

Trace Minerals: Health , Productivity, and Supplementation
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Trace minerals required by dairy cattle as listed in the 1989 NRC are Iron (Fe), Cobalt (Co), Copper (Cu), Manganese (Mn), Zinc (Zn), Iodine (I), and Selenium (Se). Each of these minerals is required in very small amounts or fractions of a teaspoon per cow per day. Molybdenum (Mo) is usually included on mineral profiles because high Mo can interfere with Cu availability. Chromium has received recent attention as a potential trace mineral for cattle but requirements are not known at this time.

Functions of these minerals in the cow are listed in Table 1. We rarely see absolute deficiencies of trace minerals except for white muscle disease in beef cattle or sheep that are not supplemented with Se. Marginal deficiencies, however, do occur and have been associated with common dairy cow problems such as retained placenta, mastitis, foot problems, and poor immune response.

Supply of these minerals in common feeds is variable; from non-existent to concentrations that can interfere with absorption or utilization of other elements. Soil concentrations of these minerals influences the content in feed and thus the designation of many regions of the country as deficient. Corah and Dargatz surveyed mineral concentrations of forages from various regions of the country. They found that Cu, Zn, Co, and Se were deficient or marginal in over 50% of the samples. In addition, concentrations of Fe and Mb were found to be high enough in 10% of the samples to cause antagonisms. Results are found in Tables 2 and 3.

Trace mineral analysis can be performed on cows or feeds. Trace minerals are generally added to rations on a “best guess” of mineral concentrations of similar feeds rather than actual analysis and most of the time the “best guess” is good enough. Trace mineral deficiencies or imbalances should be considered when problems persist in spite of a good ration, good housing, and good management. I sense that trace mineral supplements are sometimes sold as a cure for poor rations, poor housing, or poor management. Samples to collect to document trace element deficiencies or imbalances are noted in Table 1.

Supplementation was commonly provided through the use of inorganic salts of these minerals in a trace mineral salt fed free choice or added to a ration. Organic forms of the trace minerals tend to be absorbed and utilized easier by the cow, however, organic minerals tend to be higher in cost than inorganic minerals. Consider cost-benefit of the supplementation of all forms of trace minerals

Observations on trace mineral problems in Va Dairy Herds

1. High Fe and or Mo interfering with Cu utilization. Our red soils in many parts of Virginia contain high concentrations of Fe and I have seen dairy rations with > 400 ppm Fe. In addition, several forages and commodities contain Mo at > 2-3 ppm. You can overcome high Mo with supplemental Cu (Keep Cu at a ratio of > 6:1 over Mo). I think it is harder to overcome excess Fe with supplemental Cu so remove the Fe from the mineral package.
2. Heifers are not given any trace minerals. Consider a free-choice, high Se mineral for growing and gestating heifers on pasture.
3. Switch in commodities. Trace mineral content varies between feeds. Consider trace mineral analysis of the ration or commodities when adding new commodities to a ration.
3. Organic minerals. Organic minerals have a place but I do not think you can justify the cost of providing the total requirement for all cows all the time. Stressed cattle are at higher risk of trace element deficiencies so consider the organic minerals first for dry cows and cows early in lactation. Likewise, consider the organic sources for calf starter rations.

Table 1: Trace Minerals

<u>Mineral</u>	<u>NRC Requirement ration (ppm)</u>	<u>Function</u>	<u>Signs of deficiency</u>	<u>Animal Samples</u>	<u>Supplementation Sources</u>	<u>Comments</u>
Iron (Fe)	50	Carry O ₂ in blood	Anemia	Feed	Fe sulfate, organic Fe	Fe oxide is a coloring agent and not available to animal. High Fe in ration (300-500 ppm) can interfere with absorption of Cu and Zn
Cobalt (Co)	0.10	Vitamin B12	Anemia		Several Co Salts	Deficiency not commonly seen in US
Copper (Cu)	10	Blood formation, hair pigment, immune function	Gray hair on black cattle, immune depression	Liver is best, Blood only for severe deficiencies	Cu sulfate, Cu carbonate, organic Cu	High molybdenum, Fe and Sulfur can decrease Cu availability. Jerseys more susceptible to Cu toxicosis?
Manganese (Mn)	40	Enzyme activator	Reduced fertility, deformed calves		Mn salts	Deficiencies rare
Zinc (Zn)	40	Enzyme function, Immune function, Vitamin A metabolism	Scaly skin, Foot problems? increased mastitis?	Liver is best, Blood only for severe deficiencies	Zn sulfate, Zn carbonate, Organic Zn	
Iodine (I)	0.3.6	Thyroid hormone	Goiter		Iodized salt	
Selenium (Se)	0.3	Enzyme function, Immune function, spares vitamin E	White muscle disease, retained placentas, increased mastitis?	Blood, liver	Sodium selenite, organic Se, injections	Margin of toxicity is low, diet of 2-5 ppm may be toxic, rarely analyzed in feed.
Molybdenum (Mb)		Enzymes	None			Increased Mb interferes with Cu
Chromium (Cr)	???	Glucose utilization			CrCl ₃ , Cr nicotinic acid complex	

Table 2: Trace Mineral Classification for 352 forage samples

Trace Mineral	Deficient	Marginal	Adequate	High	Antagonistic
Copper	14.2 %	49.7%	36%		
Manganese	4.7%	19.3%	76%		
Zinc	63.4%	34.1%	2.5%		
Cobalt	48.6%	17.3%	34.1%		
Selenium (n=305)	44.3%	19.3%	19.7%	16.7%	
Iron	8.4%		62.8%		11.7%
Molybdenum					9.2%

Key to Classification

Trace Mineral	Deficient	Marginal	Adequate	High	Antagonistic
Copper	<4 ppm	4-7 ppm	7 + ppm		
Manganese	< 20 ppm	20-40 ppm	>40 ppm		
Zinc	< 20 ppm	20-40 ppm	>40 ppm		
Cobalt	< 0.1 ppm		0.1-0.25 ppm		
Selenium (n=305)	< 0.1 ppm	0.1-0.15	0.15-0.3 ppm	> 0.3 ppm	
Iron			50-200 ppm		> 400 ppm
Molybdenum					> 3 ppm

Note: This classification is from the Beef NRC, requirements for dairy cattle tend to be higher.

Table 3: Trace Mineral Classification by forage source

Forage	Cu	Mn	Zn	Co	Se	Fe	Mo
Alfalfa/Alfalfa Mix (n=69)	7.4	51	19.1	0.26	0.320	20.2	2.1
Fescue (n=26)	6.2	122	17.8	0.22	0.063	99.7	0.99
Grass (n=109)	6.7	113	19.6	0.26	0.158	209	1.5
Corn Silage (n=9)	5.3	52	18.3	0.25	0.153	157	1.5

Values are ppm on a dry matter basis

Data from: Corah LR, and D Dargatz. Forage Analysis from Cow/Calf Herds in 18 States. Beef Cow/Calf Health and Productivity Audit. March 1996.