Special Bulletin No. 94 Revised April, 1932

MINERALS FOR FARM ANIMALS

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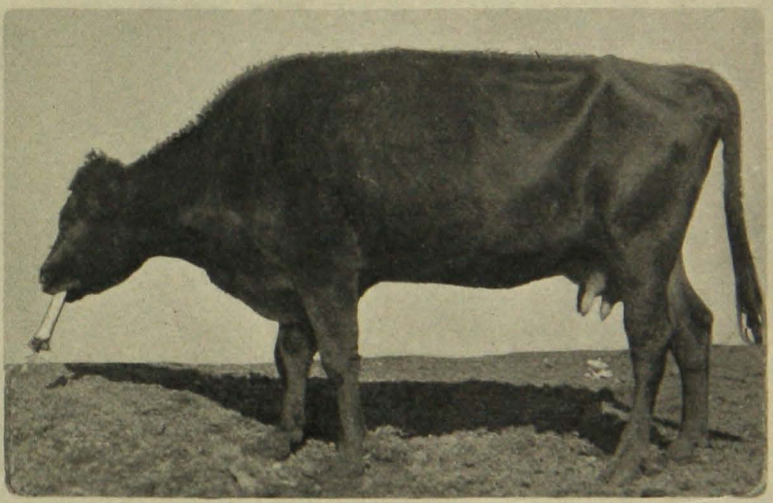

Fig. 1. This cow, suffering from lack of phosphorus, is chewing a bone.

1. Under what conditions is a lack of mineral elements likely to occur in feeding livestock?
2. How may the lack of minerals be recognized?
3. When are such deficiencies benefited best by mineral supplements?
4. What kind of mineral supplements should be used?
5. How should these supplements be fed?

Published in furtherance of Agricultural Extension, Act of May 8, 1914. F. W. Peck, Director, Agricultural Extension Division, Department of Agriculture, University of Minnesota, Co-operating with U. S. Department of Agriculture.

CONDITIONS INVOLVING MINERAL DEFICIENCY

The mineral supplement question is greatly simplified by the fact that only six mineral elements are likely to be lacking in farm rations in Minnesota. These are **sodium, chlorin, iodin, phosphorus, calcium,** and **iron.** There is, as yet, no scientific evidence to indicate that any other elements need ever be supplied on Minnesota farms in the form of mineral supplements except, perhaps, under pathological conditions. As no intelligent farmer who has livestock fails to provide the sodium and chlorin by means of common salt (sodium chloride), the possible deficiencies are narrowed still further to the elements iodin, phosphorus, calcium, and iron.

Iodin.—It has been definitely determined that an iodin deficiency in soil, water, and crops is a matter of geographic location. The Northwest and Great Lakes states are, in general, idoin-deficient regions. However, the evidence hardly warrants the general use of iodin as a mineral supplement in these regions, altho it should be supplied wherever there is definite evidence of a deficiency.

Phosphorus.—The conditions causing a phosphorus deficiency are somewhat more complicated. There may be either an actual shortage of phosphorus in the ration or there may be a failure to use all the phosphorus supplied.

It is somewhat difficult to fix a limit for the phosphorus content below which foods can be said to be deficient. Nevertheless, there is good evidence that if the dry matter of the food contains less than 0.2 per cent of the element 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 foods may be listed as follows:

Phosphorus-poor	Phosphorus in moderate amounts	Phosphorus-rich
Pearl hominy	All cereal grains (corn, wheat, oats, barley, rye)	Wheat bran
Polished rice		Wheat middlings
Beet pulp		Wheat germ
Corncobs	Alfalfa hay	Red-dog flour
Red clover hay	Corn stover	Legume seeds (soybeans, cowpeas)
Timothy hay	Corn silage	
Millet hay	Sweet clover hay	Cottonseed meal
Cottonseed hulls	Vetch hay	Linseed meal
Oat hulls	Rape hay	Dried milk
Cereal straws		Tankage

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. Many grasses are low in phosphorus; yet when animals are on fresh grass they readily store phosphorus, both because of some vitamin D in the fresh grass and, primarily, be-

cause the sunlight on the animals produces vitamin D in their bodies. Altho it has been difficult to demonstrate this effect of sunlight in the case of cattle, it has been clearly shown for swine, goats, and poultry.

The phosphorus requirement can not be stated entirely in terms of percentage of the diet, because animals require a more or less definite intake of phosphorus each day, depending on the species, size, age, and functional activity, such as pregnancy and lactation. No exact figures have been determined for various species but it is safe to assume, at least for cattle, that combinations of phosphorus-poor roughage and grains containing only moderate amounts of phosphorus will not furnish enough phosphorus without having the ration abnormally high in grain. For swine and poultry, in whose rations roughage plays a minor role, the ration should contain one or more of the phosphorus-rich foods in order to insure an adequate intake of this element.

The amount of calcium in the ration is closely associated with the proper use of phosphorus. A ration very deficient in calcium may decrease phosphorus retention. Still another factor causing a possible lack of phosphorus is the extent of the mineral strain to which the animal is subjected. For dairy cattle, a ration may contain enough phosphorus for an animal giving a moderate amount of milk, or for a mature animal not milking, but result in a loss of phosphorus by another animal giving liberally of milk. In most cases, however, a ration containing enough protein and energy-giving nutrients to support the milk flow of which the animal is capable will also contain an ample quantity of phosphorus, unless it is composed largely of foods grown in phosphorus-poor soil. The preparation of such a ration almost invariably calls for the inclusion of a high-protein concentrate rich in phosphorus.

Calcium.—Calcium deficiency is caused by conditions in many respects similar to those causing phosphorus deficiency, but calcium-poor foods are more common in livestock rations than are phosphorus-deficient foods. The danger of calcium deficiency is especially serious for species of animals, such as swine and poultry, that naturally eat very little hay or other roughage. Cattle or sheep that are fed heavily on grain for rapid fattening and consequently consume little if any roughage even when it is offered to them are very likely to suffer from serious calcium deficiency.

There is no definitely fixed calcium content of foods below which it can be stated with certainty that calcium deficiency will result. One method of considering the matter is to assume that

the calcium requirement is one and one-half times that of phosphorus, because the bodies of animals contain phosphorus and calcium in such proportion. On this basis, the livestock foods would be classified as follows:

Calcium-poor	Calcium in moderate but adequate amounts	Calcium-rich
Cereal grains (corn, wheat, oats, barley rye)	Bluegrass	Alfalfa
All cereal grain by-products	Millet	Red clover
Roots	Linseed meal	Tankage
Legume seeds (peas, beans, etc.)	Cottonseed meal	Dried milk products (skimmilk, buttermilk, whey)
All grass hay grown in lime-poor soil	Young green pasture	
	All grass hay grown in lime-rich soil	
	Dried beet pulp	
	Corn silage	
	Corn fodder	

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 sunshine on the animals promotes calcium storage through the formation of vitamin D in their bodies by the ultra-violet rays. This is particularly true for swine and poultry and is especially important for growing chickens and laying hens. Poultry houses may now be constructed with glass substitutes, which admit a considerable amount of the vital sun rays that do not pass through ordinary window glass. An adequate phosphorus supply is also essential for calcium storage.

Iron.—Deficiency of this element is limited in Minnesota to suckling pigs when the sows are kept on concrete or wooden floors with no access to soil for sow or pigs. Calves or lambs or colts kept on milk as the sole diet for too long a time may also suffer from iron deficiency. The milk of all species of mammals is deficient in iron.

RECOGNITION OF MINERAL DEFICIENCIES

Iodin.—Iodin deficiency is recognized by goiter (big neck) in new-born calves, lambs, and foals and by the birth of hairless pigs. Goiter may also occur in fowls. As new-born goitrous animals usually die, the deficiency may lead to serious results. Iodin deficiency may also cause other reproductive disturbances, but these are not easily recognizable under practical farm conditions.

Figure 2 shows goiter in a new-born calf; Figure 3, a litter of hairless pigs resulting from iodin deficiency in the ration of the sow.

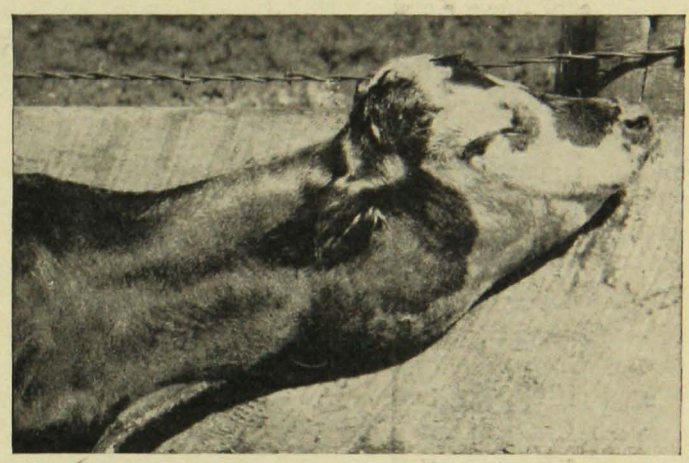

Fig. 2. Calf with Goiter as Result of Iodin Deficiency
(From Livestock and Poultry Diseases, by W. L. Billings, Minnesota Agricultural Extension Division, University Farm, St. Paul. The Macmillan Company, New York.)

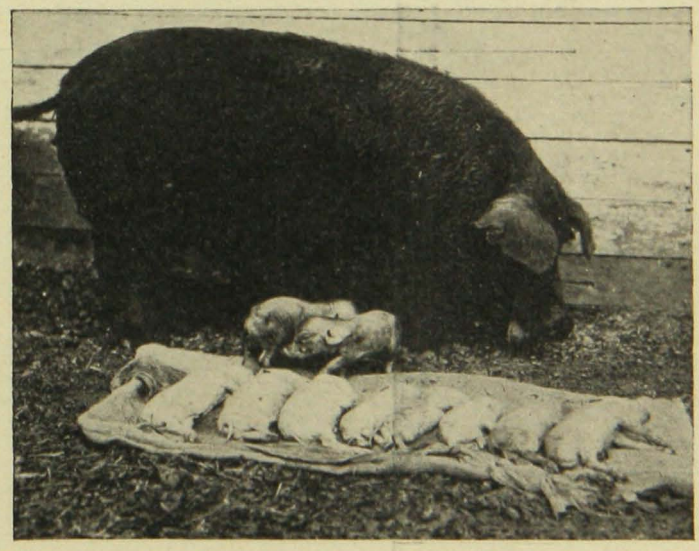

Fig. 3. Litter of Hairless Pigs Resulting from Iodin Deficiency in Ration of Sow
(From Livestock and Poultry Diseases, by W. L. Billings, Minnesota Agricultural Extension, University Farm, St. Paul. The Macmillan Company, New York.)

Farmers who have such losses should prevent their recurrence by giving iodin to pregnant animals, using one of the methods recommended below.

Calcium and phosphorus.—Except in the case of 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 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. When swine exhibit depraved appetite, however, the possibility of worm infestation should first be eliminated.

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 of the animal will often be sudden, and if this occurs, it 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 sequence and is not usually recognized until sudden collapse occurs.

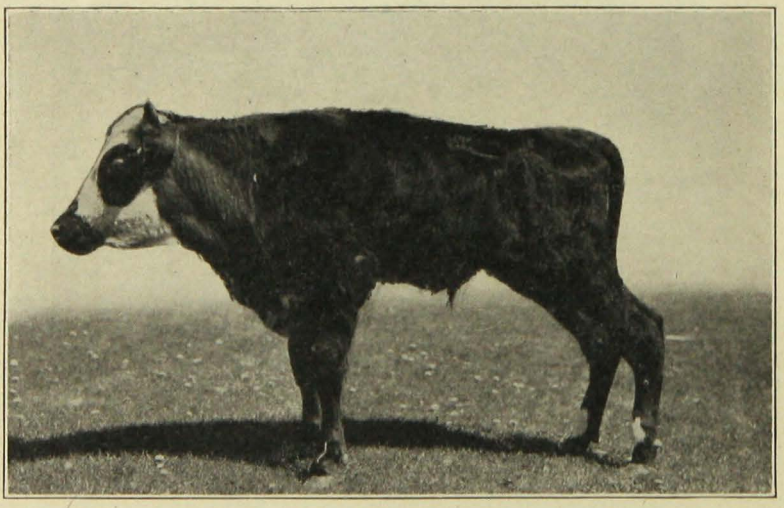

Fig. 4. Young Steer Suffering from Severe Calcium Deficiency
Note the swelling around the knees and hocks, and the unthrifty appearance.

The lack of phosphorus in the diet of growing animals results in rickets unless vitamin D is supplied. The symptoms of phosphorus deficiency in calves are the same as for mature cattle. In addition, the growth is stunted. Calcium deficiency in calves re-

sults in swelling around the joints, very unthrifty appearance, and depraved appetite for dirt, cinders, and wood. Figure 4 shows a young steer in advanced stages of calcium deficiency. The lack of calcium in pigs often produces a paralytic condition of either of the fore legs or hind legs, as shown in Figure 5. Vitamin D deficiency accentuates this condition.

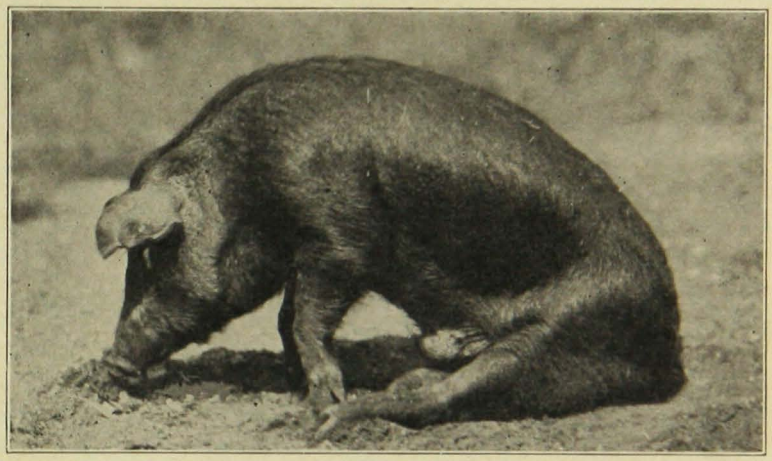

Fig. 5. This pig is suffering from a serious shortage of calcium due to feeding too heavily on grain without a calcium supplement. Any of the calcium supplements mentioned in this bulletin would have prevented this condition.

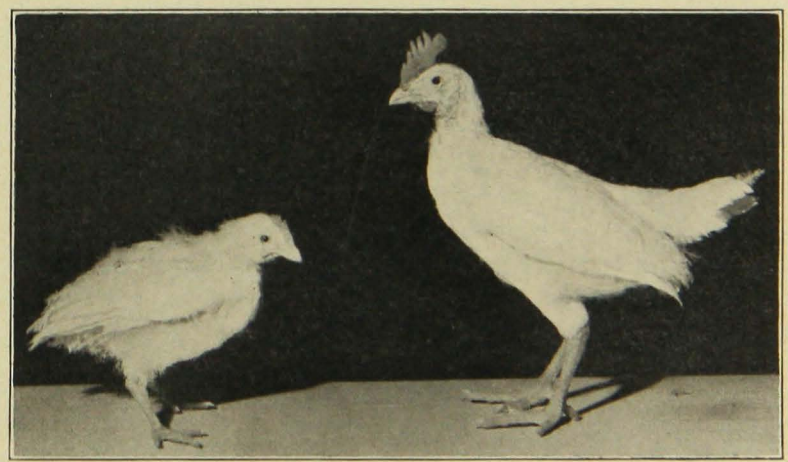

Fig. 6. With and Without Vitamin D

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.

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 rachitic con-

dition is much worse. Chicks that become rachitic are usually not worth raising, even if the condition is cured by a proper mineral diet and cod-liver oil or summer sunshine. Figure 6 shows the rachitic condition of chickens resulting from a deficiency of vitamin D in the diet or the lack of sunlight having the potent ultra-violet rays, in comparison with a normal condition when vitamin D is supplied.

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 inadequate amounts of 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.

As already stated, the rational solution of these problems is to maintain as nearly as possible a plentiful supply of minerals. This should be continuous throughout the useful lifetime of the animal.

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

Iron.—Deficiency of this element in suckling pigs or 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** its occurrence.

WHEN TO FEED MINERAL SUPPLEMENTS

Iodin.—It seems advisable to recommend that iodin be fed to all farm animals maintained for breeding purposes in Minnesota. The general feeding of iodin to livestock in this state is not warranted by the evidence now available.

Iron.—Iron should be supplied in the form of a supplement of some kind, the more practical the better, whenever suckling pigs are reared on cement or wooden floors with no access to soil.

Phosphorus.—The need for phosphorus in the form of mineral supplement seems to be limited to a few conditions: (1) When animals are confined largely to grass (both fresh and dry), in regions where there is a serious shortage of phosphorus in the soil 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.

Calcium.—Supplements containing calcium are needed (1) for laying hens; (2) for hogs fattened largely on grains and cereal by-products, or brood sows on similar limited diets; (3) for fattening young cattle or lambs fed heavily on grains and consuming very little roughage.

KIND OF MINERAL SUPPLEMENTS TO FEED

Only the simplest kind of supplements is called for. There is no conclusive evidence that Epsom salt (magnesium sulfate), Glauber's salt (sodium sulfate), and sulfur, found in some proprietary mixtures, are of any nutritive value.

Iodin.—This should be fed as sodium or potassium iodide, as sea salt from which the iodin 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.

Iron.—This may be supplied to young pigs, which are most likely to need it, either as copperas (iron sulfate) or more simply as it exists in clean dirt. It is not logical to feed a complex mineral mixture containing iron oxide or iron sulfate for the sake of the iron it contains. This is a very expensive way of supplying iron.

Phosphorus.—It is preferable to supply phosphorus in the form of a phosphorus-rich food, because by doing so the animal will also be given the advantage of other valuable food substances. Phosphorus-rich foods are generally also rich in valuable proteins and 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 boneblack from sugar refineries may be used. These are also rich in calcium. Phosphate fertilizer may be employed if palatable to the animals provided it is composed only of phosphate salts and is essentially free from calcium sulfate and from fluorides. The fluorides, which are usually found in rock phosphate, are harmful to animals. Synthetic phosphates are suitable if free from harmful elements.

Calcium.—It is desirable to supply as much of the calcium needs of animals as possible 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 bonemeal, 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, bonemeal, boneblack, or pure calcium phosphate may be used. Fertilizer bonemeal is not recommended—only the feeding types of bonemeal. Calcium phosphates that have been manufactured from reasonably pure phosphoric acid and lime are suitable. Only spent boneblack 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 question has not yet been entirely settled as to the harmful level of fluorides for livestock, but this very fact should be sufficient argument for avoiding them until the question is settled.

The other supplements named are useful for supplying calcium only. Wood ashes, sometimes recommended as a calcium supplement, 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. 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 or 40 per cent is magnesium carbonate. Magnesium can not replace calcium in nutrition. These facts should be recognized when using native dolomitic limestone as a source of calcium. Dolomitic limestones are satisfactory for home-made 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.

METHODS OF FEEDING SUPPLEMENTS

Iodin.—The exact iodin requirements of farm animals are not known. It now seems safe to assume, however, that the requirement is much smaller than was formerly believed, and that one milligram (thirty-five millionths of an ounce) a day is sufficient for any of our farm animals. Altho unbelievably small, it is very important. If iodized salt is used to supply the sodium and chlorin requirements, the iodin needs are undoubtedly supplied, if proper care is taken in iodizing the salt. Dried kelp is said to contain

0.25 per cent iodin. On this basis, half an ounce of dried kelp once a month will supply the iodin requirement of one milligram per day. If potassium or sodium iodide is to be given, one ounce of either of these substances when dissolved in ten gallons of water will give a solution one teaspoonful of which in the drinking water once a week will supply the assumed requirement.

Iron.—There are various ways of supplying iron. After experimenting with several methods, the Division of Veterinary Medicine recommends that the simplest method for pigs is to give them access to clean dirt. The Division of Animal Husbandry finds that the pigs will consume more of the dirt, and presumably assure the required intake, if about 10 per cent flowers of sulfur is mixed with it. For a more direct administration of iron, together with some copper, which is now known to assist in iron assimilation, the Division of Veterinary Medicine recommends a solution of 3.2 ounces of iron sulfate (copperas) and 0.4 ounces of copper sulfate (blue vitriol) to 5 gallons of water. This is given to pigs in doses of two teaspoonfuls per head every other day.

For calves and lambs the iron-copper solution is probably the most practical. Similar doses are no doubt sufficient, as the exact requirement is not known. The solution may be placed in the milk, if calves and lambs are fed milk separately, but if suckling the solution will have to be administered. No doubt more practical ways of administering iron and copper to calves and lambs could be devised. The problem is not so acute for these animals as it is for pigs.

Calcium and phosphorus.—The opinion is widely held that the amount of calcium and phosphorus to be fed as supplements can with safety be left to the appetite of the animals. Self-feeding of minerals to cattle and swine is a common practice. The kind of supplement to feed depends on the species.

For dairy and beef cattle and for fattening steers, some form of calcium phosphate that is palatable and does not contain toxic amounts of fluorides is all that need be supplied. Bonemeal alone or equal parts of bonemeal and salt, self-fed, meet all the requirements for calcium and phosphorus. To insure an adequate calcium and phosphorus intake, one ounce daily of bonemeal or its equivalent of calcium phosphate in some other form added to the daily grain ration should be sufficient for young stock, dry cows, and fattening steers. Milking dairy cows should receive, in addition, one ounce for each five pounds of milk produced.

For swine it seems to be good practice to employ a mineral mixture that will supply calcium, phosphorus, iodin, iron, and cop-

per. The Division of Animal Husbandry employs the following mixture, which represents the consensus of opinion of a number of leading experts in swine husbandry. It contains 50 per cent high grade limestone, 27.97 per cent feeding bonemeal, 20 per cent common salt, 2 per cent iron oxide, 0.02 per cent potassium iodide, and 0.01 per cent copper sulfate. This mixture is self-fed to growing pigs and mature swine.

For poultry, the mashes for both growing chicks and laying hens should contain one per cent sodium chloride, 4 to 5 per cent bonemeal, and 0.25 to 0.5 per cent cod-liver oil rich in vitamin D. Laying hens should also have access to crushed shells or other lime grit at all times.