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UNIVERSITY OF HAWAII AT MĀNOA



Introduction to Mineral Supplementation for Beef Cattle

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The Importance of Minerals in the Beef Animal Diet

- Mineral Status in beef herd affects reproduction, growth, milk production and health
- All of these affect profitability
- Cost of improving mineral status is low compared to production returns
- Four Basic Considerations:
 1. Mineral deficiency is at least as common as protein and energy deficiencies.
 2. Mineral is offered “free-choice” and animals may not “choose” to consume adequate amounts – **monitoring consumption is important!**
 3. Genetics may affect mineral needs. (i.e. Selecting for increased milk production; Breed differences, etc.)
 4. Mineral deficiency symptoms may be the result of an imbalance. (i.e. sulfur, iron, and molybdenum are antagonistic to copper absorption in the rumen).



Minerals and Their Function in the Body

Macro Minerals (required in larger amounts)

Mineral	Most Significant Known Functions	Sources
Macro Minerals (required in larger amounts)		
Calcium	Bone & teeth formation, nerve & muscle function	Forages, legumes, mineral supplement
Phosphorus	Reproduction, health of bones and teeth	Grains, forages, mineral supplement
Magnesium	Growth, reproduction, metabolic functions	Forages, mineral supplement
Potassium	Metabolic functions	Forages, mineral supplement
Sulfur	Metabolic functions, amino acid formation in rumen	Forages, grains, and mineral supplement
Sodium/Chloride	Regulate pH, nervous and muscular system function	Mineral supplement



Minerals and Their Function in the Body

Micro Minerals (required in smaller amounts)

Mineral	Most Significant Known Functions	Sources
Micro Minerals (required in smaller amounts)		
Chromium	Immune Response, glucose tolerance factor	Forages, cereal grains, TMS
Cobalt	Component of Vitamin B12	Legumes, forages, TMS
Copper	Hemoglobin formation, tissue metabolism	Forages, grains, mineral supplement
Iodine	Production of thyroid hormones, energy metabolism	Forages, TMS
Manganese	Reproduction enzyme formation	Forages, mineral supplement
Molybdenum	Enzyme activity	Forages, mineral supplement
Selenium	Antioxidant, glutathione peroxidase	Grains, forages, mineral supplement
zinc	Enzyme activity	Legumes, forages, mineral supplement

Source: Nutrient Requirements of Beef Cattle. 2016. Washington, D.C. National Research Council.



Mineral Needs: Macro Mineral needs for growing/finishing animals (605 lbs. steer or heifer with an expected mature weight of 1,200 lbs., gaining 1.88 lb./day) and 1,200 lbs. cows in gestation and early lactation.

Mineral	Requirements			Maximum Tolerable Concentration
	Growing/Finishing	Cows (1,200 lbs)		
		Gestating	Early Lactation	
Calcium (%)	0.36	0.15	0.25	n/a
Magnesium (%)	0.10	0.12	0.20	0.40
Phosphorus (%)	0.19	0.12	0.17	n/a
Potassium (%)	0.60	0.6	0.70	3.00
Sodium (%)	0.06 – 0.08	0.06-0.08	0.10	n/a
Sulfur (%)	0.15	0.15	0.15	0.40

Source: Nutrient Requirements of Beef Cattle. 2016. Washington, D.C. National Research Council.



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Mineral	Requirements			Maximum Tolerable Concentration
	Growing/ Finishing	Cows (1,200 lbs)		
		Gestating	Early Lactation	
Chromium (mg/kg)				1,000.00
Cobalt (mg/kg)	0.10	0.10	0.10	10.00
Copper (mg/kg)	10.00	10.00	10.00	100.00
Iodine (mg/kg)	0.50	0.50	0.50	50.00
Iron (mg/kg)	50.00	50.00	50.00	1,000.00
Manganese (mg/kg)	20.00	40.00	40.00	1,000.00
Molybdenum (mg/kg)				5.00
Nickel (mg/kg)				50.00
Selenium (mg/kg)	0.10	0.10	0.10	2.00
Zinc (mg/kg)	30.00	30.00	30.00	500.00

Source:
Nutrient
Requirements
of Beef
Cattle. 2016.
Washington,
D.C. National
Research
Council.



Mineral Deficiencies

Calcium (Ca) –

- Deficiency in young, growing cattle prevents normal bone development resulting in rickets (deficiency in Ca, P, or Vitamin D).
 - Signs include: Swollen, tender joints, soft bones, enlargement of the ends of bones, arched back, stiffness in the legs.
 - Osteomalacia – demineralization of the bones (Ca and P in dynamic state, high demand as in during lactation, etc. can result in Osteomalacia.)

Phosphorus (P) –

- Phosphorus deficiency may be the most prevalent mineral deficiency in grazing livestock throughout the world.
 - Decreased growth and feed efficiency
 - Decreased appetite
 - Impaired reproduction
 - Decreased milk production
 - Weak fragile bones



Mineral Deficiencies

Magnesium (Mg) –

- Deficiency in calves results in excitability, anorexia, hyperemia, convulsions, frothing at the mouth, profuse salivation and calcification of soft tissue.
- Grass Tetany is characterized by low Mg concentrations in plasma cerebrospinal fluid.
 - nervousness,
 - decreased feed intake,
 - muscular twitching, lack of coordination and walk with a stiff gait.
 - In later stages cows go down with head back and convulse.
 - Death occurs without treatment with a Mg-salt solution.
- Grass Tetany typically occurs in older cows (more than three lactations) that lack the ability to mobilize Mg for bones when moving onto lush, early growth pastures or fed harvested forages low in Mg
- Fertilizing pastures with N and K has been associated with increased incidence of grass tetany (in fresh or fertilized pasture insufficient availability of Mg more likely than low Mg).



Mineral Deficiencies

Potassium (K) – A deficiency in K results in decreased feed intake and weight gain, pica (eating things of no nutritional value), rough hair coat, and muscular weakness.

Sodium (Na) – Deficiencies in Na are non-specific and include pica and decreased feed intake, growth, and milk production.

Sulfur (S) – Severe deficiencies result in anorexia, weight loss, weakness, dullness, emaciation, excessive salivation, and death.



Mineral Deficiencies

Copper (Cu) – Cooper deficiency is widespread in Hawaii and throughout the world.

Signs of Copper Deficiency

- Anemia
- Decreased growth
- Depigmentation and changes in the growth and appearance of hair (usually first clinical sign)
- Cardiac failure
- Fragile bones
- Diarrhea
- Low reproduction





Mineral Deficiencies

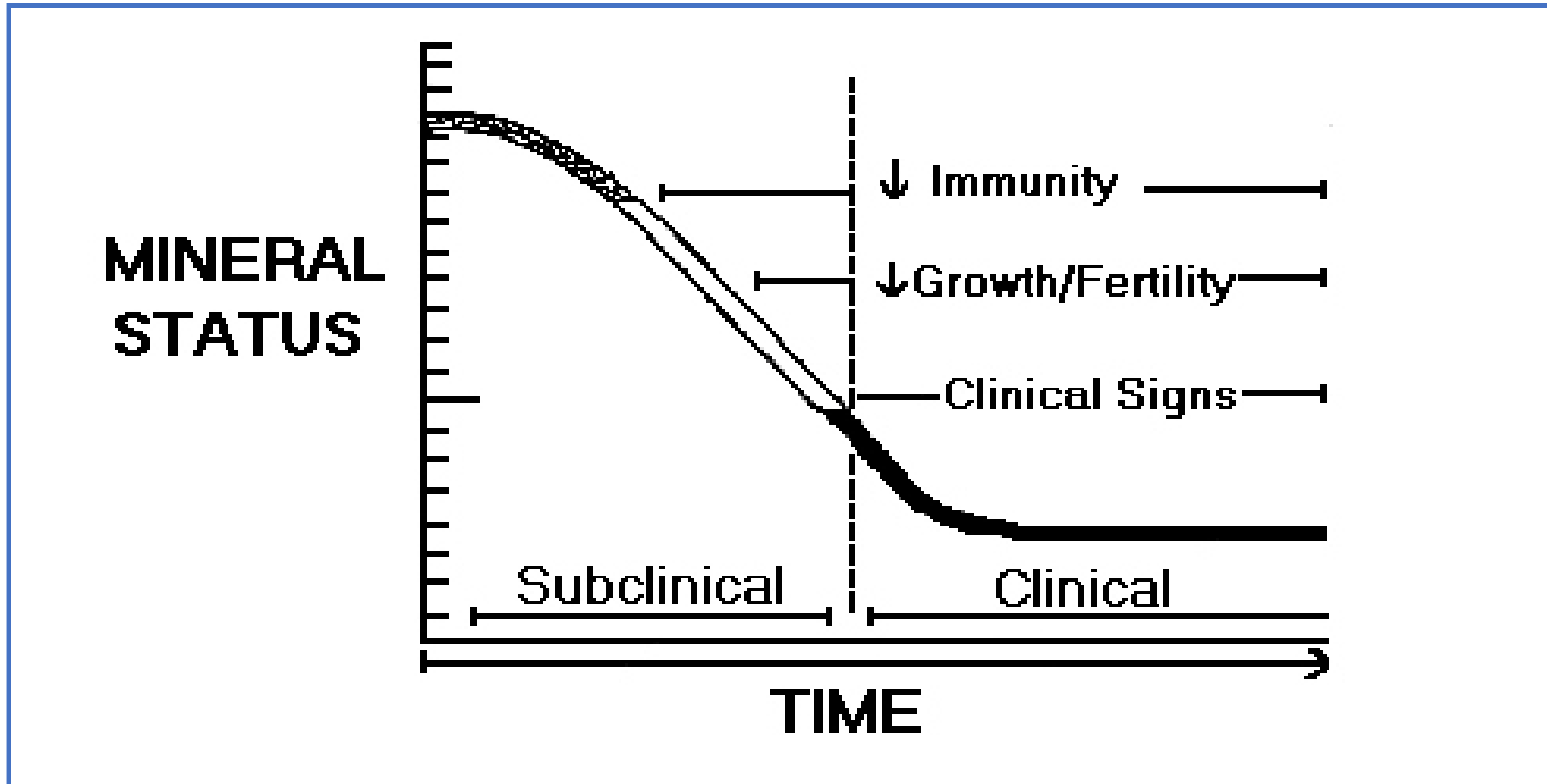
Copper deficiency is not always because of an insufficient amount of Cu in the forage. Iron, Molybdenum, and Sulfur are all antagonistic to Copper and interfere with its absorption and mode of action in the animal. Hawaii forages across the state can be high in both iron (Fe) and Molybdenum (Mo). Sulfur can be a problem where vog is an issue.

Copper Antagonist	Deficient	Ideal	Antagonistic Level**		MTC*
			Marginal	High	
Iron (ppm)	< 50	50-200	> 200 -400	> 400	1000
Molybdenum (ppm)		< 1	1-3	> 3	5
Sulfur (% DM)	< 0.10	0.15 – 0.20	> 0.20 – 0.30	> 0.30	0.40

*Maximum Tolerable Concentration
** Levels above these can potentially adversely affect copper availability.



EFFECTS OF MINERAL DEFICIENCIES ON IMMUNE FUNCTION IN COWS AND CALVES



Source: Wikse, 1992, TAMV Beef Cattle Short Course



Assessing Your Mineral Program/Herd Mineral Needs



1. Collect and analyze forage samples:

- Provides a complete nutritional profile of forage
- Will indicate the presence of deficiencies or imbalances
- Remember your analysis will only be as good as the sample
 - Collect multiple samples that include only what is being consumed
 - Sample at different times of the year and different locations as forage quality and mineral profile can change over the course of a year and across different soils, elevations, or precipitation zones



	Season	Sample Size	% DM	% CP	% Ca	% P	% Mg	% K	% Na	Fe ppm	Zn ppm	Cu ppm	Mn ppm	Mo ppm	% S	Ca:P	Cu:Mo
Oct. & Nov. 2011	Fall	n=9	23.0	15.3	0.3	0.4	0.3	3.0	0.1	458.0	48.3	8.9	144.7	0.3	0.2	0.9	69.6
			2.1	2.3	0.0	0.1	0.0	0.6	0.0	327.3	7.4	0.8	43.0	0.1	0.0	0.2	33.7
Dec. 2011 - Feb. 2012	Winter	n=9	24.1	20.4	0.4	0.4	0.3	2.3	0.1	492.7	38.4	11.2	127.6	0.9	0.2	1.1	13.4
			6.7	2.6	0.0	0.0	0.0	0.1	0.1	298.0	8.9	1.4	46.7	0.3	0.1	0.1	3.1
Mar. 2012 - May 2012	Spring	n=6	28.8	20.1	0.4	0.3	0.3	2.3	0.1	810.8	36.7	10.5	130.5	0.5	0.3	1.2	29.0
			1.7	1.7	0.0	0.0	0.0	0.5	0.0	855.3	11.5	1.9	83.9	0.3	0.0	0.1	20.6
Jun. 2012 - Aug. 2012	Summer	n=9	23.8	18.9	0.3	0.3	0.3	2.7	0.1	180.8	38.1	11.3	225.1	0.1	0.2	1.0	100.0
			5.2	1.1	0.0	0.0	0.0	0.4	0.1	49.3	5.9	1.3	63.0		0.0	0.2	39.4



Assessing Your Mineral Program/Herd Mineral Needs

2. Evaluate herd condition:

Look for signs of mineral deficiencies and or imbalances:

- rough, discolored hair coats (cows and calves slow to shed winter hair coats),
- decreased breeding efficiency (slow breeders, depressed heat cycles),
- bone and hoof problems
- depressed immune system function (less resistance to diseases and parasites).





Assessing Your Mineral Program/Herd Mineral Needs

- Evaluation of the herd:
- Key indicators = **GOLD**
 - calf **G**rowth
 - **O**pen cows
 - **L**ength of calving season
 - calf **D**eath loss
- If any of these indicators are **below industry standard** nutrition is not adequate – nutrient (protein and/or mineral) or energy supplementation may be necessary.





Assessing Your Mineral Program/Herd Mineral Needs

- 3. Evaluate mineral supplement label:** With the information from the forage analysis at hand, evaluate whether the mix of minerals and their concentrations are sufficient to make up for deficiencies or imbalances in the forage.
- 4. Monitor herd mineral consumption** – most mineral mixes are formulated to be consumed at 2 oz./head/day and are offered “free-choice”. However, this does not mean that the animals will choose to consume it appropriately.
- 5. Serum samples:** As a preliminary screen of the trace mineral status in animals, serum samples may be used. The reliability of serum analysis, to estimate the trace mineral status of animals, is limited for some elements such as copper.
- 6. Liver biopsy:** In herds where trace minerals appear to be deficient as indicated by herd history or blood levels, several animals can be selected for liver biopsy based upon their clinical signs, stage of production, reproductive history, pasture location, or previous blood work. A random assortment of animals should be chosen to represent the herd as an average.



Choosing a Mineral Program for Your Herd

1. Consider your Options:
 - Commercial mix
 - Custom mix
 - Individual Free-choice fed “cafeteria-style”
2. Important to have a firm knowledge of your herds mineral supplement needs
3. Consider the cost of supplementation in relation to the herds needs
4. Work with Cooperative Extension, Mineral Dealer, others with knowledge and experience





Table 1. Mineral supplementation components, feed rates, and associated costs for XIT Ranch with 450 head of breeding cows. Note the cost per cow differential between the Commercial Mineral Mix (\$34.66) vs. the sum of the individual free-choice minerals (\$16.69).

Product	Key Mineral Supp.	Percent of comm. Mineral Mix	Amount per animal/day (oz.) ¹	Annual per Cow (lbs)	Price per unit (50 lbs) ²	Price per lbs.	Price per Cow/yr (\$)	Total Ranch need (lbs) ³	Estimated Annual herd Cost (\$) ⁴
Commercial Mineral Mix	All	100	2	45.6	37.93	0.76	34.66	20,531	15,597
NaH ₂ PO ₄	P	0.05	0.1	2.28	116.00	2.32	5.29	1,027	2,380
MgSO ₄	Mg	0.02	0.04	0.91	24.50	0.49	0.46	411	207
CuSO ₄	Cu	0.003	0.006	0.137	152.00	3.04	0.42	62	189
Dolomite	Ca	0.155	0.31	7.07	40.50	0.81	5.73	3,182	2,578
TM Salt	All Trace		1	22.81	10.60	0.21	4.79	10,266	2,155

¹Recommended daily intake of commercial pre-mix mineral supplement is 2 oz. cow; estimated daily intake rate of individual supplements as a percent of supplement in the commercial Mineral Mix. Individual free-choice mineral shown totals 1.46 oz. per head per day, remaining consumption, 0.54 oz head per day is comprised of sodium (not shown) from TM salt.

²Most recent quoted amounts for locally available commercial mix and individual mineral components. Note that mineral prices regularly fluctuate.

³Based on 450 head of breeding cows.

⁴Based on 450 x mineral cost per cow per year.



Summary

- The mineral status of the beef herd affects reproduction, growth, milk production, and animal health.
- Not all herd health issues are mineral related. It is important to maintain quality forage to provide adequate protein and energy as well.
- Mineral deficiencies or imbalances are common in Hawaii and elsewhere
- It is important to evaluate the mineral status and needs of your herd and develop a mineral supplementation program that is right for your situation.
- There are several options when considering a mineral program, from pre-mixed commercial products, to custom mixes, to Individual mineral fed Cafeteria style.





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