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THE PIG'S NEED FOR MINERALS

by N. W. GODFREY, Adviser, Animal Husbandry

Only 16 of the one hundred odd chemical elements known are considered to be essential mineral elements for pigs. As some of these are required in much smaller quantities than others, they are referred to as trace or minor elements, while the remainder are called major elements.

For convenience, the quantities of minor elements required by pigs are usually calculated as parts of the elements per million parts of food or simply, parts per million (p.p.m.). A percentage figure is usually employed when dealing with the major mineral elements. Percentage can be simply converted to p.p.m. by multiplying by 10,000 and, conversely, p.p.m. converted to percentage by dividing by 10,000.

For example, a growing pig will probably require about 0.8 per cent. or 8,000 p.p.m. of the major element calcium in its diet, whereas its need for the minor element copper is only 10 p.p.m. or 0.001 per cent. The other minor elements required by pigs are iron, zinc, manganese, iodine, fluorine, selenium and perhaps cobalt. To supply their major element needs, pigs require calcium, phosphorus, sulphur, potassium, magnesium and salt (containing sodium and chlorine).

With grazing animals, such as sheep and cattle, the mineral content of the pasture is usually adequate except where soils low in one or more minerals produce pastures incapable of supplying the total requirements of animals grazing them. Copper, cobalt and phosphorus are examples of livestock mineral deficiencies produced by a shortage of these elements in the soil.

If pigs are being kept as "grazing" animals under extensive husbandry systems, the mineral status of the soil and pasture should be considered along with any possible need to supply supplementary mineral mixtures. However, the trend is towards intensive pig raising, with many farmers mixing their own pig rations which must contain all the minerals required by their pigs in adequate amounts.

A fairly precise knowledge of the pig's need for minerals is therefore required if these are to be supplied. In addition, care must be taken to ensure that the levels of each mineral are not excessive as this may produce undesirable imbalances or could even have toxic effects. The class of pig should also be considered. A creep ration, for example, requires different levels of many of the minerals than would be expected in a baconer ration.

Again, the levels of supplementary minerals required will depend on the other ingredients used to make up the bulk of the ration, as these will already contain their own various amounts. Rations based on meat meal, for example, would probably not need added calcium or phosphorus, whereas rations relying on vegetable protein sources would.

For the mineral elements needed in a farm-mixed pig ration, the producer has two choices. Either he mixes in each of the minerals he thinks are required, or he can purchase any one of a number of proprietary mineral pre-mixes which, incidentally, may also contain various other feed additives, some of which might be useful. In either case, he must have some knowledge of his pigs' requirements, especially as many of these pre-mixes may be quite unsuitable. If any doubt exists, competent advice should be sought.

The levels of the various mineral elements required by pigs are shown in the accompanying Table. These should not be taken as absolute but merely as a guide.
The major elements

**Calcium and phosphorus:**

These two elements are conveniently considered together because they are closely associated in many body processes. Together they form more than 70 per cent. of the body's mineral content, being found mostly in the bones and teeth. Adequate calcium and phosphorus nutrition depends primarily on a sufficient supply of each element, to some extent on the ratio between them and on the presence of vitamin D.

Although the ideal calcium-phosphorus ratio lies between 2 : 1 and 1 : 2, adequate nutrition is possible outside these limits, provided the total levels of each are sufficient. Vitamin D is required for the efficient assimilation of these elements and with plenty of this vitamin, the exact ratio is of minor importance. If vitamin D is absent from the ration, very little calcium and phosphorus can be absorbed and a deficiency will result.

Inadequate calcium and phosphorus nutrition, particularly in young growing pigs, results in the condition known generally as rickets. It is characterised by retarded growth and bone deformities which may produce posterior paralysis. In adult stock, the provision of these elements in the ration must be made as the sow's requirements are doubled during lactation.

Excessive intakes of calcium can have a number of undesirable side effects. A deficiency of zinc may result, producing a skin condition known as parakeratosis, if the level of zinc is not raised to compensate for its lowered level of absorption due to high dietary calcium. The effects of manganese deficiency can also be intensified with high levels of calcium or phosphorus in the diet.

Feeds commonly used in pig rations differ markedly in their calcium and phosphorus content. The cereals contain extremely low levels of calcium, and vegetable protein sources generally have a moderately low calcium content. On the other hand, all meat meals contain quite high levels of both calcium and phosphorus and if used as the main protein source in mixed rations with cereals, will generally supply the total requirement for these two elements.

Legume pastures and hay also contain high levels of calcium but do not feature greatly in pig feeding. Milk products have fairly high levels of calcium and phosphorus although, when diluted with cereals in a mixed ration, the resulting concentrations of these elements would be inadequate for a pig's needs without supplementation.

The total content of phosphorus in a feeding stuff does not always indicate the total amount available to the pig. Cereals, and other seeds, which are comparatively high in phosphorus have most of this element present as phytin, which is not completely broken down in the digestive tract. The availability of phytin phosphorus can vary with the level of vitamin D and other dietary factors, but it is usually safe to assume that only about a third of the phytin phosphorus in cereals is available to the pig.

If meat meal is not the basic protein source, calcium-phosphorus supplements will usually need to be added to farm-mixed pig rations. Sterilised bone meal, bone flour, dicalcium phosphate and Christmas Island rock phosphate are common local sources of these two elements whereas ground limestone and oyster flour are used if calcium alone is required. Adding rock phosphate at the level of 1½ lb. per 100 lb. of ration, for example, would increase the ration's calcium and phosphorus content by 0.48 per cent. and 0.24 per cent. respectively, which would meet about 60 per cent. of the pig's total requirements, the remainder probably being supplied in the normal ration components.

**Magnesium:**

The essential nature of magnesium has been demonstrated experimentally in pigs with purified diets lacking this element. In all practical pig rations, however, the concentration of magnesium is well above the pig's requirements and its addition is not warranted.

**Potassium:**

In common with magnesium, potassium, although essential, is never of practical importance as any pig ration will contain levels of this major element well in excess of any pig's needs.
Salt (sodium chloride):
Salt contains the elements sodium and chlorine. The pig's primary need is for sodium, chlorine being required in much smaller amounts. Despite the wide distribution of common salt in feeding stuffs, their total sodium content is rarely sufficient for the pig's needs. This contrasts sharply with the situation for grazing sheep and cattle where all normal needs are met by the salt content of the pasture.

Loss of production in pigs could result if rations were not supplemented with common salt.

The addition of up to 0.5 per cent. sodium chloride to the mixed rations of pigs will ensure their requirements for sodium are met and it also has an appetising effect. Any excess salt is rapidly excreted in the urine.

Sulphur:
The pig's sulphur needs are closely associated with its requirements for proteins which contain essential sulphur-containing amino acids methionine and cystine. There is little point then in adding inorganic forms of sulphur such as flowers of sulphur and gypsum as these will be little utilised by the animals.

Most mixed rations contain adequate amounts of sulphur as such, although there may be instances where methionine and cystine levels are below standard. A mixture of protein sources, however, usually ensures an adequate supply of these amino acids.

The minor elements
Iron:
Although iron plays a vital role in life processes, the normally high levels found in feeding stuffs ensure its adequate supply to all classes of pigs except young piglets without access to soil or some other form of iron supplementation.

Cereals and all the protein sources, except milk products, contain liberal amounts of iron relative to the pig's needs.

Because iron is an essential constituent of red blood cells, its deficiency causes anaemia. Piglet anaemia which occurs in suckling piglets is the common manifestation of iron deficiency. Although the young pig is born with a store of iron, sows' milk contains extremely small amounts and if a supplementary source is not found soon after birth the piglet's iron reserves are depleted.

Where newly-born piglets are not confined, they normally ingest enough soil to meet their full requirements for iron during the suckling period. Piglet anaemia is only a problem with litters kept in floored pens without access to soil, and there is little justification for administering iron preparations to piglets under extensive pig husbandry conditions.

It is important that iron supplements be given to piglets within the first two weeks of life where they are confined to concrete pens. A number of alternative methods can be used in this respect, and the time honoured method of throwing a shovel-full of fresh clean soil into the pen is still very effective. Reduced iron, either as a powder or a paste, is also very effective when administered by mouth.

More recently, improved injectible preparations, containing iron dextran, have been found effective in preventing piglet anaemia. However, the use of injectible iron must be restricted to pigs less than one month old. In fact, injections in general should be avoided in growing pigs as they are liable to deprecate the carcass.

There is no need to supply iron to pigs past the suckling stage. Unnecessary additions can, in fact, be deleterious. Too much iron in the diet interferes with phosphorus absorption and rickets may result on an otherwise adequate ration.

Copper:
Copper is associated with the absorption and utilisation of iron and many other body processes. Consequently, anaemia is a common symptom of copper deficiency. In Western Australia the shortage of copper is generally a regional problem of sheep and cattle grazing pastures on naturally copper deficient soils. Presumably, pigs run extensively on these soil types may also have inadequate copper intakes.

Mixed rations for pigs may or may not have enough dietary copper without some added source of this element.

Consequently it is probably good policy to add the total requirement to any pig
rations to ensure its supply, as, within limits, no harmful effects would be expected even if the level of copper is well above the requirement.

Pigs are generally considered to need 10 p.p.m. or less of copper in their diet. However, much higher levels of copper are sometimes fed to fattening stock as this is claimed to have some growth-stimulating effect. High level copper feeding at 250 p.p.m. is liable to be toxic and a safer level of 150 p.p.m. is therefore recommended if this practice is to be pursued. At these high levels of intake, copper storage in the liver can be extremely variable, and if high levels accumulate this should be considered from the public health point of view.

Zinc:
A skin condition known as parakeratosis in pigs can be attributed to a deficiency of zinc. The characteristics of this disease are specific skin lesions, retarded growth and other symptoms. Pigs need 50 p.p.m. of zinc in the diet and this level should be maintained if parakeratosis is to be avoided.

If excessive amounts of calcium are fed, the requirement for zinc is raised to 80 to 100 p.p.m. Higher levels can be fed as this element is relatively non toxic up to about 1,000 p.p.m.

The pig’s normal requirements for zinc can be met by adding 8 oz. of zinc sulphate or 2½ oz. of zinc oxide to each ton of ration.

Manganese:
Manganese has many essential functions in the body but its most noticeable effects in pigs are on skeletal growth, reproduction and lactation. These functions are severely impaired when manganese-deficient rations are fed.

The requirement for manganese in pigs is generally set at 40 p.p.m., although the precise minimum level cannot be given with certainty.

The manganese content of wheat and other cereals in Western Australia is extremely variable. Wheat for example contains, on the average, about 40 p.p.m. of manganese, but individual samples can range from 19 to 84 p.p.m. Meat meal, the basic protein source for most pig rations, probably contains 11 to 25 p.p.m.

Thus it is quite possible to produce a mixed meat meal-wheat pig ration containing less than the accepted 40 p.p.m. of manganese.

Since reasonable excesses of manganese are well tolerated, the addition of the total requirement for this element in pig rations, seems justified.

This can be supplied as 5 oz. of manganese sulphate or 4⅓ oz. of manganese chloride per ton of mixed ration.

Iodine:
A deficiency of iodine is chiefly an area problem where soils are naturally low in this element. Western Australia has no such “goitrous” regions and so there is no need to supplement the diets of livestock with iodised salt, which is the usual form of iodine administration.

Pigs need as little as 0.2 p.p.m. of iodine in their diet.

Cobalt:
Cobalt is highly important in the nutrition of ruminants, but has little practical importance in mixed pig rations. Experimentally, it has been possible to produce a cobalt response in pigs with rations containing little or no vitamin B₁₂.

To the mixer of pig rations cobalt presents no problem since the levels possibly needed are extremely small and would be more than adequate in nearly all mixed food sources. However the addition of ¼ oz. of cobalt sulphate to each ton of ration would be harmless.

Molybdenum, fluorine and selenium:
Although molybdenum, fluorine, and selenium are essential minor elements, the requirements for each are extremely low and their addition to practical pig rations should not be considered since they are highly toxic when fed in excessive amounts. No beneficial responses by pigs to supplements of these elements have been reported in Australia.

Mineral mixtures
A great many mineral mixtures are available commercially. Many might provide the pig farmer with a useful alternative to making his own preparations.

Care should be exercised in selecting a mixture which complements the mineral
content of the other basic ration ingredients. This applies particularly to calcium and phosphorus, where an excess of either can have adverse effects on the availability of other minerals.

Proprietary mixes generally contain a number of elements which are usually not necessary. The customer presumes these are added in case they are needed, that they are not harmful, and that they do not add significantly to the cost. The second presumption would be correct if the product is registered by the Department of Agriculture. It is wise to seek expert opinion on the suitability of mineral and other premixes for pigs, as salesmen cannot always be expected to give this type of advice.

Mineral mixtures prepared on the farm can be quite satisfactory. The few ingredients needed are sources of calcium, phosphorus, salt, copper, zinc and manganese. If meat-meal is the chief protein source, calcium and phosphorus would not be needed. The following rates of addition per ton of mixed ration then would be appropriate for meat-meal based rations.

Salt—10 lb. per short ton.
Copper sulphate—2 oz. per short ton.
Zinc sulphate—8 oz. per short ton.
Manganese sulphate—5 oz. per short ton.

For calcium and phosphorus, where needed, 20 to 30 lb. of Christmas Island rock phosphate or bone meal can be added to each ton of ration mixture.

Vitamins:
It is convenient when discussing mineral mixtures to make some reference to the pig's vitamin requirements as well, since these may also be included in a mineral premix before it is added to the main ration.

Vitamins are needed in very small quantities and generally add little to the cost. For this reason, manufactured feeds frequently contain a good range of vitamins to cover all possibilities. However, when making up pig rations on the farm, the addition of vitamins A and D is all that is really required, since any others will normally be contained in the main feed ingredients or synthesised in the animals' intestines. These two vitamins are now available as free flowing powders which mix easily with the ration.

The pig's minimum requirement for vitamins A and D is considered to be 1,000 and 100 international units (I.U.) respectively; these levels are given as a guide only since circumstances may warrant twice these amounts or more.

The following rates of addition per ton of mixed ration will usually provide the pig's full requirements for vitamin A and D, with some margin of safety.

Vitamin A 4.0 million I.U. per 2,000 lb.
Vitamin D 400,000 I.U. per 2,000 lb.

The appropriate quantity of commercial vitamin preparation to be used is calculated from the concentration of the material.

### MINERAL ALLOWANCES FOR PIGS IN TERMS OF TOTAL RATION CONTENT

<table>
<thead>
<tr>
<th></th>
<th>Creep rations</th>
<th>Weaner rations</th>
<th>Grower and finishing rations</th>
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<tbody>
<tr>
<td>Calcium %</td>
<td>0.8</td>
<td>0.65</td>
<td>0.5</td>
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<tr>
<td>Phosphorus %</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
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<tr>
<td>Salt (NaCl) %</td>
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<tr>
<td>Magnesium %</td>
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<tr>
<td>Iron ppm</td>
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<td>40</td>
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<tr>
<td>Copper ppm</td>
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<td>10 (higher if excess calcium fed)</td>
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<tr>
<td>Zinc ppm</td>
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</tr>
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<td>Manganese ppm</td>
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<td>Iodine ppm</td>
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<td>Vitamin A I.U./lb.</td>
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<tr>
<td>Vitamin D I.U./lb.</td>
<td>200</td>
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