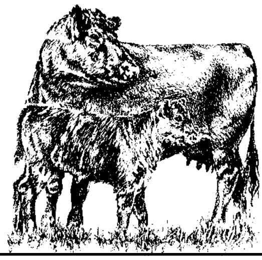

Western Beef Resource Committee **Fourth Edition**

Cattle Producer's Handbook

Nutrition Section 327

Mineral Supplementation of Beef Cows in the Western United States

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The beef cattle industry in the western United States is dependent on forage production. However, forage alone often does not provide all the essential nutrients necessary to maintain a healthy and productive cow herd. Consequently, the proper balance of protein, energy, vitamins, and minerals is needed to maintain an efficient and economical nutritional program.

If dietary nutrients are not in the proper balance, herd health, production, and efficiency will suffer. In other words, a cow's performance will be dictated by her most limiting nutrient. For example, providing 200 percent of a cow's energy requirement will not substitute for providing only 75 percent of her requirement for protein and/or minerals.

Minerals are commonly classified as either macro or micro (also known as trace) minerals. The macrominerals are calcium, phosphorus, potassium, magnesium, sodium, chlorine, and sulfur, while the common microminerals are iron, manganese, zinc, copper, iodine, selenium, cobalt, and molybdenum. Mineral supplementation of beef cattle consuming standing or harvested forage is necessary to maintain optimal reproductive efficiency, immunity, lactation, and growth.

Development of a mineral supplementation program to meet the requirements of cattle consuming a forage-based diet can be difficult. This is primarily because of challenges associated with (1) changes in animal requirements with the stage and level of production, (2) differences in the concentration of minerals in the forage, and (3) providing a mineral supplement in such a way as to ensure adequate intake and bioavailability (Green 2000). This paper will attempt to address these challenges.

Mineral Requirements

The mineral requirements of dry and lactating beef cows are presented in Table 1. Caution should be exercised when estimating a cow's mineral requirements because of the many interactions associated with certain minerals. Copper is one of the most commonly affected nutrients by interactions with other minerals. For example, Herd (1997) suggests increasing the recommended level of copper above that listed as the requirement anytime dietary molybdenum exceeds 2 ppm (parts per million), sulfur exceeds 0.3 percent, iron exceeds 250 to 300 ppm, or some combination exists in the feed and water supply.

In addition, low dietary calcium and/or high dietary potassium has been involved with grass tetany (hypomagnesia) as indicated by the so-called "tetany ratio" (diet potassium concentration divided by the sum of the diet calcium and magnesium concentration). If this ratio is greater that 2.2, the diet is classified as tetany-prone. Thus, a low content of calcium and/or magnesium (or high potassium) could create a ratio greater than 2.2.

Herd (1997) provides two points that cattle producers should consider when determining the level of supplemental mineral desired: (1) "moderately higher levels of mineral intake, for up to 6 weeks, may be needed and safe for cattle with severe deficiencies, but should not be continued once their mineral status has returned to normal" (obtain the assistance of a nutritionist and veterinarian before providing minerals in excess of requirements), and (2) "relationships in cows have been well established between stage of production and requirements for major minerals, protein, and energy; this is not true for trace minerals."

Table 1. Generally accepted beef cow mineral requirements and potential mineral formulations.

	1996 Beef NRC requirements[a]		Suggested mineral composition[b]	
Mineral	**Dry cow**	**Lactating cow**	**General formulation**	**High magnesium**
Macro minerals (%)				
Calcium	0.25	0.25 to 0.36	10 to 12	12 to 16
Phosphorus	0.16	0.17 to 0.23	6 to 12[c]	2 to 4
Potassium	0.60	0.70	—	—
Magnesium	0.12	0.20	4 to 5	10
Salt	0.07	0.10	< 15[d]	15 to 25
Sulfur	0.15	0.15	2 to 3	0 to 3
Trace minerals (ppm[e])				
Iron	50	50	—	—
Manganese	40	40	4,000	4,000
Zinc	30	30	3,000	3,000
Copper	10	10	1,200 to 2,000	2,000
Iodine	0.5	0.5	100	100
Selenium	0.1	0.1	60[f]	60[e]
Cobalt	0.1	0.1	30	30

[a]Requirements are based on the current beef NRC (1996). In addition, the values are expressed as a proportion of the total diet.

[b]Minerals are formulated to be consumed at approximately 2.0 ounces (57 g) per head per day.

[c]Formulations greater than 6 to 8 percent phosphorus may be unpalatable unless feed byproducts are added.

[d]Provide additional salt if mineral intake is excessive.

[e]ppm = parts per million

[f]Maximum allowable selenium intake is 3 mg per head per day. Therefore, maximum intake of the proposed mineral mix would be 2.0 ounces (57 g) per head per day.

If producers are concerned that their cow herd has a severe mineral deficiency, they should consult a nutritionist and have their herd's mineral status determined before providing a mineral supplement that contains higher concentrations of minerals than normally formulated. Mineral toxicities can occur without the proper guidance and supervision, often resulting in poor cow performance, increased morbidity, and potentially, death.

In addition, when preparing a mineral supplementation program, beef producers should be aware that the requirement for many trace minerals (copper, zinc, selenium, etc.) is as great or greater during late gestation as during lactation. A prime example is copper, which is low in milk. Thus, the cow must build the calves' liver copper stores during gestation to minimize the potential for deficiency after birth.

Without proper trace mineral supplementation before parturition, health disorders such as mastitis, retained placenta, stillbirths, embryo mortality, calf scours, pneumonia, apparent vaccine failure, and general reproductive problems (low numbers of cows exhibiting estrus, poor conception rate, etc.) can occur.

Forage Mineral Concentration

Native range in most areas of the western United States is deficient in one or more minerals and, therefore, a properly formulated mineral program is warranted. To properly formulate a mineral mix, the beef producer must have an estimate of mineral intake by his cow herd. This requires that cattle producers know the mineral concentration of their forage resources, which can be affected by soil characteristics, plant species, sampling date (year and month), sampling location, and annual precipitation (Sprinkle et al. 2000; Toombs et al. 2000; Ganskopp and Bohnert 2003).

Fig. 1 further supports this point. Data presented were adapted from the results reported by Ganskopp and Bohnert (2003) and Sprinkle et al. (2000) for native range in Oregon and Arizona, respectively. Calcium concentration appears to be sufficient to meet a cow's requirement throughout the year, however, forage concentration of phosphorus, magnesium, copper, zinc, and selenium is not sufficient to meet the requirements of an average cow during the majority of the year. Consequently, forage testing is essential to accurately determine the quantity and proportion of minerals necessary in a supplementation program.

It should be noted that cattle normally select plants and/or plant parts that are higher in nutrient content than clipped forage. Consequently, cattle diets may contain greater quantities of nutrients (CP, minerals, vitamins, etc.) than a forage sample would suggest. In addition,

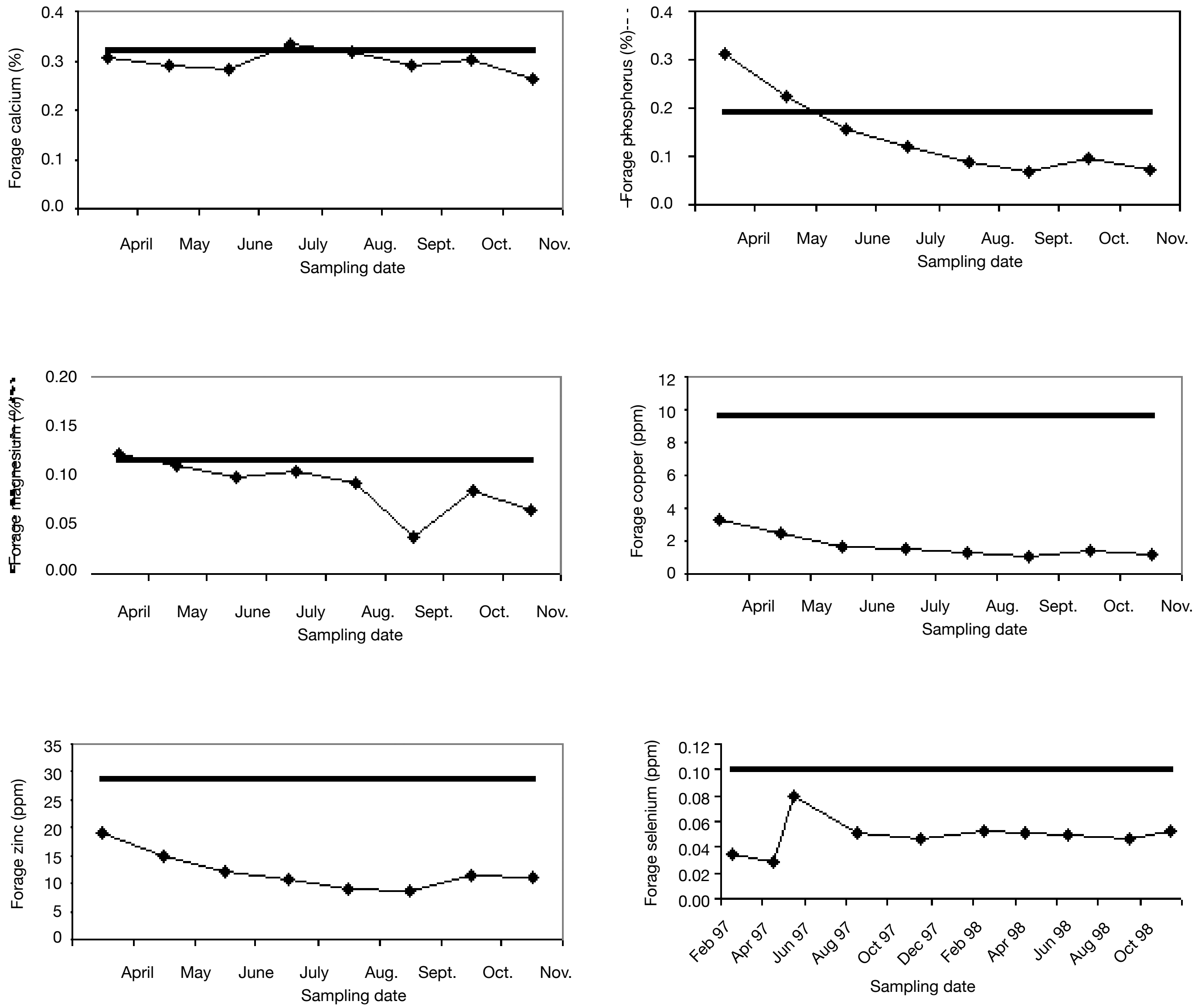

Fig. 1. Monthly forage mineral concentration of native range in southeastern Oregon (calcium, phosphorus, magnesium, copper, zinc) and southeastern Arizona (selenium). The solid horizontal lines indicate the forage mineral concentration necessary to meet the requirements of a 5-year-old, 1,000-pound Angus x Hereford cow that has a body condition score 5, is 60 days pregnant, 120 days in milk, and consuming 25 pounds of forage dry matter per day (NRC 1996; adapted from Ganskopp and Bohnert 2003 and Sprinkle et al. 2000).

water testing is necessary to assist in the correction of deficiencies or adjusting for mineral excesses.

Once a producer obtains an estimate of the mineral content of the diet (feed and water), the manager can compare it to the desired dietary concentration and formulate a successful mineral program. If an estimate or "best guess" of the mineral content of the diet is not available, Herd (1997) suggests that the mineral mix should be formulated to provide 50 to 100 percent of the National Research Council (NRC 1996) requirement for trace minerals. Herd bases this suggestion on the premise that if the mineral content of the supplement is kept in general proportion to the animal's requirements, it tends to pull the mineral content of the total diet toward balance.

Table 1 provides two generic mineral formulations for a couple of scenarios. The "General formulation" will suffice in most instances when cattle are grazing native range. The "High magnesium" mix is formulated to provide the additional calcium, magnesium, and sodium (salt) often needed when cattle are susceptible to grass tetany (such as grazing annual winter pasture and/or crested wheatgrass in known problem areas; e.g., where Mg is deficient).

Producers should not offer these supplements to sheep because of the high copper concentration. Additionally, the selenium level in both mineral mixes restricts their approved use to a maximum daily intake of approximately 2.0 ounces per head (maximum approved daily selenium intake is 3 Mg selenium per head).

Mineral Supplementation

Several methods are commonly used to supplement minerals to beef cattle. The most common are: (1) mixing minerals into a complete ration, (2) adding minerals to a supplemental feed, and (3) using free-choice mixtures.

Mixing Minerals

Mixing minerals into a complete ration is the safest and most efficient way to ensure the correct intake of supplemental minerals. However, this is not economical or practical for most beef operations in the western United States.

Adding Minerals As Supplements

If beef producers are providing protein or energy supplements to their cattle, mixing minerals with the supplement is an excellent way to furnish minerals to the cow herd on a regular basis.

As with mixing minerals into a complete ration, this is not practical nor warranted in many situations. For example, a beef producer providing alfalfa hay as a protein supplement cannot incorporate the mineral mix with the alfalfa in an effective manner. Also, cows grazing late-spring to early-summer range in the western states normally don't require additional protein or energy to maintain acceptable levels of performance.

Minerals As Free-Choice Mixtures

Consequently, the most popular method of providing minerals to beef cattle is through free-choice mixtures. The main problem associated with providing a mineral mix free-choice is the regulation of mineral intake. Beef producers cannot trust their cattle to consume minerals when they need them and leave them alone if they don't. Cattle do not possess "nutritional wisdom" that enables them to consume minerals when they need it. Mineral nutrition of cattle must be managed the same way their protein and energy needs are managed.

A common occurrence observed with cattle that haven't had access to a mineral mix for an extended period of time is that they will consume several times the recommended level of a given supplement. This is a normal occurrence that should be allowed for about 2 weeks before attempting to regulate intake.

Adding a small amount of salt to a mineral mix will normally encourage supplement intake. However, before adding salt producers should determine the concentration in the mineral mix. If the mineral contains 50 percent or more salt, supplemental intake will probably not be increased with additional salt.

Also, some grass and/or water contains high levels of salt, which will discourage mineral intake if additional salt is included in the mineral mix. In these situations, the addition of dried molasses, ground grain (corn, barley, etc.), protein supplements (cottonseed meal, soybean meal, etc.), or vegetable oils at 5 to 15 percent of the mineral mix will usually encourage intake (start low and work up to a level where the cows consume the expected amount of supplement). Also, when providing mineral free-choice to cows with calves, producers need to make sure that the calves are able to reach the mineral container so that they can have access to the mineral supplement as well.

Sources of Minerals

When designing or purchasing a mineral supplement a beef producer should be aware of the sources of mineral that are used in the mineral mix. The reason for this is that not all sources of a given mineral are used at the same efficiency by cattle. Organic forms of minerals (proteinates, complexes, and chelates) have a higher bioavailability (how well an animal uses the mineral source) compared with many inorganic forms (carbonates and oxides). However, organic minerals are expensive compared with inorganic minerals.

In addition, some inorganic sources (primarily the sulfates and chlorides) are used effectively by cattle. Herd (1997) suggests that some organic forms of minerals "may be of greater value when an animal is under nutritional, disease, or production stress." Herd goes on to state that because of the high cost of organic minerals compared with inorganic minerals, increased production must be obtained for a profit to be realized.

Beef producers have used mineral mixes composed of inorganic minerals for many years and have reported excellent performance. Therefore, it is hard to recommend the use of expensive organic minerals in normal production scenarios.

As a general rule, the bioavailabilities of inorganic mineral sources follow this order: sulfates and chlorides are similar in bioavailability while both are greater than carbonates, which have greater bioavailability compared with oxides (sulfates = chlorides > carbonates > oxides) (Table 2). For example, research has demonstrated that the bioavailability of copper oxide in a mineral mix is extremely poor.

Consequently, on first observation a mineral mix may appear to contain adequate copper levels. However, if the source of copper used was copper oxide, the mineral mix will not improve the copper status of the cow herd in an acceptable manner. A much more bioavailable source of copper would be copper sulfate.

Summary

When deciding on a mineral supplementation program, beef producers should have knowledge of their herd's mineral requirements, feedstuff mineral content, and how the mineral mix will be provided to the animals. Once the aforementioned information has been obtained or estimated, beef producers should obtain the assistance of an Extension educator or ruminant nutritionist to develop a mineral supplementation program.

All mineral mixes are not created equal. Therefore, cattle producers need to understand mineral require-

Table 2. Source, empirical formulas, mineral concentrations, and relative bioavailabilities of common inorganic mineral sources.

Supplement	Empirical formula	Mineral concentration	Relative bioavailability	Mineral availability
		(%)	(RV)	(% of DM)
Calcium				
Calcium carbonate	$CaCO_3$	38	100	38.00
Bone meal	variable	24	110	26.40
Calcium chloride (dihydrate)	$CaCl_2(H_2O)$	31	125	38.75
Dicalcium phosphate	$Ca_2(PO_4)$	20	110	22.00
Limestone		36	90	32.40
Monocalcium phosphate	$Ca(PO_4)$	17	130	22.10
Cobalt				
Cobaltous sulfate	$CoSO_4(H_2O)_7$	21	100	21.00
Cobaltic oxide	Co_3O_4	73	20	14.60
Cobaltous carbonate	$CoCO_3$	47	110	51.70
Copper				
Cupric sulfate	$CuSO_4(H_2O)_5$	25	100	25.00
Copper EDTA	Variable	Variable	95	Variable
Cupric chloride (tribasic)	$Cu_2(OH)_3Cl$	58	115	66.70
Cupric oxide	CuO	75	15	11.25
Cupric sulfide	CuS	66	25	16.50
Cuprous acetate	$CuC_2O_2H_3$	51	100	51.00
Iron				
Ferrous sulfate heptahydrate	$FeSO_4(H_2O)_7$	20	100	20.00
Ferric citrate	Variable	Variable	110	Variable
Ferric EDTA	Variable	Variable	95	Variable
Ferric phytate	Variable	Variable	45	Variable
Ferrous carbonate	$FeCO_3$	38	10	3.80
Magnesium				
Magnesium sulfate	$MgSO_4$	20	100	20.00
Magnesium acetate	$MgC_2O_2H_4$	29	110	31.90
Magnesium basic carbonate	$MgCO_3$	31	100	31.00
Magnesium oxide	MgO	55	100	55.00
Manganese				
Manganese sulfate	$MnSO_4(H_2O)$	30	100	30.00
Manganese carbonate	$MnCO_3$	46	30	13.80
Manganese dioxide	MnO_2	63	35	22.05
Manganese monoxide	MnO	60	60	36.00
Phosphorus				
Sodium phosphate	$NaPO_4$	Variable	Variable	Variable
Bone meal	Variable	21	100	21.00
Defluorinated phosphate	Variable	12	80	9.60
Dicalcium phosphate	$CaHPO_4$	18	85	15.30
Selenium				
Sodium selenite	$NaSeO_3$	45	100	45.00
Cobalt selenite	Variable	Variable	105	Variable
Zinc				
Zinc sulfate	$ZnSO_4(H_2O)$	36	100	36.00
Zinc carbonate	$ZnCO_3$	56	60	33.60
Zinc oxide	ZnO	72	100	72.00

Adapted from Hale and Olson (2001)

ments, the mineral concentration of feedstuffs, and the interactions associated with certain minerals to develop successful mineral supplementation programs.

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