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Mineral Supplements for Beef Cattle

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Introduction

Beef cattle require a number of minerals for optimal growth and reproduction. Selecting the correct mineral supplement is important for maintaining healthy animals, and optimal growth and reproduction. Since high-quality forages and/or grains can furnish a large portion of the required minerals, producers should select supplements that will meet animal requirements and avoid excesses that reduce profits and lead to unnecessary mineral excretion. Minerals not provided by feed can be easily and inexpensively supplied with a simple mineral supplement. A good mineral program for brood cows should cost about $10 to $20 per year. This bulletin provides information on basic mineral nutrition for most forage and feeding programs in Georgia.

Minerals essential to cattle nutrition are classified as either macrominerals or microminerals, depending on whether they are found at levels greater than or less than 100 parts per million (ppm) in the animal's body.

Macrominerals

The macrominerals beef cattle require include calcium, magnesium, phosphorus, potassium, sodium, chlorine and sulfur. Macromineral requirements and maximum tolerable levels for beef cattle are shown in Table 1.

Calcium and Phosphorus

Calcium and phosphorus are the major mineral components of the skeleton. Ninety-nine percent of total body calcium and 80 percent of total body phosphorus are stored in the bones. The skeletal stores of calcium and phosphorus are used to meet short-term dietary inadequacies. Long-term deficiencies of either can cause bones to weaken and even break.

Calcium and phosphorus also play important roles in other bodily functions. A decrease in either or both can cause a decrease in weight gain and/or a decrease in efficiency of gain. During lactation, low amounts of either will reduce milk production. A superior milking cow requires three times more calcium than a non-lactating cow. A phosphorus deficiency can delay puberty in heifers and can delay mature beef cows from returning to heat following parturition. Cattle also need correct amounts of calcium for the nervous and muscular systems to function properly.

Proper utilization of calcium and phosphorus is affected not only by the amount of each mineral fed, but also by their ratio. The optimum Ca:P ratio is about 1.5:1, with a range of 1:1 to 4:1 being satisfactory. In some high-concentrate rations, ratios higher than 2:1 have been successful.

Most grasses are adequate in calcium. Legumes such as alfalfa, peanut, clover and soybean hay are good sources of calcium, but corn silage and sorghum silage are poor sources of calcium. In general, most concentrates are relatively poor calcium sources. One exception is citrus pulp, which is relatively high in calcium concentration (1.9 percent). Corn, corn by-product feeds and sorghum grain are particularly low in calcium content, and cattle fed grain or corn silage-based diets require calcium supplementation.

Most forages are low in phosphorus, particularly late in the growing season. Cattle are more likely to be phosphorus-deficient during the winter, when they often subsist on dry forages. Concentrates contain moderate to high concentrations of phosphorus. Protein supplements such as cottonseed meal and soybean meal contain moderate concentrations, whereas many by-product feeds such as distillers grains, corn gluten feed and wheat middlings, have high phosphorus concentrations.

Sodium and Chlorine

Sodium and chlorine (salt) provide for the proper function of the nervous and muscular systems. They help regulate body pH and the amount of water retained in the body. A deficiency of these elements causes loss of appetite and inefficient weight gains or body weight loss. Sodium is commonly deficient in diets, but chlorine levels are usually adequate. Both minerals are present in soft tissues and fluids and there is very little storage of these elements, so a constant, daily source of sodium and chlorine must be provided. Cattle will voluntarily consume more salt when forage is young and succulent than when it matures. Silage-fed cattle will consume more salt than those fed hay, and consumption is higher in cattle fed high-roughage diets than in those on high-concentrate diets. As a rule of thumb, cattle consume 0.005 to 0.010 percent of their body weight as salt daily. For example, a mature cow weighing 1,200 pounds would consume 0.06 to 0.12 pounds (1,200 x 0.00005 = 0.6), or 1.0 to 1.9 ounces of salt daily.

Magnesium

Magnesium is essential for proper enzyme and nervous system function and for efficient carbohydrate metabolism. A magnesium deficiency is uncommon except for cows grazing lush-growth fescue or small grain pastures during the late winter and early spring, which may cause grass tetany, a serious and sometimes fatal metabolic disorder. A high rate of nitrogen and potassium fertilization contributes to grass tetany. Excess potassium inhibits magnesium absorption in both forage and animals. Grass tetany usually occurs following an extended period of cold weather combined with high levels of nitrogen and potassium fertilization. Mature lactating cows are particularly susceptible to grass tetany.

Grass tetany can usually be prevented by feeding cattle a mineral mixture containing magnesium oxide. A mineral mixture containing 10 to 14 percent magnesium consumed at 4 ounces per day should provide adequate magnesium. Adequate salt intake is also important for preventing grass tetany. Avoid using hard blocks to supplement salt when cattle are at risk for grass tetany; supply salt in a loose form to allow for adequate salt consumption. When grass tetany is not a risk, blocks can be used to supplement minerals, provided trace minerals are elevated to account for lower intake of block versus loose salt minerals. Animals with grass tetany respond almost immediately to an intravenous infusion of calcium-magnesium gluconate.

Potassium

Potassium functions in acid-base balance, osmotic pressure and the amount of water retained in the body. Grasses, particularly early lush spring growth, contains adequate amounts of potassium for grazing cattle and supplementation is rarely needed. However, potassium may occasionally be low in stockpiled forages or hay that was rained on prior to baling because potassium is soluble and will leach from the forage.

Sulfur

Sulfur is a part of the essential amino acids methionine and cystine, which make up protein. A sulfur deficiency in beef cattle diets is not likely to occur under normal feeding conditions. Sulfur is more likely to be in excess, which can interfere with the metabolism of copper, resulting in a copper deficiency. Also, excess sulfur can reduce feed intake and cause a brain lesion condition known as polioencephalomalacia (PEM). Certain by-products such as distillers grains and corn gluten feed contain higher concentrations of sulfur, which should be taken into account in ration balancing. Sulfur is often added indirectly to the mineral mix through sulfate forms of the microminerals.

Table 1. Macro mineral requirements and maximum tolerable levels for beef cattle.

Mineral	Lactating Cows	Dry Cows	Growing Calves	Maximum Tolerable Level
Calcium, %	0.31	0.18	0.58	—
Magnesium, %	0.10	0.12	0.20	0.40
Phosphorus, %	0.21	0.16	0.26	—
Potassium, %	0.60	0.60	0.70	3.0
Sodium, %	0.07	0.07	0.10	—
Sulfur, %	0.15	0.15	0.15	0.40

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Microminerals

Beef cattle require 10 microminerals. Seven of the 10 microminerals have established requirements, including iron, manganese, copper, zinc, selenium, cobalt and iodine. The microminerals chromium, molybdenum and nickel do not have an established requirement and are not normally added to mineral mixes fed to beef cattle. Only three of the microminerals (copper, zinc and selenium) are likely to be deficient in grazing beef cattle diets. Micromineral requirements and maximum tolerable levels for beef cattle are shown in Table 2.

Cobalt

Cobalt functions as a component of vitamin B-12, which is synthesized in the rumen by bacteria. The primary deficiency symptom is loss of appetite and poor growth. Most forages in the Southeast have adequate levels of cobalt; however, it is usually added in the mineral mix at approximately 10 ppm to ensure no deficiencies. High-grain diets require more cobalt than forage-based diets, and cobalt should always be included in the mineral mix when feeding grain-based diets.

Copper

Copper is the most common micromineral deficiency in grazing cattle. Copper is an important component of many enzyme systems essential for normal growth and development. Deficiency signs include reduced fertility, depressed immunity and reduced pigmentation of hair (black hair changes to red). Dietary deficiencies can occur, but most deficiencies are caused by the consumption of antagonists, which reduces copper absorption. Copper should be supplemented as copper sulfate, tribasic copper chloride or an organic complexed form because copper oxide is very poorly absorbed.

Iodine

Iodine is an essential mineral for function of the thyroid hormones that regulate energy metabolism. The first sign of iodine deficiency is goiter in newborn calves. Iodine is rarely deficient in cow herds in the Southeast. Iodine is usually supplemented as ethylenediamine dihydroidide (EDDI). The maximum legal supplementation of EDDI is 50 mg per head per day. In some instances, EDDI has been included in diets to prevent foot rot; however, the amount of EDDI required to prevent foot rot is much higher than requirements and most likely will not prevent foot rot when included at the legal maximum.

Iron

Iron is primarily required for the formation of hemoglobin. Deficiency symptoms include anemia, depressed immunity and decreased weight gains. Iron deficiency is rarely observed in grazing cattle. Iron oxide is often included in mineral mixtures, but is unavailable to the animal and serves only as a coloring agent to give the mineral a dark red color. Iron sulfate is available to the animal and should be used if iron supplementation is needed.

Manganese

Manganese is required for normal reproduction, and fetal and udder development. Manganese deficiency is rare and unlikely to be a problem in grazing cattle in Georgia. Manganese oxide is the most common form of manganese used in mineral mixes. Corn-based diets are low in manganese and supplementation is necessary when feeding these diets.

Selenium

Selenium can be deficient in some areas of Georgia. Selenium deficiency causes white muscle disease (similar to muscular dystrophy) in newborn calves. Selenium deficiency can also cause calves to be weak at birth and increase their susceptibility to calfhood diseases like scours. Increased rates of retained placentas and poor reproductive performance are often observed in cows with selenium deficiencies.

Selenium is generally added to mineral mixtures in the form of sodium selenite. Selenium is very toxic and should be used in a premixed form only. The FDA allows selenium to be used at a level not to exceed 0.3 ppm of the dry matter in the total diet of beef cattle. In areas where deficiencies occur, use the maximum legal level. The FDA allows up to 120 ppm to be included in a salt-mineral mixture for free-choice feeding. Selenium deficiency should not be a problem if adequate amounts of selenium are consumed in the mineral supplement. However, the concentration of selenium in the supplement and the labeled intake must not result in a total intake of more than 3 mg per day. Thus, a mineral labeled for intake of 4 ounces per head per day cannot exceed 26 ppm selenium.

Zinc

Zinc is marginal to deficient in most Georgia forages. Zinc is a component of many enzymes and is important for immunity, male reproduction, and skin and hoof health. Cattle have a limited ability to store zinc and supplementation is always necessary. Zinc absorption is closely tied to copper absorption, and the zinc to copper ratio should be kept at approximately 3:1. In addition, high levels of iron can decrease zinc absorption. Absorption of zinc decreases once the ratio of iron to zinc exceeds 2:1. Some feedlots feed supplemental zinc methionine to improve hoof health and thus improve daily gains and feed efficiency.

Table 2. Micromineral Requirements and Maximum Tolerable Levels for Beef Cattle.

Mineral	Lactating Cows	Dry Cows	Growing Calves	Maximum Tolerable Level
Chromium	—	—	—	50.0
Cobalt, ppm	0.1	0.1	0.1	10.0
Copper, ppm	10.0	10.0	10.0	100.0
Iodine, ppm	0.50	0.50	0.50	50.0
Iron, ppm	50.0	50.0	50.0	1000.0
Manganese, ppm	20.0	40.0	40.0	1000.0
Molybdenum, ppm	—	—	—	5.0
Nickel	—	—	—	50.0
Selenium, ppm	0.10	0.10	0.10	2.0
Zinc, ppm	30.0	30.0	30.0	500.0

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Vitamins

Vitamins are closely linked to mineral metabolism and absorption. Vitamin A helps skin and mucous membranes stay healthy. Vitamin A requirements usually are met by grazing fresh, green, growing grass. Oxidation deteriorates vitamin A during storage, so diets based on stored feeds should be supplemented with vitamin A. Supplement diets with vitamin A any time the major portion is stored feeds.

Vitamin A can be added to a mineral mix in a stabilized form to prevent oxidation. The minimum amount should be approximately 120,000 International Units (IU) of vitamin A per pound of mineral. Vitamin A can also be added to the grain mixture to provide 15,000 to 30,000 IU per head per day, depending on individual requirements. An alternative method is to inject 1.5 million IU subcutaneously if a source of dietary citamin A is not available for 60 to 90 days, although unnecessary injections are discouraged in consideration of National Beef Quality Assurance guidelines.

Vitamin D aids the absorption of calcium and phosphorus from the intestine and their deposition in the bone matrix. Signs of vitamin D deficiency are similar to a calcium or phosphorus deficiency. Most cattle exposed to direct sunlight synthesize enough vitamin D, but cattle in a covered confinement feedlot may need supplemental vitamin D.

Vitamin E is usually present in the diet in sufficient quantities for all classes of cattle; however, a selenium deficiency could lead to an apparent deficiency of vitamin E. Vitamin E can be helpful for short-term periods of stress that may occur when calves are co-mingled and transported at weaning.

Other essential vitamins are usually present in adequate quantities in the diet or are synthesized by bacteria in the rumen.

Selecting a Mineral Supplement

The average mineral content of several forages, grains and by-product feeds are shown in Table 3. The actual mineral content of feeds, especially forages and by-products, will vary, so all feeds should be tested for actual mineral content. However, the mineral concentrations can be used as a guide when choosing a mineral supplement to complement a particular feed ingredient. In addition, an example mineral mix for lactating cows is provided in Table 4. The calcium to phosphorus ratio in most mineral mixes should be 2:1 to 4:1. Phosphorus supplementation may not be needed if forages have been fertilized with poultry litter or when feeding high-phosphorus feeds such as cottonseed, cottonseed meal, distillers grains or corn gluten feed. Salt is not stored in the animal's body and should be made available continuously. Salt is the only mineral that cattle crave, and salt-deprived cattle will often eat dirt or wood. A mineral mix should contain 15 to 22 percent salt. Magnesium should be at least 14 percent in the mineral mix when grass tetany is a concern. Also, closely examine mineral tags for addition of unnecessary products such as B-vitamins (thiamine, riboflavin, folic acid). These vitamins are normally not needed by grazing cattle because they are produced by the rumen bacteria and increase the cost of the supplement.

The most important points to consider when purchasing minerals are calcium to phosphorus levels, salt level, bioavailability (particularly copper), level of "trace minerals" in the supplement, and additives. You can learn a lot about the mineral you are feeding by studying the mineral tag for a few minutes. In addition, minerals are often used to deliver products such as ionophores (Rumensin, Bovatec) and antibiotics (chlortetracycline, GainPro). Carefully read label instructions when using medicated mineral mixes to ensure adequate intake and to ensure the product is labeled for the intended use.

Grain-based diets

There are many differences between mineral supplements designed for a forage-based versus a grain-based diet. Since grains and most by-product feeds except citrus pulp contain low concentrates of calcium, supplements should contain approximately 25 percent calcium and be fed at a rate of 4 ounces per day. Supplemental salt should be provided at 1 to 1.9 ounces per day. The primary microminerals of most concern are zinc, copper, cobalt and selenium. Trace mineral salt is usually added at 0.5 percent of the diet to provide most supplemental trace mineral needs. Selenium may need to be added to maintain a total diet concentration of 0.1 ppm. Additional phosphorus supplementation is rarely required when feeding grain-based diets.

Table 3. Mineral content of commonly used forages and concentrate feeds.

Feedstuff	Calcium %	Phosphorus %	Potassium %	Sulfur %	Copper, ppm	Zinc, ppm
Bahiagrass Pasture	0.46	0.22	1.45	0.21	8.0	20.0
Bermudagrass Pasture	0.39	0.26	1.3	0.28	9.0	20.0
Bermudagrass Hay	0.43	0.20	1.61	0.21	9.0	20.0
Fescue Pasture	0.51	0.27	2.3	0.19	5.8	18.7
Fescue Hay	0.51	0.37	2.3	0.18	6.0	22.0
Corn	0.03	0.31	0.33	0.14	4.8	16.0
Corn Silage	0.25	0.22	1.14	0.12	4.2	17.7
Corn Gluten Feed	0.07	0.95	1.40	0.47	7.0	73.3
Cottonseed Meal, 41%	0.20	1.16	1.65	0.42	16.5	74.0
Whole Cottonseed	0.16	0.62	1.22	0.26	7.9	37.7
Soyhulls	0.53	0.18	1.29	0.11	17.8	48.0
Soybean Meal, 44%	0.40	0.71	2.22	0.46	22.4	57.0
Molasses	1.00	0.10	4.01	0.47	65.7	21.0
Citrus Pulp	1.88	0.13	0.77	0.08	6.2	15.0

NRC, 1996. Adapted from NRC. Nutrient Requirements of Beef Cattle, Sixth Edition.

Table 4. Example free-choice mineral specifications for lactating cows.

Mineral	4 Ounce Intake Per Day
Calcium	10 to 15%
Phosphorus	4 to 8%
Salt	15 to 20%
Magnesium[1]	1%
Sulfur[2]	0.5%
Copper	0.12% (1200 ppm)
Zinc	0.3% (3000 ppm)
Cobalt	0.001% (10 ppm)
Iodine	0.008% (80 ppm)
Selenium	0.0026% (26 ppm)

[1]Magnesium should be increased to at least 10% when grass tetany is a concern
[2]Sulfur supplementation is usually not required, however it is often added to mineral mixes by the use of sulfate forms of other minerals.

Factors Affecting Mineral Intake

Controlling intake at the desired level is very challenging because mineral intake fluctuates. Monitor mineral intake for several weeks prior to implementing management practices to alter mineral intake. If mineral intake is too high or low, move the mineral feeder either closer to or farther away from the water source and loafing areas. When cattle are over-consuming mineral, salt is often added to reduce the amount of minerals cattle eat. Salt level has a significant impact on mineral intake and is easily changed to control intake; however, you must account for the additional salt when determining the correct intake. For example, if a mineral with a recommended feeding rate of 4 ounces per day is mixed in a 50:50 ratio with plain white salt, the cattle should consume 8 ounces per day. This would supply the cattle with the targeted amount of 4 ounces of mineral plus 4 ounces of added salt. When under-consumption is a problem, try adding dried molasses or change brands to a more palatable mineral. In addition, keep in mind that calves can consume significant amounts of mineral and this should be considered before decreasing the feeding level.

If mineral intake is inadequate, try adding a palatable feedstuff to the mix. Feeds such as cottonseed meal, soybean meal, dry molasses and distillers grains can improve mineral intake. Moving the mineral feeder closer to the water source can improve intake. In addition, changing mineral brands will sometimes provide a mineral that is more palatable.

Regularly monitor mineral consumption by keeping a record of animal numbers and feeding amounts to combat potential mineral intake problems.

Mineral Feeders

Mineral feeder placement is a very important part of supplying minerals to the cow herd. Be sure an adequate number of feeders are available for the stocking rate of the pasture. A rule of thumb is to provide one mineral feeding station for every 30 to 50 cows. The best areas to place mineral feeders are near water, in shaded loafing areas and near the best grazing areas. Check feeders at least once a week and keep a clean, fresh supply of minerals present at all times. A good feeder should keep minerals dry, be portable and hold up to abuse and corrosion. Open tubs are not adequate in the Southeast. Because minerals can be corrosive to metals, feeders made of wood, fiberglass or plastic usually last longer. Permanent mineral feeders made of concrete also work well, but portability is a problem.

Supplement Form

Feeding minerals free-choice in a loose mix form is most desirable for brood cows. For cattle on complete diets, minerals are most optimally supplied when mixed in a TMR. When supplementing in a block form, trace minerals must be higher than what is contained in a loose mineral mix, as the animal will usually consume only 1 to 2 ounces per day. In addition, some blocks contain only trace mineralized salt, which will not meet the animal's requirements for macrominerals such as calcium and phosphorus. Carefully read the label on a block mineral supplement to make sure the product contains all needed minerals. Block minerals are sometimes used when supplementing cattle that have not had access to minerals for a long period of time. In this situation, cattle will greatly over-consume minerals in a loose mix form if given free-choice access. Blocks can be used for a short period of time to prevent mineral over-consumption. Do not supply plain white salt and mineral separately since intake of the mineral will likely be too low because cattle will crave only the salt.

Commercial protein and energy supplements are sometimes fortified with minerals. Commercial supplements come in the form of dry pelletted feeds, liquid molasses supplements, hard molasses-based blocks, or hard-pressed grain-based blocks. It is not necessary to provide a free-choice mineral supplement along with the commercial protein/energy supplement. Feeding minerals in both the free-choice mineral and the protein/energy supplement should not negatively affect performance, but it is an expense that could be saved. It may be necessary to only offer plain white salt blocks when feeding the commercial protein/energy supplements.

Season

Mineral intake is usually higher when lush forage is available and lower during the fall or periods of drought. Mineral content and forage digestibility declines with increasing plant maturity. Mature forages are consumed in lower quantity, further reducing mineral intake. Rapidly growing, lush forages have a higher availability of minerals compared with mature forages. In addition, mineral content is higher in forages grown on soils with greater fertility. Spring grass is usually well fertilized and highly digestible, which leads to greater intake of mineral from forages and reduced consumption of supplemental mineral during that time of the year.

Feeding Method

Stocker calves are sometimes fed a complete grain- or silage-based ration mixed on the farm. Thoroughly mixing minerals in mixed rations is difficult; only a small quantity of mineral is required and it separates easily from the larger particle sizes of grain and forages. It may be wiser to use a mineral supplement that has a higher feeding rate or feed the mineral free-choice or as a top dress.

A trial was conducted to compare feeding a mineral supplement by free-choice feeding or top-dressing the mineral on the feed each day. The mineral contained an ionophore (Bovatec®). Results of the trial, in which heifers were fed hay, corn, corn silage and minerals either in a free-choice feeder or where supplemental minerals were top-dressed (4 ounces per day) on the feed each day, are shown in Table 5. Supplementing minerals either free-choice or top-dressing resulted in similar daily gains. Heifers fed minerals free-choice consumed about 0.5 ounces per head less than the targeted intake of 4 ounces per day but were within the range required for the ionophore to be effective. If specific amounts of a particular mineral or feed additive are required per day, it would be desirable to top-dress or mix the mineral into the feed every day rather than allow free-choice consumption. When feeding minerals free-choice, closely monitor mineral consumption to make sure intake is adequate. This is of particular importance when feeding an additive such as an ionophore or antibiotic.

Table 5. Performance of heifers provided supplemental minerals either free-choice or top dressed onto feed daily.

Item	Free- choice	Top-dressed
Initial wt, lbs	574	579
Final wt, lbs	736	736
Total gain, lbs	162	157
Daily gain, lbs	1.93	1.87
Mineral intake, ounces/day	3.52	4.00

Bioavailability

Consider the bioavailability of the mineral supplements when purchasing minerals. Bioavailability of sulfates and chlorides is generally greater than bioavailability of oxides. One exception is magnesium oxide, which is absorbed well enough to be used in beef cattle minerals. However, avoid mineral supplements that use copper oxide, which is poorly absorbed. Iron oxide is also poorly absorbed and is generally used to add color to the mineral mix. Because of the forages and feedstuffs in Georgia, cattle seldom require iron supplementation, so the addition of iron oxide should not negatively affect cattle performance and may be beneficial since iron can bind other minerals and prevent their absorption.

Minerals are usually included in supplements in the inorganic form but may also be combined with an amino acid or protein and fed in the organic form (referred to as complexes, proteinates or chelates). Minerals that are sometimes fed in the organic form include copper, zinc, cobalt and manganese with an amino acid or protein. The relative bioavailability of copper, manganese and zinc from different sources is higher compared to inorganic sources as outlined in Table 6.

Organic minerals cost more than inorganic minerals; therefore, an increase in performance must be realized to offset the higher purchase price. The response to organic minerals has been variable and they are only recommended in certain situations. Organic minerals have been effective in increasing the reproductive efficiency of young breeding females under nutritional stress, or reducing morbidity and mortality of newly weaned calves that are highly susceptible to bovine respiratory disease. For cows, organic minerals are usually fed from two months prior to calving through breeding. For calves, organic minerals are generally included only during the preconditioning period. However, zinc methionine may be fed continually during the feeding period to decrease lameness.

Table 6. Relative bioavailability of microminerals from different sources[1]

Mineral	Sulfate-form	Oxide-form	Carbonate	Chloride-form	Organic-form (complex, chelate)
Copper	100	0	—	105	130
Manganese	100	58	28	—	176
Zinc	100	—	60	40	159 to 206

[1]Availability relative to that of the sulfate form.Adapted from Greene, 1995.

Identifying a Mineral Deficiency

A mineral deficiency in cattle is difficult to diagnose and can silently rob profits from the herd. Most deficiencies are related to copper, zinc and selenium, but other mineral deficiencies can occur.

Mineral deficiencies are classified as either primary or secondary deficiencies. Primary mineral deficiencies occur when cattle consume forages that are deficient in a particular mineral such as magnesium. Failure to provide a mineral supplement is the most common cause of primary mineral deficiencies. Primary mineral deficiencies rarely occur in well-managed herds that receive mineral supplements.

A secondary mineral deficiency occurs when cattle consume mineral antagonists, which interfere with the normal absorption or metabolism of another mineral. In the case of copper deficiency, cattle are consuming enough copper to meet requirements, but some other mineral antagonist such as sulfur binds to the copper and prevents it from being absorbed and used by the animal. Secondary mineral deficiencies are the most common type of mineral deficiency. Take the following steps to ensure that the problem is due to a mineral deficiency.

- First, rule out other possible causes of poor performance such as disease, plant toxins, or inadequate protein and energy in the diet. The first sign of a problem in most herds is poor reproductive efficiency. Inadequate body condition, due to protein or energy deficiency, is the most common cause of reproductive failure.
- Monitor mineral intake to ensure cattle are eating the recommended amounts. A recommended intake is usually indicated on the mineral bag.
- Evaluate the trace mineral levels and sources of each trace mineral. Remember that the bioavailability of sulfates and chlorides is generally greater than that of oxides.
- Breed can also affect the mineral requirements of the cow herd. Simmental and Charolais cattle require more copper than Angus cattle. Levels may need to be increased 25 to 50 percent for these breeds.
- If a secondary mineral deficiency is suspected, then a laboratory analysis of forages must be conducted. In some instances, water should be tested if it is suspected that it might be high in iron or sulfur.
- Blood samples and liver biopsies may also be used to assess the mineral status of a cow. Liver samples are a more accurate indicator of mineral status. These tests are expensive and should be pursued only after the above steps have been taken.
- Ask for help from county agents, specialists, veterinarians and feed dealers. No one person knows all the answers and a team approach to solving a mineral problem is often required.

Copper Deficiency

Copper deficiency is an increasing concern in Georgia and other Southeastern states. Copper deficiency causes a wide range of problems such as poor hair coat, brittle bones, reduced weight gains and a weakened immune system. The University of Tennessee reported a copper deficiency in as many as 99 percent of tall fescue forage samples, and increased deficiency in the fall rather than spring. Results of copper concentrations in forages as reported by NRC are presented in Table 7, but actual concentrations vary due to soil type, fertilization and climate. For best results, test forages and feed ingredients.

One of the most visible signs of copper deficiency is change in hair color. Cattle with black hair will develop a reddish or gray tint. Cattle with red hair will become more bleached. Another common problem associated with copper deficiency is lowered immunity. The combination of low copper and high sulfur concentrations in pasture grasses can result in copper being deficient even in the most well managed herds.

Sulfur antagonisms are the most common cause of copper deficiencies in Georgia forages. Results of the NAHMS forage survey indicated that sulfur concentrations were marginal to high antagonistic in 79 percent of samples. Iron and molybdenum showed marginal to highly antagonistic levels in 13 and 18 percent of samples, respectively. Sulfur is present in all feedstuffs and is incorporated in some mineral supplements. The most significant sources of sulfur are direct supplementation, sulfur-containing fertilizers, water and energy/protein supplements.

Ammonium sulfate fertilizers are widely available and their use is on the rise. In the past, fertilizers contained small amounts of sulfur. However, modern methods of fertilizer production have eliminated any sulfur contamination. Therefore, sulfur-containing fertilizers are now being used to supply this important nutrient to pastures. In a University of Florida study, bahiagrass pastures were fertilized with either ammonium sulfate or ammonium nitrate to provide 60 pounds of nitrogen per acre. Ammonium sulfate increased forage yield in one of three years but increased plant sulfur levels to 0.50 percent. Sulfur becomes a problem when the concentration reaches or exceeds 0.35 percent. Liver copper concentrations in cows grazing pastures fertilized with ammonium sulfate were considered deficient, but were adequate in cows that grazed forages not fertilized with ammonium sulfate. In addition, use of poultry litter as a fertilizer will also elevate forage sulfur levels.

Simply providing more copper in the mineral supplement may not improve copper status, because as long as sulfur is present in excessive amounts in the forage, copper absorption will be decreased. If sulfur levels are borderline high (0.35 percent sulfur), then it can be helpful to increase copper concentrations up to 2,500 ppm. In the Florida study, even though the cows were copper deficient, no signs of deficiency or poor performance were noted. Many times, copper deficiencies do not show up until calves become sick after weaning and shipping. In a separate study, cows deficient in copper were able to rapidly replenish their liver copper concentrations to adequate levels when fed a low-sulfur diet.

Certain energy and protein supplements can also contribute significant amounts of dietary sulfur. Feedstuffs that contain sulfur in antagonistic amounts include corn gluten feed, corn gluten meal, distillers grains, molasses, soybean meal and cottonseed meal. Protein supplements are fed in small amounts, so sulfur concentration is diluted by the remainder of the diet. Molasses-based supplements are commonly used in winter feeding programs. The University of Florida has conducted studies to examine the effect of molasses on copper absorption in grazing heifers. The researchers compared a corn-based supplement to a molasses-based supplement. Accumulation of copper in the liver increased by 46 percent for heifers fed the corn-based supplement, but decreased nine percent for heifers fed the molasses-based supplement. Absorption of other microminerals (zinc, iron, manganese) was not affected by supplement type.

Most high-sulfur feeds are only consumed during the winter feeding period and should not significantly affect copper status. Cattle are able to utilize copper stored in the liver during the grazing season, which should reduce the problem of depletion during the winter feeding period.

Sulfur from pasture and hay is the primary cause of copper deficiency because they are consumed year-around. The only concern for winter feeding is when cattle have been on pastures that are high in sulfur or are being fed hay that has sulfur levels antagonistic to mineral absorption. Consider feeding low-sulfur feeds during the pre-conditioning period, especially if your cattle have had health problems in the past when fed high-sulfur feeds.

Table 7. Classification of micro elements in forage relative to their abilities to meet either dietary requirements or cause an antagonistic problem with copper.

Microminerals	Deficient	Marginally Deficient	Adequate	MTC[1]
Aluminum (ppm)	—	—	—	1000
Copper (ppm)	<4	4to 9.9	e″10	100
Manganese (ppm)	<20	20 to 39.9	e″40	1000
Zinc (ppm)	<20	20 to 29.9	e″30	500
Selenium (ppm)	<100	100 to 199.9	200	2000
Copper:Mo ratio	<4:1	4.0 to 4.5:1	>4.5 to 5:1	—

[1]Maximum Tolerable Concentration — *Source: NAHMS, 1999*

Summary

Mineral and vitamin nutrition is vital to overall herd health and reproductive efficiency. Calcium, phosphorus and salt are most likely to be the most limiting macrominerals in cattle diets. Magnesium may be a problem during late winter or early spring, especially in mature lactating cows. Secondary mineral deficiencies are an increasing concern because of increasing sulfur concentrations in homegrown feeds. A clear diagnosis of a mineral deficiency should be established before making drastic changes in a management or mineral program. Vitamins A, D and E are the only vitamins that may be deficient in beef cattle diets. Controlling daily intake is a constant challenge, but several management strategies can be used to ensure proper daily intake of minerals and vitamins.

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