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Importance of Trace Elements in Cattle

Slow-growing and low producing animals will not require the same amounts of minerals as high producers. Often farmers are unaware of the existence of mineral requirements and it is not easy nor is it always possible to diagnose a deficiency or toxicity of any particular mineral. Improved live weight gains or increased milk production in apparently healthy animals often have demonstrated when their feeds were supplemented with minerals. These responses occurred when no evidence of a deficiency existed but, judging by the beneficial effect of mineral supplementation, there must have been a subclinical deficiency.

Quantifying trace mineral requirements is difficult because assessment of body stores concentrations can be challenging, effects on health and reproduction require large number of animals to be properly evaluated, and because requirements can be affected by factors such as stress and environment. Moreover, availability coefficients for trace minerals that are used to calculate recommendations are usually small, and multiple interactions among minerals and dietary ingredients can affect them, increasing the risk of under or overfeeding trace minerals. In addition, chemical (i.e. organic, inorganic) and physical (i.e. particle size) form of the mineral can also affect availability.

Minerals are needed to form skeletal structures, for digestion and in metabolic processes within the body. The nutrient requirement of cattle can be broken down into four principal components, maintenance, lactation, growth and reproduction. From these components requirements for energy protein, mineral and vitamins are calculated. By understanding the different factors that affect requirements, producers can make adjustments to change such as a month of cold weather, moving to a hilly pasture or the last third of pregnancy. Cattle use the nutrients for their bodily processes in the following order:

- Maintenance (keep alive and moving)
- Lactation (producing milk)
- Growth (weight gain)
- Reproduction.

The list is presented in the order in which the body utilizes its own nutrients. For example an animal will ensure it can maintain its current condition before growing or becoming reproductively active.

Twenty-one minerals are considered to be nutritionally essential to cattle. Depending on the quantities required by the animal they can be grouped into major and trace/micro elements. The most important major minerals are:

- Calcium
- Phosphorus
- Sodium
- Chlorine
- Potassium
- Sulphur
- Magnesium.

The most important trace or micro minerals are:

- Copper
- Cobalt
- Iron
- Iodine
- Zinc

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- Manganese
- Selenium.

Excesses of minerals may be harmful and cause lowered production or even death. In general deficiencies are a large issues on roughage based diets. Mineral deficiencies and in some cases imbalances cause metabolic disturbances and can produce specific deficiency diseases. Fertility and hence calving percentage can be affected. Milk production is obviously dependent on the health and the well-being of the dairy cow and any metabolic disturbance will affect milk yield.
We will now look in more detail at the different trace minerals and how they are important to the animal.

Copper (Cu) is a component of enzymes involved in electron transport, protection from oxidative stress, iron absorption and transport, and synthesis of bone and connective tissue and melanin. Signs of Cu deficiency include loss of hair pigmentation, diarrhea, anemia, reduced immune function, and fertility problems. Copper is the trace mineral with the highest risk of toxicosis if over-supplemented; signs of toxicity include hemolysis, jaundice, generalized icterus, and death.

Cobalt (Co) is a component of vitamin B_{12}, which is involved in propionate metabolism and methionine synthesis. When Co supply is not limiting, ruminal microorganisms can synthetize all vitamin B_{12} required by the dairy cow. Cobalt deficiency will decrease vitamin B_{12} production within days. However, vitamin B_{12} hepatic reserves can last for months in the adult cow. Signs of Co deficiency are those of vitamin B_{12} deficiency and include fatty liver, reduced resistance to infections, weight loss, and failure to grow. Calves are more susceptible to Co deficiency compared with adult cows because liver storage of vitamin B_{12} is limited. Signs of toxicity include reduced feed intake, body weight loss, and anemia.

Iron (Fe) is a component of the heme group of hemoglobin and myoglobin proteins. It also serves as cofactor of electron transport chain enzymes and others involved in immune function. Iron deficiency is extremely rare; Fe is a ubiquitous element that is usually found in excess in most diets. Signs of toxicity include diarrhea, reduced DMI and weight gain, and alterations in immune function.

Iodine (I) is a component of the thyroid hormones, involved in energy metabolism regulation. Signs of deficiency include goiter in newborn calves and adults, hairless, weak, or dead calves, and abortions, reduced fertility, and extended gestations in adult cows. Signs of toxicity include dry coats and increased salivation and ocular and nasal discharge.

Selenium (Se) is a component of the enzyme glutathione peroxidase, central to the antioxidant system. The most classical signs of deficiency is white muscle disease. Supplementation of Se decreases the prevalence of retained placenta, metritis, and cystic ovaries, as well as the prevalence and severity of mastitis and udder edema. Signs of toxicity include blind staggers, sloughing of hooves, lameness, loss of hair, and emaciation.

Manganese (Mn) is a component of superoxide dismutase, an enzyme involved in the cellular antioxidant defense system, and is primarily found in mitochondria and bone. Signs of deficiency include impaired growth, skeletal abnormalities, ataxia in newborns, silent heats, and lower conception rates. Toxicity is rare; signs include reduce intake and growth.

Zinc (Zn) is a component of metalloenzymes involved in carbohydrate, lipid, protein, and nucleic acid metabolism. Signs of deficiency include weak hoof horns, increased incidence and severity of mastitis,

and parakeratosis. High dietary Zn levels can decrease Cu absorption, and therefore, a sign of Zn toxicosis is anemia, which is related to Cu deficiency; other signs of Zn toxicosis include reductions in immune function.

In a grass based diet the composition of the soil, grass yield and plant diversity will influence the availability of nutrients. Soil composition and pH will influence the availability of micro minerals for the plants and therefore also for the animals who are eating these plants. High yielding grasses will dilute the mineral content and have a less divers micro mineral composition compared to pastures with different plant species. Last the weather conditions can have a big impact on the nutritional value and micro nutrient composition of the plants.

In a grass based system and cows on pasture, it can be challenging to provide good access to reliable sources of trace elements. There are 5 common methods of supplementing cattle with vitamins and minerals: Individual mineral sources, offered free access, a mixture of minerals as a lick, a supplement with minerals mixed with concentrates, liquid mixture of minerals fed to an animal individually and slow releasing bolus. Drenches do provide this option, but have to be repeated frequently as they usually do not last longer than a few weeks.

Liquid supplementation:
An estimate is made of the average production that can be expected from roughages alone. A mineral mix is made up to balance the deficiencies in the roughages and this is fed to the individual cows in measured or weighed amounts. The advantages of this system are that the stockman knows that each cow gets her requirements and is not dependent on her appetite for minerals or on her rank in the pecking order. Furthermore, cows getting little or no concentrate will still receive minerals and cows getting a lot of concentrate need not to be overfed minerals. The mineral content of the concentrate can thus be adjusted for production needs and no attempts need to be made to make up roughage deficiencies.

Specific micro minerals deficiencies can be individually catered for by liquid supplementation or by slow-release bolus. Oral dosing or liquid supplementation of animals with mineral solutions or paste of the required minerals has the advantage that all animals receive known amounts of the required mineral at known intervals. This type of treatment could prove unsatisfactory where labor costs are high and the animals must be handled frequently, specifically for treatment however the benefits could outweigh this.