MINERALS FOR FARM ANIMALS

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Only six mineral elements are likely to be lacking in farm rations in Minnesota—sodium, chlorine, iodine, phosphorus, calcium, and iron. As yet there is no scientific evidence that other elements need ever be supplied on Minnesota farms through mineral supplements except, perhaps, under disease conditions. Since every intelligent farmer provides his livestock with sodium and chlorine by means of common salt (sodium chloride), the possible deficiencies narrow down to the elements iodine, phosphorus, calcium, and iron.

Iodine.—In general, the Northwest and Great Lakes states are iodine-deficient regions. However, the evidence hardly warrants the general use of iodine as a mineral supplement in these regions, altho it should be supplied to breeding animals wherever a deficiency is clearly indicated.

Phosphorus.—The conditions causing a phosphorus deficiency are somewhat more complicated. There may be either too little phosphorus in the ration or a failure to use all the phosphorus present.

If the dry matter of the feed contains less than 0.2 per cent of phosphorus, it may be classed as phosphorus-deficient, and if more than 0.5 per cent, it may perhaps be classed as phosphorus-rich. On this basis, average analyses show that the common livestock feeds grown or fed in Minnesota may be listed as follows:

<table>
<thead>
<tr>
<th>Phosphorus-poor</th>
<th>Phosphorus in Moderate Amounts</th>
<th>Phosphorus-rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beet pulp</td>
<td>Early green pasture</td>
<td>Wheat bran</td>
</tr>
<tr>
<td>Red clover hay</td>
<td>grasses</td>
<td>Wheat middlings</td>
</tr>
<tr>
<td>Timothy hay</td>
<td>All cereal grains</td>
<td>Wheat germ</td>
</tr>
<tr>
<td>Millet hay</td>
<td>(corn, wheat, oats, barley, rye)</td>
<td>Red-dog flour</td>
</tr>
<tr>
<td>Oat hulls</td>
<td>Alfalfa hay</td>
<td>Legume seeds</td>
</tr>
<tr>
<td>Cereal straws</td>
<td>Corn stover</td>
<td>(soybeans, cowpeas)</td>
</tr>
<tr>
<td>Prairie hay</td>
<td>Corn silage</td>
<td>Cottonseed meal</td>
</tr>
<tr>
<td></td>
<td>Sweet clover hay</td>
<td>Linseed meal</td>
</tr>
<tr>
<td></td>
<td>Vetch hay</td>
<td>Skim and buttermilk</td>
</tr>
<tr>
<td></td>
<td>Rape hay</td>
<td>Tankage</td>
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</tbody>
</table>

While these facts are useful, in general, in determining whether a ration is deficient in phosphorus, they can not be used as the sole guide. Mature grasses and drouth-stricken grasses are often low in phosphorus. This is always true when the soil is deficient in phosphorus. Much of the prairie hay produced in Minnesota is phosphorus-deficient. However, when animals are on early green pasture grass they readily store phosphorus, primarily because grass is richer in this element in the early
stages of growth, even in phosphorus-deficient regions. Also in the spring and summer, the sunlight produces more vitamin D in the bodies of animals, which results in a better utilization of both the calcium and phosphorus eaten.

No exact figures have been determined for the phosphorus needs of various kinds of animals but it is safe to assume, at least for cattle, that combinations of phosphorus-poor roughage with grains containing only moderate amounts of phosphorus will not furnish enough phosphorus unless the ration is abnormally high in grain. For swine and poultry, which use very little roughage, the ration should contain one or more of the phosphorus-rich feeds.

The amount of calcium in the ration affects the utilization of phosphorus; for example, a deficiency in calcium may decrease phosphorus retention. Still another factor to consider is the mineral demand which the animal has to meet. A dairy ration having enough phosphorus for a dry cow, or one giving a moderate amount of milk, may be too low in phosphorus for a heavy milker. In most cases, however, a ration containing enough protein and energy-giving nutrients to support a full milk flow will also furnish enough phosphorus, unless it is composed largely of feeds grown in phosphorus-poor soil. Rations prepared from such feeds almost invariably need to include a high-protein concentrate rich in phosphorus.

**Calcium.**—Calcium deficiency is caused by conditions similar in many respects to those causing phosphorus deficiency, but calcium-poor feeds are more common in livestock rations than are phosphorus-deficient feeds. The danger of calcium deficiency is greatest among animals, such as swine and poultry, that eat very little hay or other roughage. Cattle or sheep that are fed heavily on grain for rapid fattening consume little or no roughage even when plenty is offered and are thus very likely to suffer from serious calcium deficiency.

It is believed that animals need about one and one-half times as much calcium as phosphorus, because their bodies contain calcium and phosphorus in such proportion. Thus on a dry-matter basis the livestock feeds would be classified as follows:

<table>
<thead>
<tr>
<th>Calcium-poor</th>
<th>Calcium in Moderate But Adequate Amounts</th>
<th>Calcium-rich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal grains</td>
<td>Bluegrass</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>(corn, wheat, oats, barley, rye)</td>
<td>Linseed meal</td>
<td>Red clover</td>
</tr>
<tr>
<td>All cereal grain by-products</td>
<td>Cottonseed meal</td>
<td>Tankage</td>
</tr>
<tr>
<td>Roots</td>
<td>Young green pasture</td>
<td>Milk products</td>
</tr>
<tr>
<td>Legume seeds</td>
<td>All grass hay grown in lime-rich soil</td>
<td>(skimmilk, buttermilk, whey)</td>
</tr>
<tr>
<td>(peas, beans, etc.)</td>
<td>Dried beet pulp</td>
<td></td>
</tr>
<tr>
<td>All grass hay grown in lime-poor soil</td>
<td>Corn silage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Corn fodder</td>
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</table>
Commercial feed mixtures, especially those designed for dairy cattle, are likely to be low in calcium unless they contain liberal amounts of legume hay or calcium-containing mineral supplements.

The factors affecting the use of calcium by animals are similar to those described for phosphorus. Animals store calcium better when on young green pasture than when on dry hay. Even calcium-rich legume roughages are apparently better calcium supplements if cured so that rain and weathering are avoided. Direct summer sunshine on the animals promotes better calcium storage through the formation of greater amounts of vitamin D in their bodies by the ultra-violet rays.

In Minnesota and similar latitudes the sun’s rays in early spring and late fall are not so potent and winter sunlight has least of the important ultra-violet rays. Potent ultra-violet sun rays are especially important for growing chickens and laying hens which receive no vitamin D supplement in the feed. It is not known to what extent winter sunshine in Minnesota supplies the vitamin D forming rays for laying hens. For pigs, which also need some form of vitamin D, there is evidence that winter sunshine, at least at University Farm, protects against rickets when the calcium and phosphorus are properly adjusted and in right concentration in the ration. This is probably true for calves and lambs. Therefore, all livestock in Minnesota should receive direct sunshine during the midday hours on bright winter days unless the weather conditions are too severe. An adequate phosphorus supply is also essential for calcium storage, although there is evidence that phosphorus in excess of one per cent of the ration of growing chicks is partly responsible for misshaped bones, especially when birds are confined to battery brooders.

FIG. 1. CALF WITH GOITER AS RESULT OF IODINE DEFICIENCY
(From Livestock and Poultry Diseases, by W. A. Billings, Minnesota Agricultural Extension Division, University Farm, St. Paul. The Macmillan Company, New York.)
Iron.—In Minnesota deficiency of iron is limited to suckling pigs kept on concrete or wooden floors with no access to soil. Calves, lambs, or colts kept too long on milk as the sole diet may also suffer from iron deficiency. All milk is deficient in iron.

RECOGNITION OF MINERAL DEFICIENCIES

Iodine.—Iodine deficiency is recognized by goiter (big neck) in newborn calves and lambs and by lack of hair in newborn pigs. Goiter rarely occurs in fowls. As newborn goitrous animals frequently die, the deficiency may lead to serious results. Iodine deficiency may cause other reproductive disturbances, but these are not easily recognizable under farm conditions, especially in fowls.

Farmers who have losses such as described should prevent their recurrence by giving iodine to pregnant animals, using one of the methods recommended later.

Calcium and phosphorus.—Except in very young animals, the lack of calcium or phosphorus is not readily recognized until it is serious and of long standing. Mature animals have a reserve of these elements that can be drawn upon in a remarkable way for months. Cattle suffering from phosphorus deficiency will first exhibit a lack of appetite for roughage and later a craving for bones, as shown by the cow on the cover page. This may degenerate into a desire to eat dirt, chew mangers
or fence posts, or devour any sort of rubbish. Stiffness and a generally unthrifty appearance will eventually follow. Swine that exhibit depraved appetite, however, should first be examined for worms.

Calcium deficiency in mature cattle does not result in a desire for bones. When depraved appetite appears, it is usually limited to the eating of cinders, dirt, or shavings. The animals will usually appear to be in excellent condition. Some swelling around the hock joints may appear, but may not be noticed unless watched for carefully. Collapse will often be sudden, and if this occurs, the animal will seldom get up again unless remedies are applied immediately. An ounce of prevention is, indeed, worth many pounds of cure. Calcium deficiency in mature swine follows the same course and usually is not recognized until sudden collapse occurs.

![Fig. 3. Young Steer Suffering from Calcium Deficiency Accentuated by Lack of Vitamin D](image)

Note the swelling around the knees and hocks, and the unthrifty appearance.

The lack of calcium or phosphorus in the diet of growing animals results in a rickets-like disease unless vitamin D is supplied. The symptoms of phosphorus deficiency in calves are the same as for mature cattle, but, in addition, growth is stunted. Calcium deficiency in calves results in swelling around the joints, very unthrifty appearance, and depraved appetite for dirt, cinders, and wood. The daily consumption of a few pounds of sun-cured hay, either grass or legume, will usually provide sufficient vitamin D and calcium to prevent such a condition. The lack of calcium in pigs often produces a paralytic condition either of the fore legs or hind legs. Vitamin D deficiency makes this condition worse.
FIG. 4. PIG SUFFERING FROM SHORTAGE OF CALCIUM

This pig is suffering from a serious shortage of calcium due to feeding too heavily on grain without a calcium supplement. Any of the calcium supplements mentioned in this bulletin would have prevented this condition.

In chicks, the need for vitamin D is so great that the legs become weak and deformed even when the diet contains adequate calcium and phosphorus. If either is deficient, the rickets-like condition is much worse. Chicks that become rachitic are usually not worth raising.

FIG. 5. WITH AND WITHOUT VITAMIN D

These chicks are of the same age and received the same ration except for vitamin D in the form of cod liver oil. The smaller chick shows typical rickets as it occurs in this species.
A lack of phosphorus also affects production. This is not often recognized by the average farmer, even when moderately severe, until a more liberal diet of phosphorus begins to pay dividends in more milk, better egg production, or more rapid growth and fattening. Steers fatten less economically when their ration contains too little phosphorus or calcium. Ordinary rations for dairy cattle seem not to be deficient in calcium, so far as milk production is concerned, if sufficient hay is given. Calcium shortage for laying hens results in soft-shelled eggs as well as decreased egg production.

The practical solution of these problems is to maintain a plentiful supply of essential minerals. This should be continuous throughout the useful lifetime of the animal, and, when necessary, should be accompanied by some form of vitamin D supplement.

Calcium and phosphorus are not to be regarded as medicines to be fed in doses, but as feeds to be supplied daily.

Iron.—Deficiency of this element in suckling pigs and other young animals is recognized by an anemic condition and poor growth. Anemia is difficult to diagnose with certainty except by a veterinarian or by a person who has had experience. The best procedure, therefore, is to take steps to prevent it.

FEEDING MINERAL SUPPLEMENTS

Iodine.—The general feeding of iodine to livestock in Minnesota is not necessary, but it should be given to pregnant females on all farms where a deficiency has shown in the past. This can be fed as sodium or potassium iodide, as sea salt from which the iodine has not been removed by refining, as commercially iodized common salt, or in the form of dried kelp. Commercially iodized salt in the loose form should be protected from the weather.

There is great difference of opinion as to the iodine requirement of various farm animals. If the requirement is similar to that which seems to have been more accurately determined for human beings, one milligram (about 15/1,000 of a grain) daily would be sufficient for a 1,500-pound cow giving 50 pounds of milk. Iodized salt used in Minnesota must contain at least 0.015 per cent iodine (0.02 per cent potassium iodide) to comply with the tentative law for this product. The above-mentioned cow consuming a normal amount of such iodized salt will obtain nearly ten milligrams of iodine daily. There is no justification, at the present state of our knowledge, either for putting more iodine in commercially iodized salt or for assuming that iodized salt containing 0.015 per cent iodine will not more than satisfy the iodine requirements of farm animals if fed regularly. One ounce of potassium iodide carefully mixed with 300 pounds of salt will give a mixture containing 0.015 per cent iodine.

Iron.—Iron should be supplied in some form for suckling pigs
for the first three weeks after birth when they are reared on cement or wooden floors with no access to soil.

There are various ways of supplying iron. The Division of Veterinary Medicine recommends giving the pigs clean dirt. For a more direct administration of iron, together with some copper, to assist in iron assimilation, the Division of Veterinary Medicine recommends a solution of 3.6 ounces of iron sulfate (copperas) to 5 quarts of water. This is given to pigs in doses of 2 teaspoonfuls per head every other day.

For calves and lambs the iron-copper solution can also be used, altho seldom needed.

**Phosphorus.**—The need for phosphorus in the form of a mineral supplement seems to be limited to a few conditions: (1) When animals are confined largely to grass (either fresh or dry), especially when the grass is scanty from drouth, or is mature, in regions where there is a serious shortage of phosphorus in the soils and crops, they respond remarkably to phosphate supplement. (2) Milk cows having large production have been benefited greatly by phosphate additions during a dry resting period. (3) When a mineral supplement containing calcium is fed, it is well to feed some phosphate with it unless the animal is already supplied with an abundance of that element.

It is preferable to supply phosphorus in the form of a phosphorus-rich feed, because doing so will give the animal the advantage of other valuable food substances. Phosphorus-rich foods are generally also rich in proteins and certain of the vitamins. It is especially logical to supply the phosphorus for the production of milk, eggs, pork, and beef in some such phosphorus-rich protein concentrates as bran, linseed meal, cottonseed meal, and tankage.

When it is necessary or advisable to feed phosphorus in a mineral supplement, bonemeal or spent boneback from sugar refineries may be used. These are also rich in calcium. Ordinary rock phosphate will be harmful to animals because it is too high in the toxic fluorides. Synthetic phosphates or phosphate fertilizers are suitable if palatable to the animals and if sufficiently low in fluoride and other harmful mineral elements. Altho the question has not yet been settled as to the amount of fluorides livestock will tolerate, this fact should be sufficient reason for avoiding them as much as possible until the question is settled. For further suggestions on feeding phosphorus see page 10, “Feeding Phosphorus and Calcium.”

**Calcium.**—Supplements containing calcium are needed (1) for laying hens; (2) for hogs fattened largely on grains and cereal byproducts, or brood sows on similar limited diets; (3) for fattening young cattle or lambs fed heavily on grains and consuming very little roughage. In these cases vitamin D is also required. In Minnesota the sunlight produces vitamin D most abundantly from April to October. If sun-cured hay is not available or cannot be fed in sufficient quantity, cod liver oil and similar products may be used. These are especially suitable
for poultry. The Minnesota State Department of Agriculture, Dairy, and Food now requires a guarantee of the antirachitic potency of all products registered for sale in the state as vitamin D carriers.

It is desirable to supply as much as possible of the calcium needs of animals in the form of calcium-rich roughages and concentrates, namely, alfalfa hay (fresh or properly cured), milk products, or tankage.

Mineral supplements that can be used to supply calcium are bone-meal, spent boneblack, calcite, precipitated calcium carbonate, whiting, chalk, air-slaked lime, limestone, marl, or crushed oyster or clam shells. Gypsum is not a logical calcium supplement for animals. When calcium and phosphorus are to be fed together, bone-meal, boneblack, or pure calcium phosphate may be used. Fertilizer bone-meal is not recommended—only the feeding types of bone-meal. Only the spent bone-black from sugar refineries should be fed. It is worth no more than its calcium phosphate content in comparison with the cost of other like substances also containing calcium phosphate. Commercial mineral mixtures made up largely of rock phosphate usually contain harmful amounts of fluorides.

The other supplements named are useful for supplying calcium only. Wood ashes are not rich in calcium. Crushed oyster and clam shells are used only for poultry. Precipitated calcium carbonate, whiting, chalk, air-slaked lime, marl, calcite, and limestone are the same substance—calcium carbonate of varying purity. Neither unslaked nor water-slaked lime is recommended because of its alkalinity, although small amounts may be tolerated. Limestones in Minnesota, however, are with very few exceptions dolomitic; that is, mixtures of calcium and magnesium carbonate. Dolomitic limestones, as a rule, contain from 80 to 85 per cent carbonates, of which 35 to 40 per cent is magnesium carbonate. Magnesium cannot replace calcium in nutrition. Dolomitic limestones are satisfactory for homemade mineral mixtures if double the amount is used and if the ration is rich in phosphorus. Commercial mineral mixtures made with dolomitic limestone are not likely to be worth the price asked.

Feeding phosphorus and calcium.—It is only when calcium and phosphorus needs cannot be supplied by natural feeds that mineral supplements are justifiable. For dairy and beef cows and for fattening steers, if only calcium is needed, it is best to supply it as pulverized high-calcium limestone or marl or other inexpensive form of calcium carbonate. Even if the ration contained no calcium, which would be impossible, one ounce of calcium carbonate daily would furnish all the calcium needs for young stock, dry cows, and fattening steers. Two additional ounces would supply the calcium for 40 pounds of milk. Limestone or marl should be mixed with the grain or self-fed mixed with salt. Assuming that one-half of the calcium requirement is met in the ration, a 50-50 salt-limestone mixture will supply the remaining calcium if normal amounts of salt are eaten.
Cattle requiring additional phosphorus will usually supply their own needs if self-fed bonemeal. One ounce daily in the grain is ample for the phosphorus needed by young stock, dry cows, and fattening steers. If one wishes to depend on the appetite for salt to insure adequate supplemental phosphorus intake, mixtures of four parts phosphate minerals (bonemeal, dicalcium phosphate or monocalcium phosphate), and one part salt have given satisfactory results for nonproducing animals. For animals in milk, a more logical mixture would be about seven parts phosphate mineral to one part salt. These mixtures should not be offered to animals that have been starved for salt.

For swine, there is much more likelihood of a calcium deficiency than of a phosphorus deficiency. In fact, it is unlikely that any swine ration balanced as to protein would ever be lacking phosphorus if the animal receives adequate vitamin D in the ration or is exposed to adequate sunshine. If animal protein feeds such as tankage, fish meal, or milk products are fed in such amounts as to furnish the required animal protein, it is very improbable that the ration will lack either calcium or phosphorus. If vegetable protein concentrates alone are employed to supply the extra protein needed to balance the grain ration for swine, calcium should be supplied by self-feeding ground limestone or bonemeal.

For poultry, common salt and compounds of calcium and phosphorus are the only mineral supplements needed. Salt is needed at the rate of one-half of one per cent to one per cent of the total ration, hens requiring the larger percentage. Rations containing 10 per cent or more of meat scraps or fish meal do not require bonemeal. When the protein concentrate is soybean oilmeal, linseed meal, or cottonseed meal, and also when grains and their by-products comprise the entire mash, 2 to 5 per cent each of both bonemeal and limestone (or oyster-shell flour) must be added to supply calcium and phosphorus. Poultry, especially laying hens, should always have access to oyster shell or limestone grit to supply calcium. Some potent source of vitamin D must also be provided in the mash unless seasonal conditions insure that direct sunlight is potent for forming vitamin D as explained on page 9.

There is a tendency to overfeed poultry with calcium and phosphorus when fattening them in battery feeders. The rations used are rich in high phosphorus protein concentrates, including milk powder which is rich in both calcium and phosphorus. In such rations there is no need for any mineral supplement containing phosphorus. Some limestone may be needed to balance the phosphorus, and salt will be needed, but that is all.

Chickens fattened in batteries are subject to slipped-tendon disease or perosis. It may be prevented by addition of a very small amount of manganese sulfate to the ration. As little as one grain per 100 pounds of ration is sufficient provided the calcium and phosphorus are not above 3 per cent and 1.6 per cent, respectively.
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