Publication 1442 (Section 2)

# SWINE PRODUCTION

## ▪ FEEDING

CANADA DEPARTMENT OF AGRICULTURE

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*Prepared under Direction of the Saskatchewan Advisory Council on Animal Production*

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## NOTE TO READERS

The attention of readers is drawn to the fact that the text for this publication was prepared by the Saskatchewan Advisory Committee on Swine Production and that where recommendations for pesticide use appear, they are consistent with those of that province. However, readers who reside in other provinces should check with provincial authorities to determine whether or not the recommendations apply in their province.

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## NUTRIENT REQUIREMENTS

### Energy

The energy requirements of swine and the energy content of feedstuffs have traditionally been expressed in terms of total digestible nutrients (TDN). The trend now, however, is to use digestible energy (DE) as the measure of usable energy in swine feeds. For conversion purposes, 1 pound of TDN is equivalent to 2000 kilocalories of DE. The energy requirements for different classes of swine, as recommended by the United States National Research Council, are shown in Table 1 expressed both as TDN and DE.

The carbohydrate portion of cereal grains is the basic source of energy for all classes of swine. These portions vary considerably in energy content, with wheat and corn being highest and lightweight oats lowest. Single grains or various combinations of grains may be employed in formulating mixtures that will provide the energy requirements for different classes of pigs. It is important that the producer plan a feeding program carefully to meet the energy requirements, but not exceed them. A deficiency of energy in the ration will reduce growth rate, whereas an oversupply will reduce market returns because of excessive fattening in finishing pigs and may cause gestation-lactation problems because of over-fatness in sows.

The energy level in the ration will, to some extent, determine the feed intake of that particular ration. However, it is often necessary to restrict feed intake, particularly for finishing pigs and pregnant sows where a high-energy grain, such as wheat, is the chief constituent of the ration. Where such restriction is necessary, it is important that nutrients other than energy not be restricted. This means, therefore, that upward adjustments in the amount of protein-mineral-vitamin supplements may be necessary.

### Protein

Protein requirements expressed as crude protein are shown in Table 2. The producer must, however, be concerned with more than just crude protein requirements or crude protein content of feedstuffs when formulating swine rations. Other considerations are digestibility and quality. There is much less variation in the digestibility of feedstuffs commonly fed to swine than in those fed to ruminants. It is for this reason that crude protein values, rather than digestible crude protein can be used in swine ration formulations with reasonable safety.

Protein quality refers to the proportion and amount of essential amino acids in the diet. Quality is of vital importance for all simple-stomached animals. The requirements for essential amino acids, as shown in Table 3, must be met. If one or more of these becomes limiting, synthesis of new tissue will be impaired and the remainder of the dietary protein will be utilized as a rather expensive source of energy. Typical Western Canadian feed grains will supply adequate levels of six of the ten essential amino acids for all classes of swine. However, these grains are nearly always deficient in lysine and sometimes they are deficient also in tryptophan, methionine and, occasionally, threonine and isoleucine. It is often necessary in practice to feed an excess of crude protein to meet the requirement for

essential amino acids and provide for maximum rate and efficiency of growth. For instance, a barley containing 15 percent crude protein may contain no more lysine than a barley containing 12 percent crude protein. The same amount of supplement is necessary to provide an adequate level of lysine in each case, and the ration formulated with the 15 percent crude protein grain will naturally be considerably higher in crude protein content.

It is important that the daily intake of essential amino acids be maintained according to requirements, regardless of any restriction on feed consumption that is undertaken to limit energy intake. Where feed restriction is practiced, protein levels in the ration will often have to be elevated to counter the intake restriction. In any event, it is recommended that protein levels in rations for gestating sows and gilts be no lower than 15 percent crude protein, where small cereal grains (wheat, oats and barley) are the energy source.

## Minerals

The 15 mineral elements essential for pigs perform a wide variety of metabolic functions. Eight of these - calcium, phosphorus, sodium, chlorine, iron, copper, iodine and zinc - must be added as supplements to rations. Five others - magnesium, manganese, potassium, selenium and molybdenum - are present in adequate amounts in otherwise balanced rations. Sufficient quantities of the other two - cobalt and sulfur - are provided as components of vitamin B12 and sulfur-containing amino acids, respectively.

*Calcium and Phosphorus* – Calcium and phosphorus are most important as constituents of bone. Here they play a structural role, but both elements have other vital metabolic functions as well.

National Research Council requirements, together with suggested allowances of these minerals, are shown in Table 4. It should be remembered that NRC requirements for all essential nutrients are minimums, with no safety factor allowed for variability in the nutrient content of feedstuffs, or for increased requirements brought about by stress.

There is some evidence that even higher levels than suggested here (Table 4) may be nearer to optimum (that is, 1.2 percent calcium and 1.0 percent phosphorus). Levels that result in maximum growth and feed efficiency have not always proved optimum when blood and bone-ash data were considered.

Availability should not be overlooked when phosphorus levels in swine rations are being calculated. More than 50 percent of the phosphorus in cereal grains (Table 5) is present as phytate phosphorus, and is largely unavailable to pigs. Only about 60 percent of the total phosphorus in cereal grains is actually available.

The ratio of calcium to phosphorus in the ration is of critical importance. Ideally, it should be near 1:1 and should never exceed 1.5:1.

A number of supplements contain calcium and phosphorus in a readily available form. These include ground limestone (calcium only), steamed bone meal, calcium and sodium phosphates, and defluorinated 'rock phosphates'. The supplement or mixture of supplements chosen should provide adequate available phosphorus, no excess of calcium, and a proper ratio of calcium to phosphorus.

*Sodium and Chlorine* – These elements, which are essential in water metabolism and in the maintenance of the osmotic and acid-base balance of the body, are the constituents of common salt. Most common feedstuffs are deficient in these elements. Requirements can be met by adding 0.5 percent (iodized) salt to rations for all classes of swine.

*Iron and Copper* – Iron and copper are required for the production of hemoglobin, the oxygen-transporting pigment of the red blood cells. A deficiency, nutritional anemia, develops very quickly in suckling pigs because of their rapid growth rate and the very low iron content of milk. Anemic pigs become unthrifty and are an easy mark for disease organisms.

Prevention, either with an orally administered iron preparation or, preferably, by injection of an iron-dextran complex, is a simple matter. Oral treatments must be administered several times, but one injection is usually adequate. Treatment should begin no later than the third day of life.

Anemia is a problem only during the suckling period. Common swine feedstuffs contain adequate iron and copper to meet later needs.

A number of attempts have been made to increase the iron content of sows' milk by feeding various iron compounds. So far, this approach has not proved practical.

*Iodine* – Iodine is a component of the thyroid hormone thyroxine, a vital regulator of metabolism. Iodine deficiencies are common in Canadian feedstuffs. They can be avoided, for the most part, by the use of stabilized iodized salt. In known deficiency areas extra iodine, as stabilized potassium iodide, should be provided.

*Zinc* – A deficiency of this element causes parakeratosis, a troublesome disorder characterized by skin lesions, poor growth and feed inefficiency. The condition can be precipitated or aggravated by excessively high levels of calcium or phosphorus, calcium being the more serious offender.

The NRC requirement for zinc is 50 parts per million (ppm) in the complete ration. A level of 100 is recommended, and an even higher level (150) may be beneficial if, for any reason, the calcium content of the ration is excessively high.

Trace mineral supplements containing magnesium, manganese, iron and copper are sometimes added to swine rations as a 'safety' or 'insurance' measure. However, there is no real evidence that they are necessary in otherwise balanced rations under Canadian conditions.

## Vitamins

Some 15 vitamins have been documented as essential to normal metabolism in pigs. Vitamins A and D (fat-soluble), and riboflavin, nicotinic acid, pantothenic acid and vitamin B12 (water-soluble) must be added as supplements to the ration. Requirements for vitamins E and K, thiamine, pyridoxine, biotin, folic acid, choline and others are probably adequately met by synthesis in the body or intestinal tract, or by the usual levels in natural feedstuffs, although there is some evidence accumulating that vitamin E may occasionally be deficient.

*Vitamin A* – The addition of adequate levels of vitamin A to all swine rations is vitally important. This substance is concerned in vision, bone formation, reproduction and disease resistance. Deficiencies occur often with disastrous results.

The vitamin should be supplied as stabilized synthetic vitamin A. This fortification is nearly always necessary, since the small grains and protein supplements (except alfalfa meal) are devoid of B-carotene, the substance from which vitamin A is formed in animals and man. Yellow corn is not a reliable source of carotene.

A substantial safety margin is recommended (Table 4) in view of the variable conditions under which feeds may be stored, and the differing degrees of stability of commercial synthetic vitamin A supplements.

*Vitamin D* – This vitamin functions in the absorption and utilization of calcium and phosphorus. Requirements may be partially met by the action of ultraviolet light on precursors in the animal body. This source should not be relied on, however. Since grains and protein supplements contain practically no vitamin D, the suggested allowance should be supplied in the form of a synthetic vitamin D supplement. An adequate level of vitamin D in the ration is of particular importance if the calcium-phosphorus ratio is out of line.

*Riboflavin, Nicotinic Acid and Pathothenic Acid* – These members of the vitamin B-complex function in a variety of metabolic enzyme systems. Deficiencies occur in swine rations based on corn and soybean meal, but less frequently where the basal grain is barley, wheat or oats. The small grains generally contain somewhat higher levels of these vitamins than does corn, although levels of all three vary widely in natural feedstuffs.

Supplemental riboflavin, nicotinic acid and pantothenic acid are usually provided in prestarter and starter rations based on small grains, and in all corn-based swine rations.

There has been considerable research interest of late in the availability of nicotinic acid in cereal grains. The findings indicate that 70 to 80 percent of the vitamin in barley and oats, and 85 to 90 percent in wheat occurs in a bound form unavailable to the pig. It might be noted that the NRC requirements for nicotinic acid are expressed in terms of available niotinic acid.

Requirements for nicotinic acid are affected to some extent by the level of tryptophan in the ration. Pigs can synthesize nicotinic acid from tryptophan.

Vitamin $B_{12}$ – The metabolic functions of this cobalt-containing substance are still being investigated. It has been established that the vitamin is of particular importance in reproduction and the early stages of growth. There is some evidence suggesting that requirements for reproduction may be considerably higher than are currently stated.

Grains and plant protein supplements contain virtually no vitamiin B12. Animal proteins contain variable amounts. Supplements are recommended in all swine rations in amounts sufficient to provide the allowances shown in Table 4.

## Feed Additives

Since the discovery some 20 years ago that small amounts of antibiotics and other antibacterials such as organic arsenicals and nitrofurans would, when added to swine rations, result in an increased growth rate and improved feed efficiency, their

**Table 1. Energy Requirements of Swine[1]**

| Liveweight range (lb) | Total air-dry feed (lb) | Daily requirements DE (kcal) | TDN (lb) | DE per lb of feed (kcal) | %TDN in ration |
|---|---|---|---|---|---|
| Starting, growing and finishing pigs | | | | | |
| 10 – 25 | 1.3 | 2100 | 1.0 | 1600 | 80 |
| 25 – 50 | 2.8 | 4500 | 2.2 | 1600 | 80 |
| 50 – 110 | 4.8 | 7200 | 3.6 | 1500 | 75 |
| 110 – 200 | 7.2 | 10100 | 5.0 | 1400 | 70 |
| Breeding stock | | | | | |
| Bred gilts | 4.5 | 6700 | 3.4 | 1500 | 75 |
| Bred sows | 4.5 | 6700 | 3.4 | 1500 | 75 |
| Lactating gilts | 11.0 | 16500 | 8.2 | 1500 | 75 |
| Lactating sows | 12.5 | 18700 | 9.4 | 1500 | 75 |
| Young boars | 5.5 | 8200 | 4.1 | 1500 | 75 |
| Adult boars | 4.5 | 6700 | 3.4 | 1500 | 75 |

[1]Nutrient Requirements of Swine, Publication 1599, National Academy of Sciences; National Research Council, Washington, D.C. 1968.

**Table 2. Protein Requirements of Swine[1]**

| Liveweight range (lb) | Protein levels (% of diet) | Feed intake Air-dry feed (lb) | Protein intake (lb) |
|---|---|---|---|
| Starting, growing and finishing pigs | | | |
| 10 – 25 | 22 | 1.3 | .30 |
| 25 – 50 | 18 | 2.8 | .50 |
| 50 – 110[2] | 15 (16 – 14) | 4.8 | .70 (.77 – .63) |
| 110 – 200 | 14 (13 – 12) | 7.2 | 1.00 (.94 – .86) |
| Breeding stock | | | |
| Bred gilts | 14 | 4.5 | .63 |
| Bred sows | 14 | 4.5 | .63 |
| Lactating gilts | 15 | 11.0 | 1.65 |
| Lactating sows | 15 | 12.5 | 1.88 |
| Young boars | 14 | 5.5 | .77 |
| Adult boars | 14 | 4.5 | .63 |

[1]Nutrient Requirements of Swine, Publication 1599, National Academy of Sciences, National Research Council, Washington, D.C. 1968.

[2]Figures in brackets are for rations using corn as the grain with the higher level for the lighter half of this weight range and the lower level for the heavier half.

Table 3. Essential Amino Acid Requirements of Swine[5]

| Amino acids | Growing pigs weighing | | | |
|---|---|---|---|---|
| | 11-22 lb | 44-77 lb | Finishing pigs | Bred sows and gilts |
| Arginine | – | 0.20[2] | – | – |
| Histidine | 0.27 | 0.18 | – | 0.20[2] |
| Isoleucine | 0.76 | 0.50 | 0.35 | 0.43 |
| Leucine | 0.90 | 0.60 | – | 0.66[2] |
| Methionine[3] | 0.80 | 0.50 | – | 0.35 |
| Phenylalanine[4] | – | 0.50 | – | 0.52[2] |
| Threonine | 0.70 | 0.45 | – | 0.42 |
| Tryptophan | 0.18 | 0.13 | 0.09[2] | 0.08[2] |
| Valine | 0.65 | 0.50 | – | 0.46 |
| Lysine | 1.20 | 0.70 | 0.50 | 0.49 |

[1] Each requirement is expressed as a percentage of the diet. Requirements are based on the protein and digestible-energy-level requirements shown in preceding tables.

[2] This level is adequate; the minimum requirement has not been established.

[3] Cystine can satisfy 40 percent of the need for methionine.

[4] Tyrosine can satisfy 30 percent of the need for phenylalanine.

[5] Nutrient Requirements of Swine, Publication 1599. National Academy of Science, National Research Council, Washington, D.C. 1968.

use has become commonplace. These substances, which act (at low levels) by bringing about favorable changes in the intestinal microflora, have undoubtedly saved swine producers millions of dollars. There have been some reports of diminished responses, particularly in experimental units, but significant improvements in growth rate and feed efficiency are still obtained, with few exceptions, in the field.

More recently a problem has come to light of antibiotic-resistant strains, the result of antibiotic feeding. The consequences of this and the associated problem of transferred resistance are potentially serious and may ultimately force a revision of our thinking on antibiotic feeding. The fact remains, however, that a 10 percent or greater improvement in feed efficiency yields a very substantial increase in the swine producer's net income.

The use of these substances should not be indiscriminate. Rather, they should be added to the ration only where an economic response can be obtained. Antibiotics are essential in rations for early-weaned pigs as they aid materially in the prevention of scours, and usually result in improved growth and feed efficiency up to 100 pounds. In finishing rations and sow rations, a significant improvement in performance is often not obtained. In these situations, the antibiotic should be removed from the ration for reasons of economy and to minimize the possibility of developing resistant strains of bacteria.

In practice, the levels of antibiotics fed vary from 20 to several hundred grams per ton of feed, depending on the disease level and the particular antibiotic used. High levels of antibiotics or other antibacterials should be used only on the advice of a qualified nutritionist or veterinarian.

**Table 4. Requirements and Suggested Allowances for Essential Minerals and Vitamins (Allowances in Brackets)**

| | Growing-Finishing pigs | | | | | Breeding stock | | |
|---|---|---|---|---|---|---|---|---|
| Liveweight range (lb) | 10-25 | 25-50 | 50-75 | 75-125 | 125-200 | Gestation | Lactation | Boars |
| Calcium (%) | 0.80 (0.90) | 0.65 (0.70) | 0.65 (0.70) | 0.50 (0.55) | 0.50 (0.55) | 0.75 (0.85) | 0.60 (0.70) | 0.75 (0.85) |
| Phosphorus (%) | 0.60 (0.75) | 0.50 (0.60) | 0.50 (0.60) | 0.40 (0.50) | 0.40 (0.50) | 0.50 (0.70) | 0.40 (0.60) | 0.50 (0.70) |
| Salt (%) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) | 0.50 (0.50) |
| Vitamin A (I.U. per lb) | 1000 (1500) | 800 (1200) | 600 (900) | 600 (900) | 600 (900) | 1850 (2500) | 1500 (2500) | 1850 (2500) |
| Vitamin D (I.U. per lb) | 100 (150) | 90 (150) | 90 (150) | 60 (90) | 60 (90) | 125 (200) | 100 (200) | 125 (200) |
| Riboflavin (mg per lb) | 1.4 (1.6) | 1.4 (1.6) | 1.2 (1.6) | 1.0 (1.2) | 1.0 (1.2) | 1.9 (2.2) | 1.5 (1.7) | 1.9 (2.2) |
| Nicotinic acid (mg per lb) | 10.0 (12.0) | 8.0 (10.0) | 6.0 (7.0) | 5.0 (6.0) | 5.0 (6.0) | 10.0 (12.0) | 8.0 (10.0) | 10.0 (12.0) |
| Pantothenic acid (mg per lb) | 5.9 (7.0) | 5.0 (6.0) | 5.0 (6.0) | 5.0 (6.0) | 5.0 (6.0) | 7.5 (8.5) | 6.0 (7.0) | 7.5 (8.5) |
| Vitamin $B_{12}$ (mcg per lb) | 10.0 (15.0) | 7.0 (8.5) | 5.0 (6.0) | 5.0 (6.0) | 5.0 (6.0) | 6.3 (10.0) | 5.0 (10.0) | 6.3 (10.0) |

**Table 5. Mineral and Vitamin Content of Common Swine Feeds[1]**

| Feedstuff | Calcium (%) | Phosporus (%) | Vitamin A (1U per lb) | Vitamin D (1U per lb) | Riboflavin (mg per lb) | Nicotinic acid (mg per lb) | Pantothenic acid (mg per lb) | Vitamin $B_{12}$ (mcg per lb) |
|---|---|---|---|---|---|---|---|---|
| **Energy Feeds** | | | | | | | | |
| Barley | 0.08 | 0.42 | – | – | 0.9 | 26.1 | 2.9 | – |
| Corn | 0.03 | 0.27 | 1500 | – | 0.6 | 9.7 | 2.4 | – |
| Oats | 0.10 | 0.35 | – | – | 0.7 | 7.2 | 5.9 | – |
| Oat groats | 0.07 | 0.43 | – | – | 0.6 | 3.7 | 6.7 | – |
| Rye | 0.06 | 0.34 | – | – | 0.7 | 1.2 | 3.1 | – |
| Wheat | 0.05 | 0.36 | – | – | 0.6 | 28.3 | 6.1 | – |
| Wheat bran | 0.14 | 1.17 | – | – | 1.4 | 95.1 | 13.2 | – |
| Wheat shorts | 0.11 | 0.76 | – | – | 0.9 | 43.0 | 8.0 | – |
| Protein Feeds | | | | | | | | |
| Alfalfa meal (dehyd.) | 1.74 | 0.28 | 100,000 | 60 | 7.0 | 17.0 | 18.0 | 14.0 |
| Alfalfa meal sum cured) | 1.46 | 0.31 | 40,000 | 4700 | 5.0 | 16.0 | 13.0 | – |
| Distibllers' dried solubles | 0.31 | 1.06 | – | – | 7.7 | 52.4 | 9.5 | 0.2 |
| Linseed meal | 0.40 | 0.83 | – | – | 1.3 | 13.7 | 8.1 | – |
| Rapeseed meal | 0.40 | 0.90 | – | – | 1.9 | 75.9 | 4.5 | – |
| Soybean meal (44%) | 0.32 | 0.67 | – | – | 1.5 | 12.2 | 6.6 | – |
| Soybean meal (50%) | 0.26 | 0.62 | – | – | 1.4 | 9.8 | 6.0 | – |
| Fish meal (herring 70%) | 2.94 | 2.20 | – | – | 4.1 | 40.4 | 5.2 | 135.0 |
| Meat meal (55%) | 8.49 | 4.18 | – | – | 3.6 | 15.1 | 4.1 | 50.0 |
| Dried skim milk | 1.26 | 1.03 | – | – | 9.1 | 5.2 | 15.3 | 25.0 |
| Dried whey | 0.87 | 0.79 | – | – | 13.6 | 5.1 | 21.7 | 11.0 |

[1] Average values. The nutrient content of any of these feedstuffs varies widely.

## Nutritional Deficiencies

Nutritional deficiencies are abnormal conditions or poor performance because of faulty ration balancing or feeding methods. Nutritional deficiencies probably account for more economic loss to swine producers than diseases and undoubtedly malnutrition increases the danger of infectious diseases.

It is emphasized that the diagnosis of nutritional deficiencies is not easy and may require the assistance of the veterinarian and careful examination of the feed before the causes of difficulties can be determined. It should also be noted that multiple deficiencies complicate the diagnosis and the remedies that might be tried. However, a general appreciation of the kinds of symptoms associated with the more common deficiencies will assist the producer in assessing his problems.

A shortage of *energy,* due to feed restriction, underfeeding or using high-fiber, lightweight grain, results in slow growth and poor feed conversion in young pigs and may affect reproduction in breeding stock.

*Protein* deficiency in the ration results in slow growth, poor feed conversion reduced appetite, poor skin and hair, and impaired reproductive performance.

*Protein quality* or *amino acid deficiency* can occur even though the protein level seems high enough and can lead to problems similar to those incurred by protein deficiency. Cereal grains sometimes contain as much protein as recommended for a certain class of pigs but there may still be a significant shortage of one or two essential amino acids.

*Calcium* deficiency can cause several problems: sometimes slow growth and reduced appetite, poor skin and hair condition, lameness and stiffness, weak bones, posterior paralysis, dead newborn pigs, poor breeding performance. Calcium excess may lead to the disorder called parakeratosis, a mange-like, discolored, scabby skin condition.

*Phosphorus* deficiency is easily confused with calcium deficiency in that several similar symptoms appear: slow growth, reduced appetite, lameness, stiffness, weakened bones and impaired reproduction. It is thought that some of the phosphorus problems are associated with the fact that only one third to one half of the phosphorus in cereal grains is available to the pig for absorption, being tied tightly in a complex chemical form. Consequently rations have frequently been undersupplemented with phosphorus.

*Salt* disorders in the diet are possible and may sometimes be related to quality of the drinking water. Salt is composed of sodium and chlorine. Sodium deficiency adversely affects appetite, growth rate and skin condition. Chlorine deficiency also affects feed utilization and gains, and may produce lameness and reproductive problems. Salt poisoning can occur with as little as 2 percent salt in the total diet when good water is not freely available.

Saline or alkali waters contain salts rich in sodium and/or magnesium together with sulphates and bicarbonates. Such water often creates problems, especially in young pigs. Water should be checked by a water analyst before embarking on a major swine production program.

*Magnesium* deficiency rarely occurs, but when it does the symptoms include lameness and poor reproductive performance.

*Iodine* deficiency affects swine in much of the geographical interior of Canada and reflects a deficiency of this element in the soil. The main symptom is the birth of hairless, weak or dead pigs. The feeding of iodized salt as 0.5 percent of the ration will usually provide protection against iodine deficiency, but additional iodine in stabilized form is sometimes added to rations of pregnant females.

*Iron* deficiency is mainly a problem of very young pigs raised on concrete. Milk contains very little iron, so if iron injections or dietary supplements are not provided within a day or two of birth, pigs show signs of anemia. This results in paleness (in light-skinned breeds), weakness, slow growth, and susceptability to infectious disease. Natural feeds used beyond the weanling stage normally contain enough iron without supplementation.

*Copper* deficiency under practical feeding conditions is probably rare, but the symptoms include poor hair and skin condition, lameness, weakened bone structure and impaired growth. It is required, with iron, for normal red blood cell formation.

Copper fed at levels well in excess of nutritional requirements results in growth promotion under some conditions. This is a chemotherapeutic effect. Results under Canadian conditions have not been consistent. The producer should watch for research reports clarifying the matter.

*Zinc* deficiency usually results in parakeratosis and is most likely to occur on high-calcium, low-phosphorus rations. The skin first appears pimply, rapidly changing to a scabby, thickened, mange-like appearance. Growth rate is reduced, appetite fails and diarrhea may occur.

*Vitamin A* deficiency affects growth rate and lameness may occur. Reproduction is affected so that fetuses may be resorbed after early prenatal death, pigs may be born dead or, if alive, blind and weak.

*Vitamin D* deficiency results in lameness and poor bone structure. Following the onset of lameness, appetite may fail and growth rate decline.

*Vitamin E* deficiency may be related to poor reproductive performance in gilts and sows, lameness and poor performance during growth. It is suspected that some or all of the vitamin E of feedstuffs is being destroyed in some of the methods of harvesting and storage such as supplementary heat drying and high moisture storage of corn. Also, the point must be remembered that we are using less oats now than previously and oats have been regarded as a fair source of vitamin E. Vitamin E and/or selenium deficiencies of pigs have become sufficiently commonplace that 5,000 to 20,000 IU of vitamin E is recommended per ton of feed. The usual amount of vitamin E used is 10,000 IU per ton of feed. The recently observed increased incidence of Mulberry Heart Disease is a result of lack of vitamin E (See Section on Diseases).

*Thiamin* is unlikely to be deficient in usual rations but if it is inadequate, reduced appetite and gains will follow. Diarrhea is often a result and reproductive performance is affected.

*Riboflavin* is commonly deficient in swine rations so it is customary to add this vitamin in making supplements or rations. The deficiency symptoms are many and varied with unthriftiness being the most common symptom. Reproductive problems, including birth of abnormal pigs, result from feeding females riboflavin-deficient rations.

*This pig is severely affected by faulty calcium and phosphorus levels in the ration. It is stiff, unthrifty and suffers severe pain when walking or attempting to rise.*

*Niacin*, like riboflavin, results in unthriftiness if it is seriously lacking in rations. Diarrhea is common and reproduction is adversely affected. Niacin in cereal grains is unavailable to the pig and, while it is customary to add niacin to swine ration formulations, it is not certain yet whether such additions are necessary of, if so, at what levels.

*Vitamin $B_6$ (Pyridoxine)* deficiency is probably rare in Canada. Severe deficiencies can cause nervous disorders, fits, etc. Milder cases result in general unthriftiness and lameness.

*Vitamin $B_{12}$* is required for several metabolic functions and must be provided in the pigs' diet. Deficiency results in poor growth, anemia, and possibly abnormal young at birth. If meat and fish meal are not used as major protein sources in the ration, supplementary $B_{12}$ must be supplied.

*Choline* deficiency results in unthriftiness, poor coordination, decreased survival in newborn pigs and inferior reproductive performance. More research is needed to determine the probability of encountering choline deficiency in pigs under Canadian conditions. Since necessary dietary levels of choline are highest for very young pigs, it is likely that choline deficiency would be encountered most frequently at this age.

*Biotin* deficiency has been produced experimentally with rather unusual rations but it is not clear that biotin is deficient in ordinary rations as fed in this country. The deficient pig shows hair loss, dermatosis, peculiar gait particularly of the hind legs, and cracks in the feet.

*Weanling pigs showing advanced cases of parakeratosis. Note thick skins and scabby conditions. This condition is caused by zinc deficiency and aggravated by calcium deficiency or imbalance in relation to phosphorus.*

Deficiencies of other vitamins such as inositol, para-aminobenzoic acid, folacin and ascorbic acid appear to be of little or no importance in practical swine feeding.

## Descriptions of Common Feedstuffs

Barley is the most widely used grain in swine rations in Canada. Corn is gaining in importance in eastern Canada and appreciable quantities of oats, wheat, rye, screenings, damaged grain, etc. are used, depending on availability and cost. Cereals constitute the main sources of energy in the pig's diet and since the pig is not capable of utilizing fiber effectively, the amount of bulk, or conversely bushel weight, is important in selecting and using grain in the ration. Wheat and corn contain more digestible energy than needed for maximum growth rate; the other cereals tend to contain too little energy and hence blends of grains are often preferred.

All cereal grains are low in protein, calcium, phosphorus, vitamin D, vitamin B12 and (with the exception of yellow corn) vitamin A and therefore require supplementation. Occasionally other B-complex vitamins may be seriously lacking.

*Barley* – Barley is a very palatable and relatively nutritious grain for pigs and has been used successfully as the only cereal in rations for pigs of various ages. Barley varies in digestible energy value according to bushel weight and kernel plumpness. Barley weighing over 50 pounds a bushel will permit rapid gains in growing pigs, but most barley will give better rates of gain if some wheat or corn is added to increase the digestible energy value.

While heavy barley is good for self-fed growing pigs, such rations may lead to overfinish during the finishing period. It is likewise too 'rich' for self-fed pregnant sows (see restricted feeding).

*Wheat* – Wheat contains more digestible energy than oats or barley. It is nutritious and palatable to pigs and can be used to advantage either as the major grain in the ration or in various mixtures, price permitting. As with heavy barley, rations high in wheat content can lead to excessive energy concumption unless some form of feed restriction is practiced.

Wheat usually contains 13 to 15 percent protein, and thus is generally higher in protein content than oats and barley. Lower grades of wheat, in contrast to oats and barley, often contain more protein than top grades because of the predominance of the protein-rich outer layers (bran and shorts).

Wheats of the soft, winter or Durum types are usually lower in protein content but otherwise, according to the limited evidence available, are about equal to the hard spring wheats.

*Corn* – Corn is an excellent feed for swine. When adequately supplemented with protein, minerals and vitamins it can supply all of the grain in starter, grower and finisher rations. Corn has the lowest protein content (9 percent) of any of the common grains fed to swine and is similar to wheat in energy content. When these two factors are considered, the general recommendations for feeding corn are similar to those for the feeding of other grains.

*High-moisture grain* – There is growing interest in Canada in storing and feeding cereal grain containing 25 to 35 percent moisture. This system requires storing the grain in silos that can be properly sealed to prevent spoilage. Results in Ontario indicate lower storage costs compared with drying and storing grain in ordinary bins. It also may allow earlier harvesting. Feeding results have been good, although the difference in moisture contents of high- and low-moisture grain must be considered in calculating feed efficiency data.

*Rye* – Rye resembles wheat in being high in energy and low in fiber, but it is not as palatable to livestock. When fed, it should constitute one third or less of the final mixed ration. The ergot content must be low (below one ergot body per 1000 kernels of rye) to guard against toxicity in the pigs.

*Screenings, wild oats, wild buckwheat, etc.* – The feeding values of such feeds usually correspond to the cereal grain content of the material in question. Lightweight fibrous matter such as chaff and hulls reduces the feeding value. 'Black' weedseeds likewise have little feeding value and furthermore some weedseeds may be toxic.

Frozen flax seed may contain prussic acid and cause illness or death. It should be fed sparingly or cooked or stored for a season to eliminate the hazard.

*Damaged grain* – Drought, rust, frost, fire, heating and other factors often make grain unsalable, and feeding it to livestock offers a chance to recover some of the losses. All of these types of damage reduce the feeding value somewhat through loss of some of the nutrients in the grain and through lower palatability because of off-flavors and off-odors. Such grain does not appear to be toxic except in rare cases. For this reason, it is best not to feed damaged grain to pregnant or nursing sows.

*Mill by-products* –These include bran, shorts and middlings. Bran is low in energy but rich in protein, minerals and B vitamins. It is also laxative and therefore useful in sow rations near farrowing time. Shorts and middlings are popular feed ingredients for young pigs. They contain about 17 percent protein and are slightly richer in energy than oats.

*Meat meal* – This packinghouse by-product constitutes a rich source of protein and had been used extensively in swine feeding. Meat meal is often an excellent source of lysine, an amino acid often in short supply in grain, and also of calcium, phosphorus and certain B-vitamins. However, these meals vary in quality depending on such factors as the quality of the original material used, and the temperature and period of cooking during processing.

Proteins of animal origin are no longer regarded as essential in pig rations because of present knowledge and availability of vitamins and amino acids. Cost and chemical composition are therefore the deciding factors.

*Fish meals* – Fish meals are richer in protein than packinghouse by-products. The protein is of an excellent quality, and ranges in content from 60 to 70 percent. Fish meal is worth more than meat meal, per unit of protein, because its lysine content is higher and the protein is more readily digestible.

*Protein feeds of plant origin* – These include soybean meal, linseed (flax) meal, rapeseed meal and sunflower meal. Soybean meal is a popular ingredient in swine feeds because it is palatable, contains 44 percent or more protein, and gives good results when properly used. Linseed meal contains about 34 percent protein and is also relatively lower in lysine content and digestible energy than soybean meal, but it is palatable and tends to be laxative. Sunflower meal contains about 41 percent protein and is probably equal or superior to linseed meal in swine rations, on a protein basis.

Rapeseed meal is now widely available in Canada. It contains about 36 percent protein of quality approaching that of soybean meal in terms of the amino acids present, but is higher in fiber and lower in digestible energy than soybean meal. It contains compounds that affect the thyroid gland if the meal is fed at too high levels. Using rapeseed meal to supply 25 percent of the supplemental protein in starter, grower and finisher rations has been shown to have no adverse effect on pig performance and twice this level has been found satisfactory for half-grown market pigs. Because of its strong flavor, rapeseed meal should not be used in early weaning rations and because of its potential goitrogenic properties it should not be used in excess of 3 percent in gilt and brood-sow rations. Small litters and lactation failure have occurred in gilts fed 7 or 8 percent meal in the rations during gestation.

*Alfalfa meal* – Alfalfa meal (dehydrated) is commonly used in the rations of breeding stock where 5 percent or more may be included to provide extra vitamins (carotene or vitamin A and certain B vitamins). It is also quite rich in calcium (about 1 percent) and contains protein of good quality. It is often regarded as an 'insurance' factor in feeding brood sows to guard against the possibility of undersupplying certain minor nutrients in the ration. However in modern feed formulation, with the wide selection of vitamin, mineral and amino acid sources available, alfalfa meal is not considered as important in feeding market pigs as it was once, although most good commercial supplements and complete feeds contain

some 'dehy'.

*Pasture* – Lush, vigorously growing, green pasture also is an excellent source of supplementary feed, and can provide much of the feed for mature boars and dry sows. However, especially in some areas of the Prairie Provinces, the quality of the pasture may not be high enough throughout the grazing season. Although many breeders believe that brood sows and boars should have access to good pasture in season, there is a growing trend toward complete confinement of the herd. This is a management decision reflecting the fact that research and experience have now resulted in our ability to raise pigs successfully through successive life cycles without access to pasture and sunlight.

*Root crops, potatoes* – Although of high water content, these feeds are satisfactory as part of the ration since the dry matter is characteristically high in energy, and low in protein, mineral and fiber. The digestibility of crude protein in raw, cooked and dried potatoes can range from 27 to 84 percent, and in potato pulp is close to 25 percent. Suitable supplementation of the total ration is required when feeding potatoes and their by-products. Potatoes have a replacement value of 4 pounds per pound of barley but cooking improves feeding value by 33 percent. Pigs should have reached 100 pounds body weight before feeding potatoes and then not exceed 8 pounds daily intake or about 5 percent of body weight.

Feeding of potatoes or their by-products to pigs can assume economic importance, for example, in the potato-growing areas of the Maritime Provinces. Dried, molassed, potato pulp (a by-product of the potato starch industry) will allow satisfactory weight gains when included up to 15 percent in grower or 20 percent in finisher rations.

*Bone meal, bone flour* –These are excellent sources of supplementary calcium and phosphorus. Bone meal is usually granular but bone flour is fine and sometimes dusty, and somewhat unpleasant to handle. They are of about equal nutritional value and contain about 24 percent calcium and 12 percent phosphorus.

*Dicalcium phosphate and defluorinated rock phosphates* – These products are obtained from deposits in the earth and can be used as substitutes for bone meal. Those that contain excessive fluorine must be defluorinated before they can be sold. They are less palatable than bone meal. Dicalcium phosphate contains about 26 percent calcium and 18 percent phosphorus, and rock phosphate about 34 percent calcium and 14 percent phosphorus.

*Ground limestone* – This is a very useful supplement in certain pig rations, but supplies only calcium, of which it contains 38 percent.

*Salt* – Salt is required by pigs and is available in plain, iodized and cobalt-iodized forms. Either of the iodized forms is recommended.

*Commercial protein supplements* – These supplements are usually designed to provide all the extra protein, amino acids, vitamins and minerals that need to be added to the cereal grain portion of the ration. The protein contents vary from brand to brand but usually range between 32 and 40 percent protein, and this may be the main reason for price variations. Assuming two supplements to be equal in other respects but containing 35 and 40 percent protein, about 20 percent less of the higher protein supplement would normally be needed.

Supplements vary in quality aside from protein content. The swine producer should therefore buy from reputable manufacturers, be satisfied that the mixing recommendations will provide the necessary nutrients as described under the sections on Nutrient Requirements and Feeding, and finally should employ the services of a Feed Testing Laboratory to ensure that proper levels of supplementation are being used for his particular conditions.

Commercial supplements may contain additives (see section on Feed Additives).

It should be unnecessary to add anything but a good commercial supplement to cereal grain for pigs weighing more than 35-40 pounds. The further addition of more minerals or vitamins only adds to cost and may actually unbalance the diet, adversely affecting pigs.

## Feed Quality Control

There are several levels of producer quality control all relating to the need to provide pigs with diets that are nutritionally adequate, palatable, highly digestible, economical, and free of materials harmful to the pig or to the ultimate human consumer.

The Feeds Act and Regulations, administered by the Canada Department of Agriculture, regulates all feeds but requires the registration only of all mixed feeds such as various kinds of complete feeds, supplements, premixes, etc. Registration involves submission of lists of ingredients, comparisons of ingredient composition with known dietary requirements of the pig, examination and approval of claims regarding expected performance of the feed in question, controls on 'medicated' feeds, mixing and feeding instructions, required guarantees on specified essential nutrients, etc. Ingredients for which no convincing claim of effectiveness can be made must be listed as 'non-active ingredients' on the label. Only those nutrients present at levels that would supply a major proportion of an animal's daily requirement may show a guarantee.

The degree of control exercised varies with the nutrient ingredient in question, with maximum flexibility being allowed where health risks are minimal. Calcium-to-phosphorus ratios and maximum fluorine levels are clearly specified, but protein minimum levels have been deleted. These are simply a few examples to indicate the nature and degree of protection afforded the producer, the feed manufacturer and the consumer, but there are still 'quality control' decisions required of the swine feeder.

The wide range of feeds, supplements, etc., available to the farmer often causes confusion. The recommended solution to such decision-making problems is a working knowledge of (a) the recommendations on nutrients required by the classes of pigs involved, (b) the feeding value of any available grain or based feeds and finally (c) from these two vantage points, the determination of the additional nutrients required to balance the rations. From here on it becomes a matter of selecting supplements that most economically meet the nutritional requirements of the pigs. This will often involve obtaining analyses of grains on hand, but this is readily accomplished in Feed Testing Laboratories.

## Swine Feed Preparation

*Grinding* – It has been well established that the reduction in particle size by grinding exposes a greater surface area to the digestive process. The consequent improved utilization of nutrients is undoubtedly the most important reason why grinding has become accepted as an essential part of the processing of swine feeds. Other important advantages include facilitation of mixing operations, prevention of particle segregation, and provision of a medium into which micronutrien and drugs can be reliably blended.

The feeding value of barley is improved about 15 percent on the average by grinding. Oats are improved by approximately 25 percent, and wheat from 5 to 25 percent, depending on feeding procedure. Benefits from grinding wheat are somewhat less than for barley or oats.

Recommendations as to fineness of grind of the small cereal grains have become reasonably well standardized and apply to all classes of swine. A medium-fine grind is desirable for barley, a fine grind is preferable for oats, and a coarse grind for wheat. The latter grain, if finely ground, will cause an undesirable pasty mass in pigs' mouths.

*Pelleting* – The economic justification for the pelleting of swine rations has for several years been a subject of controversy among swine nutritionists. There are a number of important factors bearing on this question, and no 'cut-and-dried' answer is possible, at least insofar as growing-finishing pigs and brood sows are concerned.

The use of pelleted swine feeds is increasing. The practical advantages, which are the basis for this increased usage, include improved palatability, reduction of wastage and wind loss, ease of handling, and elimination of the ingredient separation which occurs during feed handling and transport.

Some improvement in daily rate of gain and overall feed efficiency generally results when swine rations are pelleted. The improvement in gains has been mainly due to increased feed consumption, and the improved efficiency has been generally attributed to higher energy digestibility. Work in Illinois suggests that the pelleting process renders the starch fraction of corn more susceptible to attack by digestive enzymes. At the University of Saskatchewan, it has been noted that other factors such as antibiotic feeding were capable of improving energy digestibility and in so doing eliminated the benefits of pelleting. The response to pelleting is very definitely affected by the composition of the ration.

Any detailed consideration of pelleting must be in terms of the various age classes of swine. There is ample evidence indicating that the prestarter and starter rations fed to young pigs should be pelleted or, preferably, crumbled. Increased feed intakes, presumably reflecting improved palatability, have been a consistent finding, and maximum feed intakes during this period are of paramount importance. Pellets or crumbles are better utilized, there is less wastage, and feeding is more hygienic.

The picture is less clear with growing and finishing pigs. U.S. studies have shown consistent positive responses to pelleting of corn rations is gains and feed efficiency.

At the University of Manitoba, some improvement in growth and feed efficiency has been accompanied by a deleterious effect on carcass quality. In these experiments, it was concluded after considering pelleting charges and effects on

carcass quality that pellets were uneconomical for barrows and resulted in only a small saving with gilts. In subsequent work at Manitoba, it was found that the detrimental effect of pelleting on carcasses could be reduced by restricting feed intakes.

Results of an experiment at the University of Alberta demonstrated little in the way of improved gains and feed efficiency. There was a definite adverse effect on carcass quality attributable to pelleting.

Improvements in growth and feed efficiency in the Manitoba and Alberta studies have been of about the same magnitude and somewhat less that those generally quoted in the U.S. as economic justification for the pelleting of swine rations. Pelleting charges of, say, $2 per ton represent an increase of approximately 3.5 percent in feed costs. If pelleting costs are related to improved feed conversion, we would appear to be just about 'breaking even'. A reduction in carcass quality (a factor ignored by most U.S. reports) can thus mean a real economic loss for the Canadian producer. Undoubtedly, there are pigs that can produce top quality carcasses on high energy rations, but such pigs are a minority. It would seem safe to state that pelleting *per se* should be accompanied by restriction of feed intake, particularly with barrows, if losses due to poor carcass quality are to be avoided.

Justification for pelleting sow rations must be on the basis of reduced wastage, elimination of separation problems, and ease of handling. There is no convincing evidence of nutritional benefits.

## Feeding the Various Classes of Swine

*Pregnant Sows* – Many swine producers underrate the importance of meeting the nutritional requirements of pregnant sows. There are a number of nutrient deficiencies, for example, calcium, phosphorus and vitamin A, that can have a disasterous effect on fetal development. It is necessary, therefore, to provide a ration containing approximately 75 percent TDN, 15 percent crude protein and levels of essential minerals and vitamins that should meet, and preferably slightly exceed, minimum requirements. A variety of grain mixtures can be used and these should be supplemented by 10 to 12 percent of a good 35 or 38 percent protein-mineral-vitamin supplement (Table 1). In addition to the supplement, 5 to 10 percent alfalfa meal is recommended.

Feed intake must be regulated. The current NRC recommendation of 4.5 pounds per head daily, though adequate in most cases, may be insufficient for sows in a cold environment and may represent an excessive intake in some complete confinement programs. It is important, however, where intakes are reduced below the NRC

**Table 6. Effects of Pelleting Small Grain Rations for Growing and Finishing Pigs (U.S. studies)**

| | Percentage improvement | |
|---|---|---|
| Institution | Gains | Feed conversion |
| Montana | 9.7 | 7.0 |
| North Dakota | 11.8 | 9.8 |
| Michigan | 23.0 | 18.0 |

Table 7. Effects of Pelleting Small Grain Rations for Growing and Finishing Pigs (University of Manitoba)

| | Av. daily gain (lb) | Av. daily feed cons. (lb) | Feed/lb gain (lb) | Fat Measurements Shoulder | Back | Loin |
|---|---|---|---|---|---|---|
| Gilts: | | | | | | |
| Mash | 1.48 | 5.42 | 3.45 | 1.66 | 0.87 | 1.29 |
| Pellet | 1.75 | 6.04 | 3.65 | 1.73 | 0.93 | 1.27 |
| % improvement | 18.2 | 11.4 | 5.8 | -4.2 | -6.9 | 1.6 |
| Barrows: | | | | | | |
| Mash | 1.55 | 5.80 | 3.74 | 1.63 | 0.93 | 1.32 |
| Pellet | 1.83 | 6.73 | 3.68 | 1.74 | 1.03 | 1.40 |
| %Improvement | 18.1 | 16.0 | 1.6 | -6.7 | -10.8 | -6.1 |

recommended level, that adjustments to the ration be made so that only energy is being restricted. The level of feeding should be increased a week or so prior to breeding, to 6 or 7 pounds daily, reduced after breeding to the recommended level for gestation and increased again during the last 3 weeks prior to farrowing. It is, in fact, during this latter period when most of the deposition of essential nutrients in the fetus takes place.

A few days prior to farrowing, 5 to 7 percent of dried beet pulp, or about 25 percent of wheat bran, should be incorporated into the ration to provide a laxative.

*Lactating Sows* – The gestation ration is quite adequate for lactating sows. Feed should be limited to a bran mash for the first 24 hours after farrowing. Thereafter, several days should elapse before the sow is brought to full feed, but generous feeding is important from this point on to maximize milk product on. The objective should be to provide, as far as possible, for milk production by adequate feed intake during the lactation period to avoid severe weight losses in the sow. Sows should be fullfed throughout lactation, although a temporary cutback in intake may be necessary if the litter is being weaned at 3 to 4 weeks. Examples of suitable sow rations based on small cereal grains are shown in Table 1.

*Nursing and Early Weaned Pigs* – The importance of providing suckling pigs with palatabl, well-balanced rations cannot be over emphasized. A sow reaches the peak of her lactation at about the time her piglets are 4 weeks of age and thereafter, her production declines steadily. It is therefore essential that creep feed be consumed both to maximize the growth rate of the young pigs and to minimize the digestive upsets that are so often the basic cause of outbreaks of weanling diarrhea.

Creep feeding should begin at from 7 to 10 days of age. Highly palatable, easily digested and nutritious rations are necessary. Examples of a pre-starter or early weaning ration and a starter ration, with feeding recommendations, are given in Tables 2 and 3. The pre-starter ration, is somewhat higher in protein content than currently recommended for pigs of this age. However, because of limited feed intake by suckling pigs, a higher than recommended protein level is necessary if the actual daily intake of protein is to meet requirements. These rations have performed well in experiments at the University of Saskatchewan.

It is important that everything possible be done to encourage creep feed consumption prior to weaning. The feed should be supplied in a creep and renewed

frequently to avoid its becoming stale. Clean fresh water should always be available to the suckling pigs immediately adjacent to the creep feeder.

It is recommended that the early weaning and starter rations be fed in pellet or crumble form. This, in most instances, means the use of a commercial product.

An antibiotic or antibiotic mixture, which is effective as a growth promotant, is important and should be included in pre-starter and starter rations at the manufacturer's recommended level. The producer should keep a continuous record of antibiotics used in swine rations for the guidance of his veterinarian in case of a disease outbreak.

*Garbage Feeding* – Garbage from hotel, restaurant, institutional kitchens, etc. has been fed successfully to pigs. The nutritional quality of garbage varies according to source, but typical ranges in nutrient contents (on a dry matter basis) are 13 to 18 percent crude protein, 11 to 30 percent fat, 3 to 8 percent crude fiber and 5 to 6 percent total minerals. The protein is 75 to 90 percent digestible and the energy is about 70 to 95 percent digestible.

The mineral content, largely unground bones and eggshells, is not well utilized by pigs, and mineral supplementation is beneficial. About the same level of minerals should be added as is required with grain (dry basis).

Garbage tends to be deficient in vitamin $B_2$ (riboflavin), pantothenic acid, vitamin A and vitamin D. Levels of thiamine and niacin are usually adequate.

**Table 8. Sow Rations (Gestation and Lactation)[1,2]**

| Ingredient | A | B | C |
|---|---|---|---|
| Wheat, ground | 750 lb | 650 lb | 100 lb |
| Barley or heavy oats, ground | – | 100 lb | 750 lb |
| Light oats, ground | 100 lb | 100 lb | – |
| Alfalfa meal, dehydrated | 50 lb | 50 lb | 50 lb |
| 38% "sow concentrate" | – | 100 lb | 100 lb |
| Soybean or linseed oil meal | 45 lb | – | – |
| Meat meal | 20 lb | – | – |
| Fish meal | 20 lb | – | – |
| Salt (iodized) | 5 lb | – | – |
| Ground limestone | 5 lb | – | – |
| Bone meal | 15 lb | – | – |
| Zinc oxide | 0.1 lb | – | – |
| Vitamin A | 2,500,000 IU | – | – |
| Vitamin $D_2$ | 200,000 IU | – | – |
| Vitamin $B_{12}$ | 10 mg | – | – |
| Crude protein (min.) % | 15 | 15 | 15 |
| Estimated T.D.N. % | 75 | 75 | 75 |

[1] Gilts and sows should be restricted to 4.5 – 5.5 lb of gestation ration per head daily. These allowances may need to be increased for very thin animals or in very cold weather. Gestation rations must be diluted, preferably with additional alfalfa meal, if they are to be self-fed.

[2] Lactation rations may be self-fed. Consumption will range from 12 to 20 lb per sow daily. Maximum consumption should be encouraged during lactation.

The gestation-lactation ration is an excellent feed for the breeding boar.

Table 9. Pre-starter (Early Weaning Ration)

| | |
|---|---|
| Wheat, ground | 250 lb |
| Oat groats, ground | 100 lb |
| Skim milk, dried | 150 lb |
| Whey, dried | 100 lb |
| Wheat germ meal | 80 lb |
| Fish meal | 100 lb |
| Soybean oil meal | 50 lb |
| Lard, stabilized | 50 lb |
| Sucrose | 80 lb |
| Brewers' dried yeast[1] | 30 lb |
| Salt (iodized) | 10 lb |
| Ground limestone | 10 lb |
| Iron sulfate | 0.5 lb |
| Copper sulfate | 0.05 lb |
| Zinc oxide | 0.1 lb |
| Vitamin A | 1,500,000 IU |
| Vitamin D | 150,000 IU |
| Vitamin $B_{12}$ | 15 mg |
| Antibiotic (broad spectrum) | 25-100 gm |
| Crude protein | 26-27 % |
| Estimated TDN | 80 % |

[1] Appropriate levels of synthetic riboflavin, niacin and calcium pantothenate may be substituted.

Pre-starter should be self-fed in a creep from 10 days of age through weaning at 15 lb to a weight of 25 lb. Consumption will range from 12 to 20 lb/pig.

Garbage averages about 80 percent water, but this is also variable depending on the amount of water added during cooking. According to law, garbage must be properly cooked to ensure control of certain diseases and parasites. Consequently, anyone considering garbage feeding should check with local health authorities and federal Health of Animals Branch personnel to comply with current regulations.

Obviously the economics of garbage feeding involves factors not found in grain feeding. The possible presence of such items as broken dishes, cutlery and cans should not be overlooked. Garbage on a cooked, dry-matter basis may be roughly equivalent in feeding value to high-protein cereal grains. Consequently, after hauling, cooking and extra labor charges are considered, average garbage would be worth about $6.00 to $7.00/ton when grain is worth $1.50/hundredweight on site.

*Growing and Finishing Pigs* – Recommendations for feeding the pig from weaning to market age cannot be made without reference to the management system involved and the matter of carcass quality. Formulas adopted may differ depending on whether self-feeding, restricted feeling or liquid feeding is used. (Sometimes separate feeding of mineral protein supplements is practiced but this is not regarded as an efficient way of providing balanced rations.)

Well-bred pigs, efficiently fed and managed, can reach 200 pounds market weight in less than 150 days and produce high-quality carcasses. R.O.P. testing in Canada

**Table 10. Starter Rations**

| | |
|---|---|
| A. Wheat, ground | 450 lb |
| Oat groats, ground | 240 lb |
| Sucrose | 100 lb |
| B. Soybean oil meal | 120 lb |
| Fish meal | 50 lb |
| Brewers' dried yeast[1] | 20 lb |
| Salt (iodized) | 5 lb |
| Ground limestone | 5 lb |
| Bone meal | 10 lb |
| Zinc oxide | 0.1 lb |
| Vitamin A | 1,200,000 IU |
| Vitamin $D_2$ | 150,000 IU |
| Vitamin $B_{12}$ | 15 mg |
| C. Antibiotic[2] (broad spectrum) | 20-50 gm |
| Crude protein (min) (%) | 18 |
| Estimated TDN (%) | 80 |

[1] Appropriate levels of synthetic riboflavin, niacin and calcium pantothenate may be substituted.

[2] Commercial supplements may not provide sufficient antibiotic.

Portion B of the ration may be replaced by 25% of a good commercial 38% protein-mineral-vitamin supplement ("hog concentrate").

Starter should be self-fed in a creep from 10 days of age through weaning at 6 weeks of age or older to a weight of 45-50 lb. Consumption will range from 30 to 40 lb per pig. Early weaned pigs should be fed this ration from 25 to 45-50 lb.

employs a high-energy, self-fed ration as a means of identifying fast gaining, efficient, meaty strains of pigs. The same pig characteristics are needed in profitable commercial operations. However, if inherited lean-meat quality is lacking in the feeder pigs, restricted feeding may result in improved carcass quality at the expense of decreased through-put in the barn because operators practicing feed restriction often find that 'maturities' run to 180 or more days at market weight. Restricted pigs may require a more highly fortified ration because certain daily requirements of nutrients must be met and of course the hope is that the decreased daily gain will not restrict muscle or red-meat development, but just fat deposition.

The percentage of protein needed in the diet declines as the pig matures. However, a shortage of protein can adversely affect both carcass quality and efficiency of feed conversion. There is often doubt about the actual level of protein in the grain portion of farm-mixed rations, so a safety margin is advised. Some producers employ a straight 16 percent protein level, single ration concept throughout the growing-finishing period. This level of protein exceeds actual requirements if the quality or amino acid makeup of the protein is correct. Unfortunately in practice, the amino acid balance is seldom ideal, and with the current level of technology it is impractical to make it ideal, so a safety margin of 2 or 3 percent extra protein is realistic.

Table II. Formulas for grower rations containing 16% protein

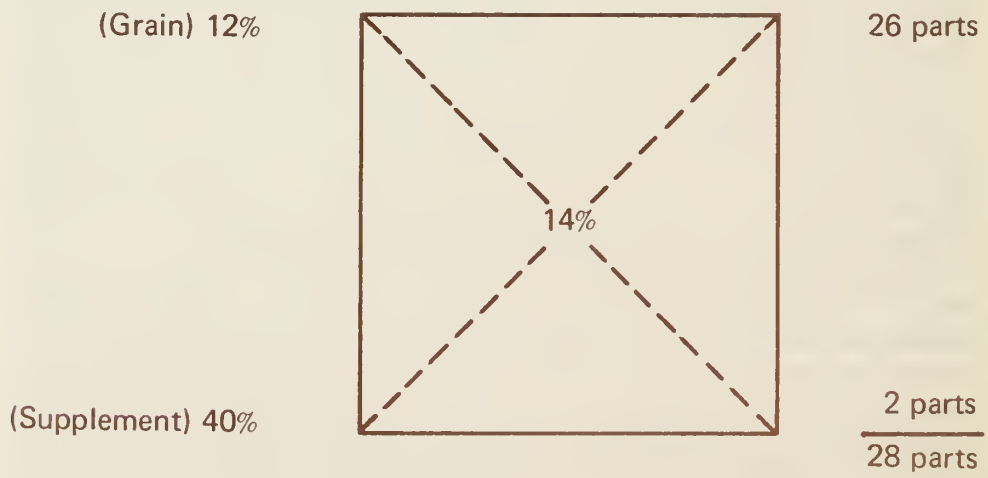
| Ingredient | Barley | Barley | Barley Wheat | Oats Wheat | Corn | Corn Oats |
|---|---|---|---|---|---|---|
| Barley | 1702 | 1638 | 1160 | 859 | – | – |
| Wheat | – | – | 480 | – | – | – |
| Oats | – | – | – | 859 | – | 500 |
| Corn | – | – | – | – | 1540 | 1090 |
| Supplement, 35% | – | 362 | – | – | – | – |
| Supplement, 40% | 298 | – | 280 | 282 | 460 | 410 |

Safety margins are involved with most nutrients to ensure that the minimum requirements are met because inevitably it is necessary to estimate, rather than analyze, the nutrient contents of some of the ration components.

The formulas shown in Table 11 are typical of rations based on the various grains. Such rations are likely to be adequate in terms of minerals and vitamins but could fall short of supplying 16 percent protein if the grain used contained a much lower level than average. Only by analysis can this be avoided.

A protein-mineral-vitamin supplement will contain about 75 percent of a mixture of protein-rich feeds such as meat meal, soybean meal, rapeseed meal, fish meal, etc. depending on cost. The remainder will be made up of iodized salt, calcium and phosphorus sources, trace minerals, vitamins A, D, B12, riboflavin, pantothenic acid, niacin and possibly other vitamins. Some form of medication (antibiotics, arsenicals, etc.,) may be included.

Calculation of ration formulas containing different protein levels or rations containing grain and/or protein supplements with different protein contents can be accomplished by the following method. Assume that one wishes to formulate a 14 percent protein ration using grain containing 12 percent protein and a 40 percent




protein supplement. Set the protein percentage on the left side of the square and the desired percentage protein in the middle. Subtract across the diagonals to obtain the parts grain and parts supplements. The percentage of supplement in the

ration is obtained by dividing the parts supplement by the total parts and multiplying by 100

$^{2}/_{28} \times 100$ - 7.15 percent supplement (and therefore 92.85 percent grain).

Only protein was considered in this example, and prepared protein-mineral-vitamin supplements may fail to give satisfactory results if levels of use depart much from usual situations. For instance, the above calculations might show that much less supplement would be needed when high-protein grain is available. However, the reduction might risk mineral, amino acid or certain vitamin deficiencies unless further adjustments are made.