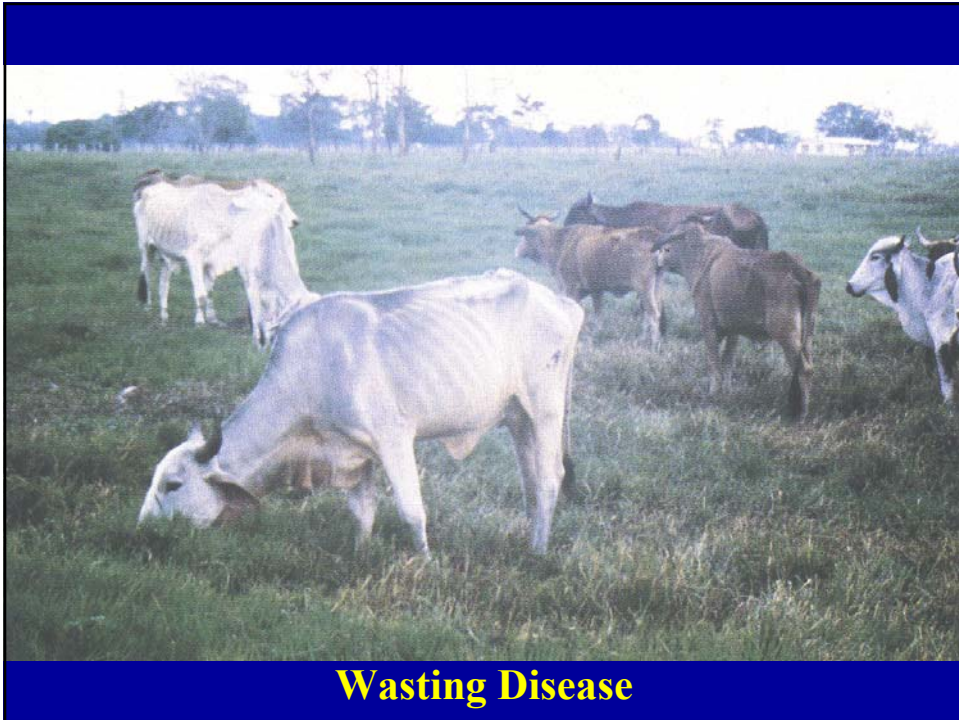




**SOIL-PLANT-ANIMAL
INTERRELATIONSHIPS IN
ANIMAL NUTRITION**

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Nutritionally Essential or Beneficial Trace Elements Affected by Fertilization

- Cobalt
- Copper
- Selenium
- Zinc
- Boron
- Nickel

Trace Elements in Animal Nutrition Not Relevant for Fertilization

- Iodine - Fertilization an inefficient mechanism for increasing intake
- Iron - Rarely a critical concern for domestic animals
- Manganese - Practical problem only for confined poultry
- Chromium, lithium, silicon, and vanadium - Require more research to establish nutritional importance for animals.

Selenium Deficiency in Ruminants

- **Calves and Lambs**
 - **White Muscle Disease**
 - **Stiff Lamb Disease**
- **Older Ruminants**
 - **Unthriftiness**
 - **Poor Reproductive Performance**
 - **Impaired Immunity**
 - **Placental Retention**

Selenium Deficiency in Monogastric Animals

- **Horses and Foals**
 - **White Muscle Disease**
- **Swine**
 - **Hepatitis Dietetica**
 - **White Muscle Disease**
 - **Mulberry Heart Disease**
- **Poultry**
 - **Exudative Diathesis**
 - **Exocrine Pancreatic Atrophy**

Selenium Toxicity Signs

- Grazing Animals
 - Alkali Disease: emaciation, hair loss, hoof sloughing and deformities, stiffness and lameness
- Swine
 - Impaired reproductive performance
 - Separation of hoof and skin at the coronary band
- Chickens
 - Decreased egg production and hatchability
 - Deformed chicks at hatching

USA-NRC Selenium Requirements (mg/kg diet)

- **Beef Cattle ----- 0.10**
- **Dairy Cattle ----- 0.30**
- **Sheep ----- 0.10-0.20**
- **Growing Pigs ----- 0.15-0.30**
- **Gestating and Lactating Sows -- 0.15**
- **Immature Laying Chickens ----- 0.10-0.15**
- **Laying Hens ----- 0.05-0.08**
- **Broiler Chicks ----- 0.15**

Occurrence of Selenium Deficiency

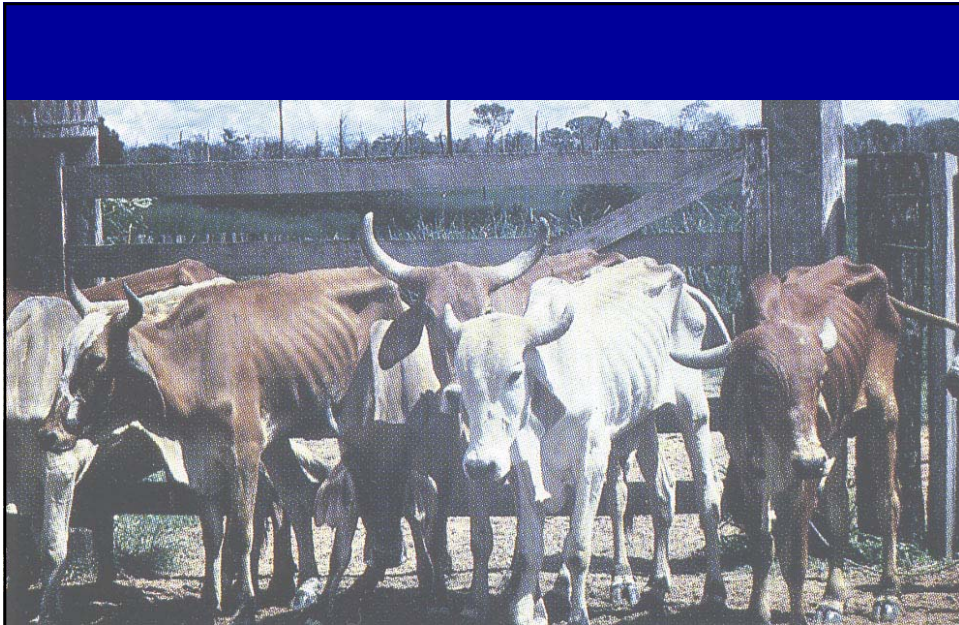
- **Mountainous countries of Northern Europe (Finland, Sweden, and Scotland)**
- **Pumice soil areas of New Zealand**
- **West of the Rocky Mountains in Canada and the United States**
- **Coastal areas of North America**
- **Large areas of Australia, China, India, Japan, and Venezuela**

Occurrence of Selenium Toxicity

- **Areas in States of Nebraska, South Dakota, Utah and Wyoming in the USA**
- **Areas in Australia, China, India, Ireland, and Israel**

Selenium Fertilization

- **Recommended 10 g Se/hectare**
- **Finland adds 6 mg Se/kg of fertilizer**
- **Most effective are slightly soluble forms (e.g., CuSeO_4 , BaSeO_4)**
- **Reduce selenium uptake by applying sulfur, gypsum, or superphosphate**



Cobalt Deficiency

Cobalt Deficiency

- **Severe - Muscular wasting, anemia and eventually death**
- **Mild - Impaired reproductive performance**
- **Ovine white liver disease in lambs resulting in anorexia, anemia, and unthriftiness**

USA-NRC Cobalt Requirements (mg/kg diet)

- **Beef Cattle ----- 0.10**
- **Dairy Cattle ----- 0.11**
- **Sheep ----- 0.10-0.20**

Occurrence of Cobalt Deficiency

- **Occurs in areas with**
 - **Coarse volcanic soils**
 - **Leached podsolized sands**
 - **Sandy loams derived from granites**
 - **Calcareous, wind-blown shell sands**
 - **Ironstone gravel**

Occurrence of Cobalt Deficiency (Enzootic Marasmus)

- **New Zealand - Bush Sickness**
- **Southern Australia - Coast Disease**
- **Western Australia - Wasting Disease**
- **Florida, USA - Salt Sickness**
- **Michigan, USA - Grand Traverse Disease**
- **Kenya - Nakuruitis**
- **Great Britain - Pining**
- **Netherlands & Germany - Lecksucht**

Cobalt Fertilization

- **A single application of 1.5 kg of cobalt sulfate per hectare every 3 to 4 years has been found effective.**
- **Cobalt fertilization is unreliable on soils that are highly alkaline, heavily limed, or high in manganese**

Copper Deficiency in Ruminants

- **Anemia**
- **Severe diarrhea**
- **Depressed growth**
- **Infertility**
- **Heart failure**
- **Neonatal Ataxia**
- **Hair depigmentation**
- **Defective wool keratinization**
- **Bone and connective tissue disorders**



Copper Deficiency

USA-NRC Copper Requirements (mg/kg diet)

- **Beef cattle -----10**
- **Lactating dairy cattle -----9-11**
- **Dry (pregnant) dairy cattle -- 12-18**
- **Sheep (<1 mg Mo/kg diet) ---- 7-11**

- **Sheep and Cattle fed more than 2 mg Mo/kg diet - suggested intakes range from 17 to 30 mg/kg diet**

Occurrence of Copper Deficiency

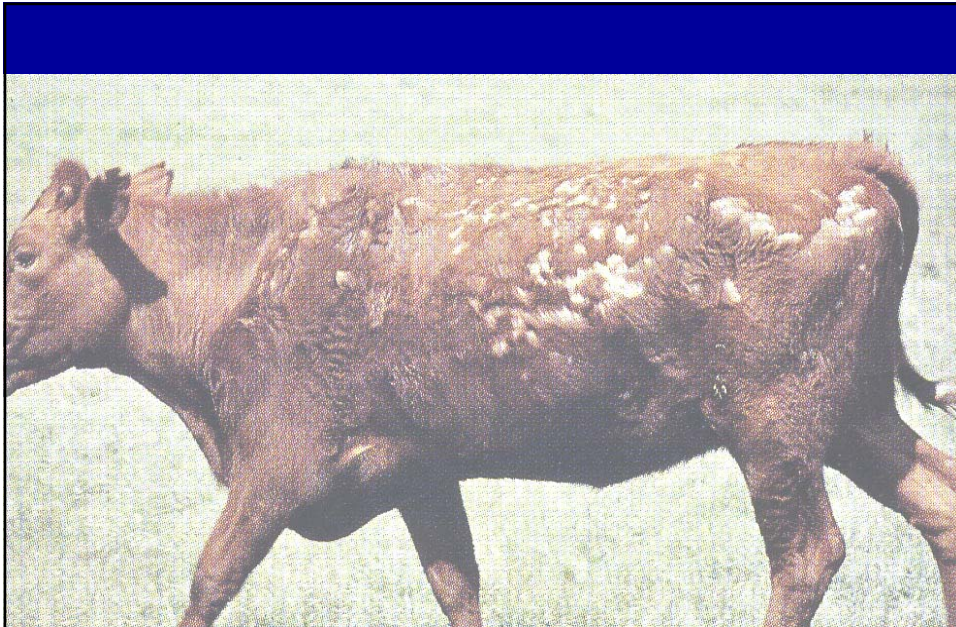
- **Areas where soils and herbage are low in copper (e.g., western Australia)**
- **Areas where soils are high in organic matter**
- **Areas where soils and thus herbage are high in molybdenum**
 - Peat soils in New Zealand and southern Australia
 - Alluvial plains of Argentina
 - Lower lias clay and marine shales of England and northeastern Manitoba, Canada
 - Gray soils of northeastern Saskatchewan, Canada
 - Humic peat soils of Europe

Copper Fertilization

- **A single application of 5-7 kg copper sulfate per hectare has been found suitable for raising herbage copper for 3-4 years.**
- **Fertilizers not very useful for soils with high organic matter because of formation of unavailable humic acid-copper complexes**

Zinc Deficiency in Ruminants

- Loss of appetite
- Excessive salivation
- Parakeratosis
- Loss of crimp in wool fibers
- Bowing of hind limbs
- Stiffness of joints and swelling of hocks
- Hypogonadism
- Impaired immune response
- Impaired wound healing



Zinc Deficiency

Zinc Deficiency in Monogastric Animals

- Swine
 - Loss of Appetite
 - Parakeratosis
 - Reduced litter size
- Chickens
 - Severe dermatitis and poor feathering
 - Thickened and shortened long bones
 - Reduced hatchability of eggs
 - Abnormal embryo development

USA-NRC Zinc Requirements (mg/kg diet)

- Beef cattle ----- 30
- Lactating dairy cattle ----- 43-55
- Dry dairy cattle ----- 21-30
- Sheep----- 20-33
- Growing pigs ----- 50-100
- Gestating and lactating pigs ----- 50
- Immature laying chickens ----- 33-38
- Laying hens ----- 29-44
- Broiler chicks ----- 40

Occurrence of Zinc Deficiency

- Nearly one-half of the soils in the world are considered zinc-deficient
- Areas of world where increased zinc intake has helped grazing animals include southern and western Australia, Guyana, and United States (Idaho)

Zinc Fertilization

- Application of 5-7 kg zinc sulfate per hectare, or an equivalent as zinc ores, every 2-3 years to soil will increase zinc in forages and grains

Boron and Nickel Nutrition

- **Beneficial Effects of Boron**
 - Bone health
 - Conception
 - Immune function or inflammatory process
- **Beneficial Effects of Nickel**
 - Alleviates “bush sickness” (cobalt deficiency)
 - Reproductive performance

Boron and Nickel Requirements

- It may be prudent to formulate livestock diets to contain at least **5 mg boron and 0.2 mg nickel/kg.**

Occurrence of Boron and Nickel Deficiencies

- **Boron deficiency in the field has been reported for at least 132 crops in 80 countries.**
- Nickel deficiency found in plants in the state of Georgia in the United States.



Figure 1. Boron deficient areas. Areas identified on the basis of crop responses to boron and by soil B analysis. Solid lines indicate that boundaries have a firmer basis.

Boron Fertilization

- **Application of 1 - 2 kg of boron per hectare is recommended for the season-long elevation of boron status of annual crops.**

Conclusion

- **Using fertilizers to improve the trace element nutritional value of plants may be a practical means of increasing animal productivity**
- **Trace element intakes that can be improved by fertilization include selenium, cobalt, copper, zinc, boron, and possibly nickel.**