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Mineral and Vitamin Supplementation of Beef Cows in Arkansas

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Introduction

Cattle require the proper balance of water, energy, protein, vitamins and minerals to achieve optimal production. In some cases, all the necessary vitamins and minerals are present in the forage. However, it is not unusual for forage-based diets to be deficient in one or more minerals and vitamin A. Because of this, a general understanding of vitamin and mineral nutrition is necessary to help guide vitamin and mineral supplementation programs.

Production Losses Due to Mineral and Vitamin Deficiencies/Toxicities

Production losses associated with mineral and vitamin deficiencies or toxicities may be either acute or subacute. Acute problems are more easily identifiable because they impact the herd in a manner that becomes obvious. Examples include high incidences of grass tetany, very low calving rates, deformities at birth and retained placentas. Subacute losses often cost the beef industry the most money because these losses often go unnoticed. Subacute losses are disguised in slight, as opposed to gross, reductions in pregnancy rate or growth rate. Identifying these problems on a producer-farm requires very good recordkeeping with benchmarks for performance expectations. Discovery of the benefits to supplementing nutrients to overcome subacute deficiencies requires research at universities and government facilities that are capable of examining the effects of adding specific nutrients to a diet under controlled, replicated conditions.

Evaluating a Mineral Deficiency

The goal of mineral supplementation is to overcome inadequacies or imbalances. Evaluating a mineral deficiency may require sampling both the diet (including feed and water) and the animal (including blood or tissue). Diet samples are a good starting point and are usually less expensive; however, tissue and blood samples may be better indicators when antagonistic minerals are present in the diet.

- **Forage Test and Water Test** – Provides gross indication of nutrients available to cattle. It does not indicate the biological availability or how much is actually available for bodily processes.
- **Blood/Tissue Analysis** – More expensive than a forage test.
  - Good indicator of deficiencies in the herd.
  - Screening multiple animals is required.
  - Values compared to averages observed at the lab and reported in literature provide a benchmark to determine deficiencies.
  - Whole blood is preferred for selenium evaluation, and liver biopsy samples are more indicative of copper status since copper is stored in the liver.

Vitamins for the Cow Herd

Vitamins are classified as either water soluble or fat soluble. Water-soluble vitamins are actively synthesized by rumen microorganisms or in tissue; therefore, vitamins of this form normally do not require supplementation. Fat-soluble vitamins include vitamins

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A, D and E. Because one or more may be deficient in specific situations, they are normally included together in supplements or injectable preparations.

Vitamin A. Vitamin A is the vitamin that is most likely to be deficient for beef cattle. When vitamin A is deficient at the tissue level, problems can arise with impaired production and decreased integrity of epithelial tissues (skin and eyes). The deficiency shows up as decreased feed intake and daily weight gains, runny eyes, poor conception rates and increased susceptibility to diseases such as pinkeye.

The vitamin A precursor, beta-carotene, is found at high levels in growing or freshly stored green forages, but it is low in mature or drought-stricken forage and hay that has been stored for prolonged periods. The liver can store large amounts of vitamin A, and stores will generally last from two to four months following extended time grazing green forage. Because of these factors, vitamin A deficiency in Arkansas is most likely to occur during the latter portion of the wintering period (when animals have been fed stored hay for several months) or during an extended period of drought. Requirements for vitamin A are 1,270 IU/pound of dry feed for pregnant beef heifers and cows and 1,770 IU/pound of dry feed for lactating cows.

Supplemental vitamin A can be given either in the diet or by injection. Vitamin A is often included in free-choice mineral supplements. However, when added to mineral supplements, vitamin A can be destroyed by some minerals if the supplement is stored for long periods. Also, it may be provided during periods it is not needed. Vitamin A may also be included in protein/energy supplements. Because this type of supplement is likely to be fed to the beef herd during winter feeding or during times of drought, this is a good way to supplement.

Injectable forms of vitamin A are also available. Due to the large dose of vitamin A from injections, withdrawal time must be considered when marketing cull cows.

Vitamin D. Vitamin D is found in sun-cured forages and is also synthesized in the skin of animals exposed to sunlight. If animals are kept in confinement where they have little exposure to sunlight, a deficiency might result. The deficiency would show up as stillborn calves, rickets in young animals and bone weakness in older animals. Because it is unusual to confine beef cattle for extended times in Arkansas, supplementation is not normally required.

Vitamin E. Vitamin E is an antioxidant that prevents the formation of peroxides that can damage body tissues. Its function is related to that of selenium, which detoxifies peroxides once they are formed. White muscle disease in calves can result from vitamin E deficiency, but it is more often due to a deficiency of selenium. Vitamin E is found in forages, but it may be destroyed during sun-curing and long-term storage. Use of a mineral supplement or an injectable preparation containing vitamins A, D and E should provide enough of these vitamins to overcome any possible problems.

Minerals for the Cow Herd

Cattle usually require some form of mineral supplementation during all times of the year. The required minerals are divided into major (macro) and trace (micro) minerals. Major minerals are reported as a percentage of the diet. The major minerals include sodium, chlorine, potassium, calcium, phosphorus, magnesium and sulfur. Trace minerals are required at much lower levels than the major minerals but are just as essential. Trace minerals are commonly reported as parts per million (ppm). Required trace minerals include zinc, copper, selenium, manganese, iron, nickel, cobalt, molybdenum and iodine. The daily requirements for major and trace minerals are reported in Table 1.

Major Minerals

Salt (sodium chloride). Supplemental salt is almost always required by the beef herd. The only exception is when water is very high in salt or with forages that are grown on very salty soils. Sodium and chlorine are major electrolytes found in body fluids, and there is very little storage. Because of this, cattle will develop deficiencies rapidly and should have constant access to salt or a supplement containing salt. In complete mineral supplements, the level is usually 15 to 25 percent.

Phosphorus. Phosphorus is often deficient in forages for lactating cows with superior milking ability. Phosphorus is high in oilseed meals (soybean and cottonseed meal) and also fairly high in grains, so when diets contain substantial amounts of these ingredients, supplementation is usually not needed. Phosphorus is one of the structural components of the skeletal system, and levels build up when cows are grazing lush forages that contain phosphorus at levels above requirements. Some of the phosphorus in bone can be mobilized during early lactation to overcome shortfalls in intake, but prolonged dietary deficiency has been reported to result in depressed reproductive efficiency and milk production. Mineral supplements are often referred to based on their phosphorus content, such as 10 percent mineral, indicating the content of phosphorus in the mineral supplement.

Calcium. Calcium is usually not deficient in grass forages fed to beef cattle in Arkansas. In addition, legumes such as alfalfa and clover are high in calcium. Grains, by-product feeds and corn silage are low in calcium, and diets high in these feed ingredients will need to be supplemented, usually with feed-grade limestone or calcium carbonate. Like phosphorus, calcium is a structural part of bone, so temporary shortfalls in the diet can be overcome by the animal mobilizing some of the calcium in bone. When the diet contains added fat, such as when whole cottonseed is fed, the calcium requirement

is increased. Calcium to phosphorus ratio is not as important for cattle as it is for other livestock, but situations where phosphorus is high relative to calcium may result in urinary calculi (stones). **Calcium to phosphorus ratio should normally be maintained at a level between 1:1 and 5:1.** A ratio of calcium to phosphorus in the mineral supplement should not exceed 3:1 in most situations. However, 6:1 minerals may be formulated and used when high rates of grain or by-product feeds will be fed (≥ 1% BW).

Magnesium. Forages contain adequate magnesium during most of the year, but levels can be very low during times of rapid growth in the spring and fall, especially in well-fertilized pastures. There can also be high levels of potassium in forage at this time, which can interfere with the absorption of magnesium. The low level of magnesium in forage often corresponds to calving seasons and the onset of lactation, which is when cow requirements are highest. These factors and very low body magnesium stores can lead to acute magnesium deficiency, a malady known as grass tetany. Supplementation with magnesium oxide is recommended for 30 days prior to calving and during the first three months of lactation. Provide a mineral with enough magnesium (at least 10 percent in a 4-ounce/head/day mineral) with less attention paid to phosphorus during periods that promote magnesium deficiency. Refer to Table 2 for Hi-Mag supplement.

Potassium. Potassium is usually excessive in most forages used in Arkansas with the exception of weathered stockpiled forages. Potassium is primarily present as an electrolyte in body fluids, so there is little storage. Despite this, situations where potassium supplementation of the brood cow herd is needed are rare.

Sulfur. Sulfur is a component of several amino acids that are the building blocks of protein. Sulfur, other than that fed in the form of protein, is usually needed only when diets contain substantial amounts of nonprotein nitrogen (NPN). In these situations, the ratio of nitrogen to sulfur should be maintained between 10:1 and 15:1. High sulfur levels can interact with copper and molybdenum, which can result in a copper deficiency. Corn by-product feeds can be very high in sulfur. A neurological disorder (polioencephalomalacia) may result when cattle consume excessive quantities of these feeds, especially in the presence of other sources of sulfur such as water.

Trace Minerals

Trace mineral levels of forages should be compared to requirement levels shown in Table 1 to determine deficiencies. Also evaluate forage for excessive levels of iron, sulfur and molybdenum which may interfere with copper utilization. Because of the low level in forages and lower bioavailability, trace mineral supplements are usually formulated to meet at least 100 percent of beef cattle requirements.

Zinc. Zinc is deficient in many Arkansas forages. Forty percent of hays tested at the U of A Agricultural Services Lab were deficient in zinc. This value does not factor in bioavailability. Zinc is a part of many important enzyme systems in the body, and its deficiency leads to depressed feed intake and growth rate, an abnormal hair coat and skin lesions. Zinc is

Table 1. Major Mineral and Trace Mineral Total Dietary Requirements – Percent or PPM, Dry-Matter Basis

Mineral	2016 Beef NRC Requirements		Maximum Limit
	Dry Cow	Lactating Cow	
Calcium, %	0.25	0.25 - 0.36	2[1]
Phosphorus, %	0.16	0.17 - 0.23	1[1]
Potassium, %	0.6	0.7	2
Magnesium, %	0.12	0.2	0.4
Sodium, %	0.07	0.1	--
Chlorine, %	0.2[1]	0.25[1]	--
Sulfur, %	0.15	0.15	0.4
Iron, ppm	50	50	500
Manganese, ppm	40	40	1,000
Zinc, ppm	30	30	500
Copper, ppm[2]	10	10	40
Iodine, ppm	0.5	0.5	50
Selenium, ppm	0.1	0.1	5
Cobalt, ppm	0.15	0.15	25
Molybdenum, ppm	--	--	5

[1] From 1989 Dairy NRC

[2] Copper requirements are highly variable (from 10 to 30 ppm). Levels of copper up to 30 ppm may be needed with some breeds of cattle where molybdenum is >2-3 ppm, sulfur is >0.3%, iron is >300 ppm in the diet, or some combination exists. Include iron and sulfur from water. **Remember that high copper levels are toxic to sheep**. The Continental breeds of cattle have higher requirements, and some breeds are more susceptible to toxicity, e.g., Jerseys and possibly Brahmans.

Table 2. Recommendations on Mineral and Vitamin Supplement Composition for Beef Cows Provided Various Quality Pasture or Hay

Forage Quality	Moderate Quality (Fertilized)	Intermediate Quality		Low Quality (Non-Fertilized)		Lush Pasture (for Grass Tetany Prevention)	Hay + By-Product/Grain at 1% BW
Mineral	Trace Mineral Salt[1]	12:6:4		12:14:4 or 12:6:2		12:4:10 Hi Mag	24:4
Minimum Forage Phosphorus, % dry matter	0.24	0.22		0.18		0.20	--
Dry or Lactating Cows	Dry or Lactating	Lactating		Lactating		Early Lactation	
Intake (oz/cow/day)	1	2	4	2	4	4	4
Calcium, %	--	12	12	12	12	12	24
Phosphorus, %[2]	--	6-8	4-6	12	6-8	4	0-4
Potassium, %[2]	--	--	--	--	--	--	--
Magnesium, %	--	4	2	4	2	10	--
Salt, %[3]	80+	10-25	10-25	10-25	10-25	10-25	10-25
Sulfur, %[2]	--	0-3	0-3	0-3	0-3	0-3	0-3
Iron, ppm[4]	--	--	--	--	--	--	--
Manganese, ppm	5000	4000	2000	4000	2000	2000	2000
Zinc, ppm	16000	8000	4000	8000	4000	4000	4000
Copper, ppm	5000	2500	1250	2500	1250	1250	1250
Iodine, ppm	160	100	50	100	50	50	50
Selenium, ppm	100	40	20	40	20	20	20
Cobalt, ppm	70	30	15	30	15	15	15
Vitamins A, D, E[5]							

[1] Most commercial trace mineralized salts contain inadequate levels of trace minerals for Arkansas conditions and are therefore not recommended. This may serve as a guide for custom blends.

[2] When needed, include in protein supplement to obtain adequate intake.

[3] Provide additional salt in supplement if consumption is excessive. If greater consumption is needed, add 5 to 15 percent molasses, grain or cottonseed meal.

[4] Add none above that contained in other mineral compounds used.

[5] Generally, vitamins should be provided when green forage is not available. Reasonable rates of vitamins for a 2 oz/cow/day mineral supplement consumption would be as follows (IU/lb supplement): A - 200,000 to 400,000; D3 - 15,000 to 40,000; E - 100 to 200. For 1 oz/cow/day, double the levels, and for 4 oz/cow/day intake of mineral supplement, reduce the levels by 50 percent.

important in male reproduction. An adequate zinc status is also needed for normal immune response. Storage of zinc is minimal, and deficiencies occur rapidly following introduction of animals to a diet severely deficient in zinc. Zinc methionine, an organic form of zinc, has improved performance in feedlot cattle and in cattle grazing forages already containing adequate levels of zinc. Zinc methionine can help overcome foot problems in cattle. Veterinarians and nutritionists recommend feeding zinc methionine as an aid in controlling, and even treating, foot rot in beef cattle. High levels of iron in the diet interfere with the absorption of zinc and increase the dietary requirement.

Copper. Copper, like zinc, is deficient in many areas of Arkansas (52 percent of hays tested were low in copper). It also comprises an essential part of many different enzymes in the body. Copper is important for adequate growth, reproduction and immunity. Some breeds have been shown to be more prone to copper deficiencies. Unlike zinc, copper is stored tenaciously in the liver, and levels build up rapidly when animals are fed high levels of copper. Copper is extremely toxic to sheep, so many supplements sold to cattle producers contain little copper, primarily to prevent liability of the supplement manufacturer in case the product is fed to sheep. Cattle producers should avoid using a low copper mineral unless complementary grazing programs with sheep are being used. **Copper oxide should be avoided as a copper source because of its poor bioavailability, which will affect the level of copper required in supplements.** High levels of molybdenum, sulfur, iron or zinc in the diet interfere with normal copper absorption and metabolism.

Selenium. Selenium levels are marginal to deficient throughout Arkansas. Sixty-two percent of hays tested for selenium were deficient. Severe selenium deficiency results in white muscle disease in lambs and calves, which is characterized by stiffness and heart failure. The activity of selenium is related to vitamin E, and supplementation with either will help prevent white muscle disease. However, since vitamin E levels are normally not a problem, selenium deficiency is usually the underlying problem. Marginal selenium deficiency can result in retained placenta, impaired fertility, silent heats and unthrifty weak calves with poor immune response (resulting in high preweaning death losses). Selenium can be provided in mineral mixes or in an injectable form.

The maximum level of selenium that can be legally added to a supplement is 3 mg per head per day at its highest intake (27 ppm in a 4-ounce mineral).

Manganese. Manganese levels in forages vary considerably, depending on the soils on which they are produced. Manganese is a part of several important enzyme systems. A deficiency may result in impaired reproductive performance in both cows and bulls and in the birth of deformed calves.

Cobalt. Cobalt is needed only for the ruminal synthesis of vitamin B12. Cobalt requirements are higher when cattle are fed high-grain diets, because more B12 is required to metabolize the end products of rumen fermentation. Cobalt may be very deficient in some soils, so including it in trace mineral supplements is a sound practice.

Iron. Iron is a part of hemoglobin which transports oxygen to body tissues. Since most forages contain high levels of iron and because substantial amounts of soil are consumed during grazing, iron is almost never deficient in cattle fed forage-based diets. A more common problem with iron is that it may be excessively high in forages or in drinking water, which can interfere with the absorption of copper and zinc.

Iodine. Iodine makes up part of the thyroid hormones. A deficiency results in a condition known as goiter, which is actually an enlarged thyroid gland. Iodine is normally included in trace mineral supplements. Added iodine compounds should provide no more than 10 mg of iodine per day. In the past, high levels of iodine (EDDI) were used for foot rot prevention. This practice is no longer recommended. Other measures for foot rot control such as including zinc methionine or antibiotics in minerals, foot baths or hydrated lime around mineral feeders should be used in herds where foot rot is a problem.

Recommendations on Mineral Supplements

Recommended mineral supplements shown in Table 2 were formulated using an Arkansas forage mineral analysis database consisting primarily of hay samples collected throughout the state from 1985 to 2000. The supplements shown here may be used as a guide to choosing a commercial mineral mix or custom blending a mineral and vitamin supplement.

Supplement options. Free-choice mineral supplementation options include (1) purchasing a commercial supplement, (2) using a home-mix or (3) having the mineral supplement custom-mixed. Commercial supplements are the most convenient because they can be purchased in small quantities, are available in various formulations and include options fortified with feed additives that help prevent disease or control flies. A common complaint with commercial supplements is local dealers changing brands or not maintaining consistent supplies. Custom-mixed mineral and vitamin supplements provide the opportunity to fine-tune nutrients based upon local forage, feed and water content, as well as fortify the supplement with feed additives similar to those available in commercial supplements. Custom mixes are usually less expensive than similar formulations purchased in 50-pound quantities through a local feed store. Custom-mixed products usually require bulk purchases of 4 tons or more, which limits this option to either large operations or cooperative farm groups. The final option is a home-mix. This option is least practical if trying to supplement trace minerals or include a medicated feed additive. Most operations do not have sufficient mixing facilities to accomplish a safe and uniform mix of trace mineral packages or medicated feeds. Although not practical for most, this option can be accomplished. Some cattle producers have used poultry litter as a foundation for home-mix mineral supplements due to litter's rich trace mineral content.

Mineral types. Mineral sources are available in two general forms, inorganic and organic. Most inorganic sources include sulfates, chlorides, carbonates and oxides. For example, copper may be in the form of copper sulfate, tribasic copper chloride or copper oxide. Inorganic forms are acceptable with the exception of copper oxide due to its poor availability. Iron oxide is also poorly available, but it is primarily used to add the red coloring to mineral mixes. Organic sources include terms such as chelates, amino acid complexes or minerals that have an amino acid in the nomenclature such as copper lysine. Yeast also provides organic source minerals such as selenium. Organic forms have a greater biological availability than inorganics. However, the use of organics does not guarantee significant improvements in production. Research has demonstrated improvements in health, growth and/or reproduction in young growing cattle; however, a benefit to mature beef cows managed under natural service reproduction has not been demonstrated.

Feed additives. Commercial minerals may contain ionophores, antibiotics (chlortetracycline is most common in Arkansas), dewormers and fly control compounds. These mixes can be valuable under certain situations, but always make sure that the mineral is fortified with the minerals you need in addition to the feed additive. Feed additives also add expense, so use the feed additives for the correct indications during the proper time of year. For more information on medicated feed additives and their purposes, review the Extension publication *FSA3012, Feed Additives for Beef Cattle*.

Intake control. How to control intake is one of the most frequently asked questions. Mineral consumption is affected by numerous factors, some related to additives in the mineral and others related to environment. If cattle are over-consuming mineral, regulation options include adding salt, relocating the mineral feeder farther from the water source, regulating intake by the frequency mineral is fed, such as providing a one-week supply of mineral at a time, or changing to a different brand of mineral. The

flavoring agents added by one company may result in over-consumption in your environment, while the formulation of another company does not. If cattle have been without mineral for a while, they tend to over-consume initially. If cattle are under-consuming mineral, regulation options include moving the mineral feeder closer to a water source, adding a palatable feedstuff such as distiller's dried grains or dried molasses or switching to a different brand of mineral.

Injectable mineral options. Injectable forms of minerals are available similar to injectable forms of vitamins. These are available as trace mineral supplements and are often administered during critical phases of production which often coincide with timing of health and management practices (vaccinating, weaning, estrous synchronization). Research with injectable minerals has shown health and growth benefits in purchased stocker cattle; however, significant benefits to overall pregnancy rate, weaning rate or retained calf health and growth have not been observed. For mature cows, a significant increase in pregnancy to timed artificial insemination has been reported.

Feeding Mineral Mixes

Cafeteria feeding. Cafeteria-style mineral supplementation involves providing multiple mineral options. This can either be providing plain salt in addition to a complete mineral mixture or providing a selection of individual ingredients for cattle to choose. Cattle will select feedstuffs for their palatability, not because they feel they need sulfur, iron or copper in their diet. Cattle crave salt and have demonstrated pica and may be found chewing bones and other items that are not a common part of the cow's diet when extremely phosphorus deficient. Because cattle crave salt, salt can be used to stimulate intake of less palatable supplements such as magnesium oxide. Because cattle crave salt, salt should not be provided in addition to complete mineral mixes as cattle may want to avoid the less palatable complete mineral, favoring the pure salt option. Only consider the use of additional salt if it is recommended on the feed label or cattle are over-consuming the complete mineral option.

Mineral feeders. Mineral supplements should be fed from a covered feeder that protects the mineral from rain. If the supplement becomes wet, it can harden and intake will be reduced. Check the mineral supply at least weekly, and if the mineral has hardened, break it up or replace it if necessary. Several types of mineral feeders are available commercially that are designed to offer good rain protection including feeders with a rotating cover and vane, feeders with a rotating trough and vane and feeders that set on the ground with a rubber lid. Home-built feeders also work well, but hardening of the supplement tends to be more of a problem. The roof of a home-built feeder should be low enough to keep out as much rain as possible. In recent years, cattle producers have also recycled plastic barrels that contained human food-grade products such as drink syrups as feeders. These feeders are constructed by cutting an opening for cattle to reach inside. The barrels are then hung by the lip-seam, opposite the side of the opening, so that they hang at an angle to help shed rain away from the opening or placed in used rubber tires with 3 to 4 bolts to prevent tipping. Mineral feeders should be low enough that the mineral is accessible by 3- to 4-month-old calves.

Information in this fact sheet was taken from two publications and originally adapted for use in Arkansas by Dr. George V. Davis, Jr., former Extension livestock specialist. The original manuscripts were *Vitamins and Minerals for Beef Cattle* written by Matthew H. Poore, Extension animal husbandry specialist, and Jerry Spears, professor of animal science, North Carolina State University; and *Mineral Supplementation of Beef Cows in Texas* by Dennis B. Herd, former professor and Extension beef cattle nutritionist, the Texas A&M University System.

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