Mineral Nutrition for Beef Cattle

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Introduction

Nutritional needs of cattle can be broken down simply in to three sections:

1. Energy and protein
2. Water
3. Minerals and vitamins

Water, energy and protein are essential for survival and performance and make up the biggest proportion of the ration. Minerals and vitamins are required in relatively small amounts. These are vital components that allow chemical reactions in the body to take place. Each has a different function within the body, such as catalysts which drive metabolic processes or components of cell division for growth. Therefore, they are a necessary part of the ration and are important for good growth, fertility, health and immunity.

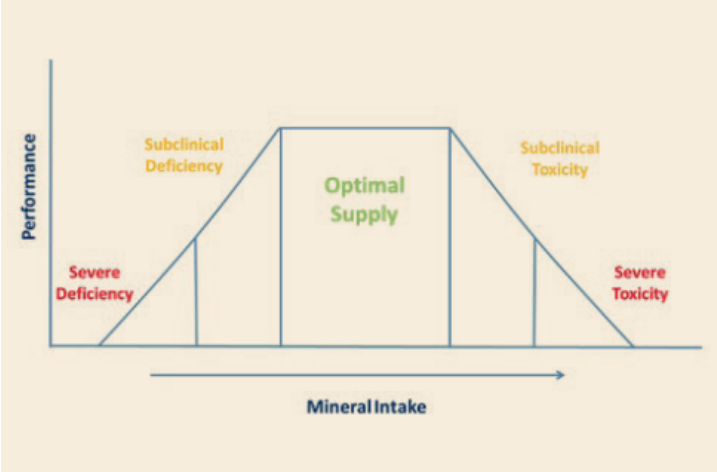
The largest variable in cattle rations, (excluding intensive barley beef rations), is the proportion of forage to concentrate. It is important to get the basal ration right and then complement this with the most appropriate mineral supplement. Cattle performance, whether it is growth or reproduction, can be compromised if the correct mineral nutrition is not in place.

Balancing requirement and supply

Requirement for minerals will depend on the stage of production of the animal i.e. the requirements for maintenance, will be different for a high producing animal (e.g. growing steer or lactating suckler), or pregnant cow. Other factors to consider are the environment (housing, climate, stress) the animal is in.

Most minerals need to be supplied daily e.g. magnesium in cows, however others are stored in the body allowing the animal to build up reserves e.g. copper is stored in the liver and vitamin B12 is made in the rumen by the microbes using cobalt supplied in the ration. Some deficiencies or toxicities are sub-clinical e.g. poor performance that you can't see by eye or clinical e.g. grass staggers or rickets.

Figure 1: Mineral nutrition is a balance and there is an optimal range.



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Macrominerals and microminerals

Minerals can be categorised into Macrominerals and Microminerals. Macrominerals are those that are required in grams (g) per day and microminerals (trace elements) are required in smaller amounts, milligrams (mg) per day. Vitamins are also required in smaller amounts and are measured in international units (iu).

Macrominerals

The main macrominerals required by cattle are:

Potassium – required for osmoregulation and the regulation of the acid-base balance within the body. Nutritional problems tend to involve excesses rather than deficiencies, particularly in ruminants whose natural diet generally provides a surplus of potassium. Forages are typically high in potassium and grains are low.

Phosphorus – needed for normal oestrus cycles, milk production and energy metabolism. Required for growing cattle for normal skeletal development. The phosphorus content of forages is related to the protein content and protein supplements are typically high in phosphorus.

Magnesium – required for activation of enzymes. Low magnesium is most commonly associated with 'grass staggers' but sub-clinically low levels can affect calcium absorption in cows too and lead to metabolic disorders such as slow calving and milk fever.

Calcium – most abundant mineral in the body stored in the bones. Needed for milk production and for normal skeletal development in growing cattle. Generally forages are good in calcium, grains are poor.

Sodium – essential for transporting nutrients around the body. It is generally considered in conjunction with chloride due to their related metabolism and functions. Sodium is important in water regulation as well as amino acid and glucose uptake. Forages are generally poor sources of sodium.

Microminerals

These are known as trace elements and required in smaller amounts and below are the main trace elements required in beef cattle:

Copper – important for carrying oxygen in the blood along with iron and is an essential part of many enzyme pathways, as well as development and maintenance of blood vessels. Essential for fertility, ovulation and growth. Absorption in calves (pre-ruminant) is around 50% whereas this drops to around 1-5% in mature cattle. Copper is stored in the liver which contains more than 70% of the total body copper.

Zinc - an enzyme activator with an essential role in the immune system and is largely involved in the synthesis and metabolism of proteins and carbohydrates. Zinc has many roles and is essential for skin, hair and hoof health.

Selenium - an antioxidant with related functions to vitamin E in the immune system. It is involved in the activation of thyroid hormones with iodine, vital element in the production of essential amino acids, stimulating immunoglobulin producing cells and transporting blood to tissues. Soil and pasture selenium levels are well correlated with levels in animals and pasture and forages are normally low in selenium.

Iodine – role is to make two hormones: triiodothyronine (T3) and tetraiodthyronine (T4, thyroxine) produced in the thyroid gland. These thyroid hormones are involved with thermoregulation, circulation, foetus development, immune function, reproduction, digestion and muscle function. Iodine has a very high absorption rate of around 70-80% from the rumen. Brassica crops have thiocyanate goitrogens which prevent the uptake of iodine by the thyroid and need additional supplementation.

Cobalt – ruminants require daily intake of cobalt for the rumen microbes to make vitamin B12.

Manganese – involved in enzyme activation, functioning of the brain and nervous system, connective tissue formation and growth and bone development.

The base ration that animals are on will determine how likely they are to be short of minerals. For example, a good grass silage ration, compared to a straw based ration will need to be supplemented differently due the difference in the nutritive value in the basal forage. The more variety of feeds in the base ration, the better the mineral and trace element supply will be.

Table 1: Critical dietary requirements plus EU legal maximums for beef cattle.

Nutrient	Beef Growing/ Finishing	Beef cow Gestation	Beef Cow Early Lactation	Max Tolerable Level (g/kgDM)	
	g/kgDM*				
Phosphorus P	1.8-2.3	0.8-2.2	2.6-2.8	10	
Potassium K	6-8	6	7-10	20	
Magnesium Mg	1.0	1.2	2.0	4	
Calcium Ca	2.8-4.3	2.1-3.6	2.9-3.3	20	
Sodium Na	0.6-0.8	0.6-0.8	1.0	35.4	
mg/kgDM*				**EU max. legal limit**	
				mg/kg DM	**mg/kg @88%DM**
Copper Cu	10	10	10	34	30
Zinc Zn	30	30	30	136	120
Selenium Se	0.1	0.1	0.1		
Iodine I	0.5	0.5	0.5	11	10
Cobalt Co	0.15	0.15	0.15	1.14	1
Manganese Mn	20	40	40	174.5	150

*per kg of dry matter that the animal is consuming. Please note these are critical requirements and are based on the minimum level to overcome deficiency. Antagonists are not accounted for and a safety factor should be included appropriate to the ration being fed.

A trusted nutritionist can help you work out mineral nutrition requirements using a forage analysis and rationing software.

Vitamins

Vitamin A – involved in eye function and growth, reproduction and immune response.

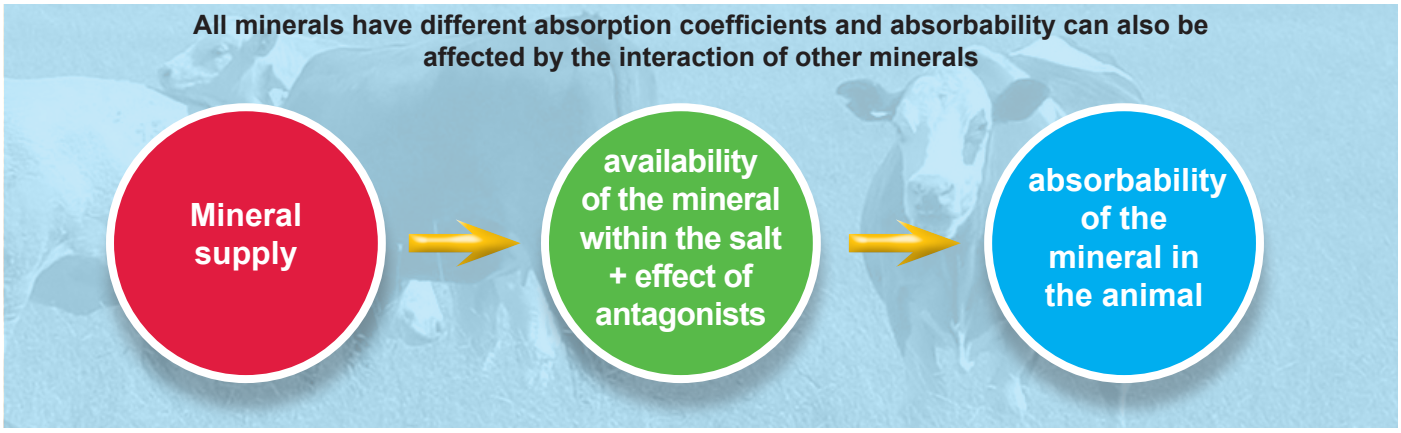
Vitamin D – involved in absorption of calcium and phosphorus.

Vitamin E – functions as a biological antioxidant, protecting cells against oxidative damage.

In ruminants, all the vitamins in the 'B' complex (vitamin B1, B2, B6, B12) are synthesised by microbial action in the rumen and generally will provide adequate amounts. Under certain conditions deficiencies of thiamin (B1) and cyanocobalamin (B12) can occur in younger animals. B1 deficiency, causing cerebrocortical necrosis (CCN), occurs when rumen conditions produce compounds which destroy the vitamin. Cobalt is required to make vitamin B12 and deficiency occurs when dietary levels of cobalt are low. If cobalt levels are adequate, then except with very young ruminant animals, a dietary source of vitamin B12 is not required.

Table 2: Vitamin requirements of beef cattle

Vitamin (iu/kg DMI)	Growing/Finishing	Pregnant	Lactating
A	2200	2800	3900
D	275	275	275
E	35	35	35



Selecting mineral supplements for cattle

It can be a daunting thought choosing minerals for your stock and we can often be swayed by good marketing. It is best to understand what the requirement of the stock is and the supply from the base ration. There is always going to be a grey area and weighing up the cost of adding minerals versus the potential cost of lower production by not adding minerals. It is always more costly to underfeed.

Step by step guide below:

1. Ensure that the main nutrients of the animal's diet (energy, protein and water) are being met. No mineral supplement will make up for shortfalls or excesses in this area.
2. Once the ration has been formulated look at the mineral supply from the ration and where it may be short: for example a suckler cow on a straw based ration will likely be more deficient in major minerals and trace elements than cows on a grass silage based ration and likewise growing cattle on a mixed ration will need a different mineral to finishing cattle on a cereal based ration.
3. Take a holistic approach to mineral supply – look at the soil and forages. High antagonistic levels in the soil may affect uptake of elements by the plant and therefore supply to the animal. Carry out a forage mineral analysis on batches of silage at least every three years to assess shortfalls or excesses. Too much of some elements can have an antagonistic effect e.g. molybdenum and sulphur on copper absorption and high potassium affecting the absorption of magnesium.
4. Find out what the current mineral status of the cattle is; is there are clinical issue or a suspected issue with minerals or trace elements? Blood analysis or a liver biopsy for copper and cobalt, is worth considering as evidence for a particular issue. This is especially important before making decisions about bolusing cattle or additional supplementation due to antagonists in forage.

Taking care not to over supply

Consider all sources that the cattle are receiving including from background feed. Not only is oversupply of mineral supplements wasteful financially it can also be detrimental to animal health – more doesn't mean better. It also has an impact to the environment with excessive elements being excreted. Use the facts to make informed decisions on supplementation.

Methods of supplementation

Method	Pros	Cons
In feed powdered mineral mixed in or top dressed on ration	- All cattle get their share/intakes are guaranteed - Cost effective	- Requires to be top dressed or mixed in to feed so not suitable in outdoor or remote feeding systems
Free access powdered mineral not mixed in to feed	- Cost effective - Allows mineral provisions at grass and to remote areas - No carrier feed required	- Relying on cattle taking supplement - No guaranteed intakes - Cattle may not take enough or take excess - Can be wasteful - Can be affected by weather - Need topping up regularly
Molassed mineral bucket/tub	- Allows mineral provisions at grass and to remote areas - Convenient - No carrier feed required - Molasses encourages intakes - Some can provide additional energy or protein if required	- Relying on cattle taking supplement - No guaranteed intakes - Cattle may not take enough or take excess - Expensive (plastic bucket, process of making them) - Cost to dispose of plastic
Molassed mineralised feed block	- Allows mineral provisions at grass and to remote areas - Convenient - No carrier feed required - Molasses encourages intakes - Some can provide additional energy or protein if required	- Relying on cattle taking supplement - No guaranteed intakes - Cattle may not take enough or take excess - Expensive (however, less plastic than a bucket for disposal)
Bolus	- Great for addressing known trace element deficiencies - Long acting for specific trace elements	- Selective trace element supplementation only - Can contribute to excesses if another supplement is to be fed to supply macrominerals - Expensive - Needs handling of cattle to insert into rumen via the mouth - Some may be regurgitated
Drenching of trace elements	- Provides a top up of essential trace - elements at key times of stress or increased need (for calving and subsequent fertility) - Fast acting treatment to correct animal with known deficiency	- Labour intensive for handling cattle - Does not provide macrominerals - Length of time product works for/remains in animal's system is often unknown
Injection of trace elements	- Can target specific animals for treatment for clinical deficiency - Elements go direct into blood stream and availability not affected by antagonists in forage	- Can only be done under veterinary guidance - Labour intensive and requires animal handling - Cost