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TRACE MINERAL REQUIREMENTS FOR BEEF COWS:

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What Do We Know? Mineral supplementation strategies are influenced by forage mineral bioavailability, trace mineral interactions, stage of production and breed. Trace elements most identified as having an impact on productivity of grazing cattle include copper, zinc and selenium. Adequate intake and balance between trace minerals is required for proper functioning of both immunity and reproduction.

How do forage levels influence supplementation decisions? Forages provide the nutritional base of cow-calf operations. Supplementation decisions pivot around the quantity and quality of the forage-base. In addition to protein and energy content of the feed resource, mineral concentrations are important. A recent survey of 352 cow/calf operations across 18 states revealed a deficiency for zinc with only 2.5% of the analyzed forages having adequate zinc levels ($\geq$ 30 ppm). Forage values for copper indicated 14.2% were deficient, and 49.7% contained marginal levels. Iron and molybdenum levels in 10% of the forages were high enough to cause a copper deficiency due to antagonistic effects on copper absorption. Trace mineral concentrations in forages can vary among regions, within a state and even within a ranch. The following table demonstrates the variation measured among four pastures on a ranch in southwestern Montana. Forages were sampled during the late spring and early summer months. These analyses would indicate that copper, zinc and manganese would be adequate. But, the antagonistic effects of iron, sulfur and molybdenum have the potential to negatively affect the utilization of these minerals.

Variation in the Mineral Content of Forage Samples From a Southwestern Montana Ranch*

	Pasture			
Mineral	A	B	C	D
Cu, ppm	7	10	7	0
Zinc, ppm	36	36	24	37
Mn, ppm	57	65	55	41
Mo, ppm	0.62	0.19	4.1	
S, %	0.26	0.47	0.46	0.36
Fe, ppm	457	385	179	136

**Beef requirements for Cu=10 ppm, Zn=30 ppm, Mn=20-40 ppm, S=.15% and Fe =50 ppm*

Why consider interactions between trace minerals? Balanced consumption of trace minerals can be as important for cattle as adequate intake levels. Molybdenum, sulfur and iron have been shown to interfere with copper absorption. The antagonistic mechanism of iron is not well understood. Molybdenum and sulfur form thiomolybdates that bind copper, resulting in compounds that cannot be absorbed by the animal. Excessive dietary zinc can also negatively affect copper status through the absorption process involving metallothionine.

How do trace minerals affect the immune system? Trace mineral deficiencies in beef cattle have been shown to alter various components of the immune system. Copper-deficient cattle have a decreased ability to respond to viral and bacterial challenges. Zinc has been shown to have a positive impact on immunity in stocker and feeder cattle with limited research in beef cows. Montana State University research demonstrated improved antibody titers for IBR in yearling heifers when copper, zinc, manganese and cobalt were supplemented.

Can reproduction be influenced by trace mineral deficiencies? Intake of bioavailable minerals is necessary in postpartum cows for proper involution of the uterus, display of estrus, ovulation, conception and maintenance of a new fetus. In a copper-deficient status, productivity may be reduced due to metabolic alterations of enzyme systems. Delayed or suppressed estrus and embryo death have been identified as common symptoms of copper deficiency in beef cattle. Infertility associated with copper deficiency may also be caused by excessive dietary molybdenum. Heifers receiving a diet with marginal copper levels and excess molybdenum exhibited delayed puberty, lower ovulation rates and lower conception rates. Zinc deficiency can adversely affect reproductive processes in females from estrus to parturition. Inadequate zinc levels in gestating cows may cause abortion, fetal mummification, lower birth weight or altered myometrial contractibility with prolonged labor. Impaired growth, delayed puberty and decreased appetite in zinc-deficient bull calves have been observed. Loss of appetite results in lowered mineral ingestion, further decreasing feed utilization due to hindered nutrient metabolism.

Do marginal deficiencies affect production? Determining subclinical or marginal mineral deficiencies can have an economic impact on beef cattle production. Trace mineral imbalances can be the result of many factors: dietary levels, water source, production demands, breed differences and mineral interactions. Subclinical trace mineral deficiencies in cattle may be a larger problem than an acute deficiency because specific clinical symptoms are not obvious enough to allow the producer to recognize a deficiency. Cattle with a subclinical status continue to reproduce or grow but at a reduced rate, have decreased feed efficiency, and a depressed immune system.

How do producers determine the mineral status of their beef herds? Evaluating serum trace mineral concentration has been a common practice to evaluate herd mineral status. However, not all copper circulating in the blood is available to the animal, and serum copper values can be affected by a number of factors, including dietary molybdenum and sulphate, infection, trauma and stage of gestation. In addition, serum copper levels were not well correlated to liver copper and are not considered a reliable indicator of copper status in cattle. Breed differences may also influence serum values because variations in plasma copper have been reported to have a heritable component. Differences in liver and serum concentrations of copper and zinc have been observed among breeds of cattle. Limousin had higher liver copper levels than nine other breeds, except Angus. In Saskatchewan, copper deficiency occurred more frequently in Simmental cattle compared to other breeds. Assessing zinc status in cattle is equally difficult because there is not a good indicator for determining marginal deficiencies. Given the complexity of determining mineral status in cattle due to interactions among minerals, variability of trace mineral levels in forage and bioavailability to the animal, dependence on a single variable of mineral status may result in an erroneous diagnosis.

Montana State University Research - A study was conducted at Montana State University to evaluate the influence of form of trace mineral supplementation (complexed vs. inorganic sulfate forms) in the presence of antagonistic minerals (molybdenum, sulfur and iron) on liver and serum mineral concentrations in beef heifers. Liver and serum samples were collected five times; presupplementation, calving, breeding, 150 days postsupplementation, and precalving the following year. At the start of the breeding season, liver copper concentrations were increased more for heifers consuming complexed (CX) and inorganic (IN) forms of copper, zinc, manganese, and cobalt compared to heifers receiving control supplement with no additional trace minerals. Heifers did not receive any trace mineral supplementation following the start of the breeding season. Postweaning liver copper levels (150 days without supplement), remained higher for CX than control, with IN having intermediate values. It appeared that both CX and IN supplements were able to increase liver copper storage following calving even in the presence of antagonistic minerals.

Liver zinc concentrations were similar among treatments initially, postweaning and precalving the following year. Liver values collected within 24 hours of calving were highest for CX fed heifers compared to those receiving IN or control. At the start of the breeding season, liver zinc levels remained higher for CX group than IN or control. The difference in hepatic zinc levels at calving and breeding may be a result of greater bioavailability of zinc methionine in the CX treatment compared to zinc sulfate in IN.

Serum mineral concentrations for copper and zinc did not differ among treatments at any collection period.

Summary - The difference observed in copper and zinc liver concentrations were not reflected by changes in serum copper or zinc levels and suggest that serum mineral values did not provide a good indication of changing mineral status in the animal. There were no correlations between serum and liver copper or zinc concentrations at any sampling time. Future work is necessary to determine effects of combining inorganic and organic forms of supplemental trace elements on animal production and mineral status. Better methods of accurately determining marginal deficiencies of trace elements is warranted. Our work indicated that copper levels in the liver remained at fairly high levels several months after supplementation ceased.