedding (mainly wood shavings, coffee husks), wasted feed and feathers. Hence it represents a vast reservoir of cheap nutrient. Good management, including exclusion of dead birds/ other extraneous materials from the litter and appropriate processing prior to feeding, such as sun drying (sometimes using a solar drier) has been reported to prevent growth of microorganisms.

However, even in the face of the incidence of Avian Influenza, on-farm generated poultry litter in farms where integrated system is practiced, with no reported disease cases could be a potential cheap source of feedstuff for growing-finishing pigs. Poultry waste has been successfully used in some countries like Egypt.

The total bacterial count can be considerably lower in sun dried poultry waste compared to the oven dried waste. According to earlier research, aflatoxins were not detectable in the concentrate mixtures containing poultry litter.

Feeding Trough Size

The feeding trough should be firmly anchored to the floor to prevent overturning and wasting feed.

Size of feeding trough for different age and purpose is given in the table:

Pig Categories	Length	Width	Height
Suckling piglet	15-20cm per pig	20cm	10cm
Fattening pig	30-35cm per pig	20cm	15-20cm
Pregnant sow	40-50cm per pig	35-40cm	15-20cm
Lactating sow	40-50cm per pig	35-40cm	15-20cm
Breeding boar	40-50cm per pig	35-40cm	15-20cm

Good pig appetite is important. Pigs will eat more fresh clean feed than if it is contaminated, stale or moldy. Clean feed troughs daily. Sufficient feeder space is necessary, so each pig can eat what it wishes every day. On many farms feed waste is 15% or more. Feed waste must be avoided as much possible.

Pigs must be fed on time: this makes the pigs familiar to the feeding regime. Pigs need to be fed according to their sizes and ages. Troughs must be anchored so they cannot be turned over.



Drinkers

The feeding trough can also be used to supply water. At large farms automatic drinkers are used (bowls or nipples).

All pigs need sufficient clean drinking water. A pregnant sow: 10 - 12 liters water per day. A lactating sow: 20 - 30 liters per day. A growing pig: 6 - 8 liters per day. A boar: 12 - 15 liters per day.

Not enough water can reduce daily feed intake. Ample clean water must be available to drink at all times.



Feeds Rations for Pigs

What is a ration?

A *ration* is the amount of feed that is fed to pigs during a 24-hour period.

What composes a ration?

The feed ration must consist of feeds appropriate to the pig's anatomy. The volume and content of the dry matter of feed must correspond to the capacity of the digestive system. The ration should include a variety of feeds (carbohydrates, proteins, minerals, vitamins, among others). The ration's structure (feed ratio) varies with the breed of pig, age; intended use and manner of feeding.

Standards for planned rather than actual productivity are used.

Nutrients of Pig Rations

- ❖ **Energy:** Farm grown or purchased grains. Energy from carbohydrates and fats in the feed. Farm grown grains are usually the cheapest source of energy for pigs. Corn and milo (grain sorghum) are popular feed grains. Wheat, oats, and barley (*if you have them on your farm*) may also be used for feeding pigs.
- ❖ **Protein:** Soybean meal/commercial sources. Protein from soybean meal, fish meal, meat scraps, tankage, or commercial protein concentrates. The amount of protein in a ration and the quality (balance of amino-acids) of protein are extremely important in pig rations.
- ❖ **Minerals:** Commercial/ farm-mixed minerals. Minerals from grain and protein sources but primarily from mineral supplements. Over 15 different minerals are essential for swine growth.

Calcium, phosphorus and iodized salt (iodine, sodium, and chlorine) make up the largest mineral requirement. The other important minerals (iron, copper, zinc, and manganese) can be supplied in a trace-mineralized salt combination. Confinement rearing of pigs dictates that all of the required major and minor minerals be included in pig rations. A calcium-phosphorus deficiency or imbalance can create serious health problems within confined sow herds.

Calcium and phosphorus: Although used primarily in skeletal growth, calcium and phosphorus play important metabolic roles in the body and are essential for all stages of growth, gestation, and lactation. The requirements for calcium and phosphorus are higher for younger pigs and lower for finishing pigs, but the ratios of calcium: phosphorus are approximately the same for all weight groups. These levels are adequate for maximal growth (rate and efficiency of gain), but they do not allow for maximal bone mineralization. Generally, maximal bone ash and strength can be achieved by including 0.1%–0.15% additional calcium and phosphorus in the diet.

For gestating and lactating sows, calcium and phosphorus requirements are influenced by stage of gestation (the first 90 days versus the final 25 days of gestation), parity, milk production, and other factors. The higher requirements during late gestation are attributed to rapid development of the fetuses. Swine producers may choose to feed slightly higher levels to sows to ensure adequacy of these minerals and to prevent posterior paralysis in heavy milking sows.

The ratio of total calcium: total phosphorus should be kept between 1.25:1 and 1:1 for maximal utilization of both minerals. A wide calcium: phosphorus ratio reduces phosphorus absorption, especially if the diet is marginal in phosphorus. The ratio is less critical if the diet contains excess phosphorus. When based on digestible phosphorus, the ideal ratio of calcium to digestible phosphorus is between 2:1 and 2.5:1.

Most of the phosphorus in cereal grains and oilseed meals is in the form of phytic acid (organically bound phosphorus) and is poorly available to pigs, whereas the phosphorus in protein sources of animal origin, such as meat meal, meat and bone meal, and fish meal, is in inorganic form and is highly available to pigs. Even in cereal grains, availability of phosphorus varies. For example, the phosphorus in corn is only 10%–20% available, whereas the

phosphorus in wheat is 50% available. Therefore, swine diets should be formulated on an “available phosphorus” basis to ensure that the phosphorus requirement is met.

Phosphorus supplements such as monocalcium or dicalcium phosphate, defluorinated phosphate, and steamed bone meal are excellent sources of highly available phosphorus. These supplements also are good sources of calcium. Ground limestone also is an excellent source of calcium.

Phosphorus is considered a potential environmental pollutant, so many swine producers feed diets with less excess phosphorus than in the past to reduce phosphorus excretion. Supplemental phytase, an enzyme that degrades some of the phytic acid in feedstuffs, is commonly added to diets to further reduce phosphorus excretion. The general recommendation is that dietary calcium and phosphorus can both be reduced by 0.05%–0.1% when ≥ 500 units of phytase per kg of diet are included.

Sodium and chloride: These minerals are provided by common salt, which contains 40% sodium and 60% chloride. The recommended level of salt is 0.25% in growing and finishing diets, 0.5–0.75% in starter diets, and 0.5% in sow diets. These levels should provide ample sodium and chloride to meet the animal's requirements. Animal, fish, and milk byproducts can contribute some of the sodium and chloride requirement.

Potassium, Magnesium and sulfur: Practical diets contain ample amounts of these minerals from the grain and protein sources, and supplemental sources are not needed. Magnesium oxide supplementation has been used to prevent cannibalism, but controlled studies do not support this practice.

Iron and copper: These minerals are involved in many enzyme systems. Both are necessary for formation of Hgb (Hemoglobin) and, therefore, for prevention of nutritional anemia. Because the amount of iron in milk is very low, suckling pigs should receive supplemental iron, preferably by IM injection of 100–200 mg in the form of iron dextran, iron dextrin, or gleptoferron during the first 3 days of life.

Giving oral or injectable iron and copper to sows will not increase piglet stores at birth nor will it increase the iron in colostrum and milk sufficiently to prevent anemia in neonatal pigs. High levels of iron in lactation feed results in iron-rich sow feces that pigs can obtain from the pen.

Iron can also be supplied by mixing ferric ammonium citrate with water in a piglet waterer or by frequently placing a mixture of iron sulfate and a carrier, such as ground corn, on the floor of the farrowing stall.

The copper requirement for growing pigs is low (3–6 ppm) but higher for sows (like 10 ppm for gestation and 20 ppm for lactation).

Copper at pharmaceutical levels in the diet (100–250 mg/kg) is an effective growth stimulant for weanling and growing pigs. The action of copper at high levels appears to be independent of, and additive to, the growth-stimulating effect of antibiotics. Copper sulfate at high levels in the diet results in very dark-colored feces. Also, high copper diets result in marked increases in the copper content of excreted manure.

Iodine: The thyroid gland uses iodine to produce thyroxine, which affects cell activity and metabolic rate. The iodine requirement of all classes of pigs is 0.14 mg/kg of diet. Stabilized iodized salt contains 0.007% iodine; when it is fed at sufficient levels to meet the salt requirement, it will also meet the iodine needs of pigs.

Manganese: Although essential for normal reproduction and growth, the quantitative requirement for manganese is not well defined. Manganese at 2–4 mg/kg in the diet is adequate for growth, but a higher level (25 mg/kg) is needed by sows during gestation and lactation.

Zinc: Zinc is an important trace mineral with many biologic functions. Grain-soybean meal diets must contain supplemental zinc to prevent parakeratosis. Higher levels of zinc may be needed when dietary calcium is excessive, especially in diets typically high in phytic acid such as corn-soybean meal diets. Pharmacologic levels of zinc (1,500–3,000 mg/kg) as zinc oxide have consistently been found to increase pig performance during the postweaning period. In some instances, high levels of zinc oxide have been reported to reduce the incidence and severity of post-weaning diarrhea. Responses to zinc oxide and antibiotics seem to be additive in nature, much like the responses to high copper and antibiotics; however, there is no advantage to including high copper and high zinc in the same diet. Similar to copper, high levels of dietary zinc cause increased zinc content in the excreted manure.

Selenium: The selenium content of soils and, ultimately, crops is quite variable. Under most practical conditions, 0.2–0.3 mg of added selenium/kg of diet should meet the requirements.

Chromium: This trace mineral, which is a cofactor with insulin, is required by pigs, but the quantitative requirement has not been established. In some studies, chromium at a supplemental level of 200 mcg/kg (ppb) improved carcass leanness in finishing pigs and improved reproductive performance in gestating sows, but these effects have been somewhat inconsistent.

Cobalt: Cobalt is present in the vitamin B12 molecule and has no benefit when added to swine diets in the elemental form.

- ❖ **Vitamin:** Commercial vitamin supplements. Vitamins from direct sunshine, dehydrated alfalfa meal, green pasture, or synthetic sources such as vitamin premixes. Vitamins regulate many body functions and are essential for rapid growth of pigs. Vitamin A affects the eye and normal vision, Vitamin D particularly affects phosphorus-calcium metabolism, and the B-Vitamins are responsible for the nervous system. Vitamins must be included in the ration of confinement-reared animals.

Vitamin A: This fat-soluble vitamin is essential for vision, reproduction, growth and maintenance of epithelial tissue, and mucous secretions. Vitamin A is found as carotenoid precursors in green plant material and yellow corn. β -Carotene is the most active form of the various carotenes.

The use of stabilized vitamin A is common in manufactured feeds and in vitamin supplements or premixes. Concentrates containing natural vitamin A (fish oils most often) may be used to fortify diets. Green forage, dehydrated alfalfa meal, and high-quality legume hays are also good sources of β -carotene. Both natural vitamin A and β -carotene are easily destroyed by air, light, high temperatures, rancid fats, organic acids, and certain mineral elements. For these reasons, natural feedstuffs probably should not be entirely relied on as sources of vitamin A, especially because synthetic vitamin A is very inexpensive. An international unit of vitamin A is equivalent to 0.30 mcg of retinol or 0.344 mcg of retinyl acetate.

Vitamin D: This antirachitic, fat-soluble vitamin is necessary for proper bone growth and ossification. Vitamin D occurs as the precursor sterols, ergocalciferol (vitamin D₂) and cholecalciferol (vitamin D₃), which are converted to active vitamin D by UV (Ultraviolet)

radiation. Although pigs can use vitamin D₂ (irradiated plant sterol) or vitamin D₃ (irradiated animal sterol), they seem to preferentially use D₃. Some of the vitamin D requirement can be met by exposing pigs to direct sunlight for a short period each day. Sources of vitamin D include irradiated yeast, sun-cured hays, activated plant or animal sterols, fish oils, and vitamin premixes. For this vitamin, 1 IU is equivalent to 0.025 mg of cholecalciferol.

Vitamin E: This fat-soluble vitamin serves as a natural antioxidant in feedstuffs. There are eight naturally occurring forms of vitamin E, but d- α -tocopherol has the greatest biologic activity. Vitamin E is required by pigs of all ages and is closely interrelated with selenium. The vitamin E requirement is 11–16 IU/kg of diet for growing pigs and 44 IU/kg for sows.

Green forage, legume hays and meals, cereal grains, and especially the germ of cereal grains contain appreciable amounts of vitamin E. Activity of vitamin E is reduced in feedstuffs when exposed to heat, high-moisture conditions, rancid fat, organic acids, and high levels of certain trace elements. One IU of vitamin E activity is equivalent to 0.67 mg of d- α -tocopherol or 1 mg of dl- α -tocopherol acetate.

Vitamin K: This fat-soluble vitamin is necessary to maintain normal blood clotting. The requirement for vitamin K is low, 0.5 mg/kg of diet. Bacterial synthesis of the vitamin and subsequent absorption, directly or by coprophagy, generally will meet the requirement for pigs. Although rare, hemorrhages have been reported in newborn as well as growing pigs, so supplemental vitamin K is recommended at 2 mg/kg of diet as a preventive measure. Generally, hemorrhaging problems can be traced back to the feeding of diets with moldy grain or other ingredients that contain molds.

Riboflavin: This water-soluble vitamin is a constituent of two important enzyme systems involved with carbohydrate, protein, and fat metabolism. Swine diets are normally deficient in this vitamin, and the crystalline form is included in premixes. Natural sources include green forage, milk byproducts, brewer's yeast, legume meals, and some fermentation and distillery byproducts.

Niacin (Nicotinic acid): Niacin is a component of coenzymes involved with metabolism of carbohydrates, fats, and protein. Pigs can convert excess tryptophan to niacin, but the conversion is inefficient. The niacin in most cereal grains is completely unavailable to pigs. Swine

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