Dairy Cow Mineral Basics

Minerals can be divided into macro (large amounts) or trace (small amounts) minerals depending on the quantity required by the animal. Even small imbalances or deficiencies can develop into reproductive, health or milk production problems. As production per cow continues to improve, it is more critical to ensure the mineral demands are adequately met through the diet. While shortages in macro minerals like calcium and magnesium are more commonly seen as typical milk fever and grass staggers, the classic trace mineral deficiency symptoms are not that obvious and are more likely to manifest as lower growth rates, reduced reproductive performance and lower milk production.

There are 7 macro minerals classified as essential nutrients for dairy cows. These are calcium, phosphorous, magnesium, potassium, sulphur, sodium and chlorine (salt).

There are 5 trace minerals that have been identified as lacking in New Zealand. They are copper, zinc, iodine, selenium, and cobalt.

Under typical New Zealand grass-based systems, pasture is obviously the predominant feed in the cow diet. Both the mineral content of the pasture and the bioavailability of the minerals are therefore critical to the meeting the cow requirement. There is a considerable range in the mineral content and bioavailability in pastures in NZ and can vary depending on soil type and the season.

This makes it almost impossible to make specific recommendations and without correct supplementation a shortage can easily result. The effects of mineral shortages are discussed below, but any deficiency will result in a loss of profitability through lower milk production, poorer growth rates, reduced immunity or lower reproductive performance. It is simply false economy to try and cut corners and costs by “saving” on mineral supplementation.

Dusting minerals has been popular in the past but is very inefficient as mineral intakes can vary to such a degree that double to triple the amount is often recommended to be dusted. This means the mineral intakes can fluctuate widely. It can also reduce pasture palatability and dry matter intakes. Supplementing minerals via the drinking water is also less than ideal due to the strong possibility of “contaminating” the water and reducing palatability and intakes as well as a range of mineral interactions that can occur. Water intakes can vary during hot and cold weather and also be influenced by dry matter content of the feed or any other water source. These application systems depend on the cow intakes, which can be low and variable around calving time, just when adequate mineral intake is most critical. A much better approach is to ensure the correct daily intake of the minerals by feeding each cow the required amount of minerals in a palatable carrier like molasses. Conedose has been developed to feed each cow the correct amount of minerals every day without any wastage or dustiness in the shed.

Typical mineral content values in NZ pastures compared to the NRC recommended mineral content of lactating cow diets are shown in the table below. The higher the production the higher the level of minerals required in the diet. Some of the ranges can be considerable with a mineral being deficient at the lower end of the range while surplus at the higher end of the range for example pastures with 4 grams calcium/kg DM will be deficient while 10 grams per kg DM will be sufficient.

	Pasture	Requirements
Macro Minerals	g/kg DM	
Calcium	4-10	5-6.5
Phosphorous	3.5-4.5	3.5-4
Magnesium	2-2.7	2-2.5
Potassium	15-45	9-10
Sodium	0.3-6	1.8
Chlorine	1-15	2.5
Sulphur	1-6	2
Trace Minerals	mg/kg DM	
Copper	3-15	10
Iodine	0.1-1.5	0.6
Cobalt	0.04-0.3	0.1
Zinc	2-80	40
Selenium	0-0.1	0.3

MACRO MINERALS

Calcium - Ca

Function
Calcium is the most abundant mineral in the body and an important mineral excreted in milk. Lactating cows have a high demand for calcium with milk fever being a classic symptom of calcium deficiency.

Availability
Calcium content in NZ pastures shows a great variation between seasons. The level of calcium in pastures is lowest during winter and early spring just when cow demand typically increases with calving and peak milk production. Supplementing calcium to fresh cows in spring is essential. Pastures calcium content may be marginal for high producing cows throughout the whole season.

Symptoms
Feeding a diet low in calcium over a long period can result in depletion of calcium reserves in bones, resulting in fragile easily fractured bones and lower milk production.

Supplementation
Supplementing calcium using lime flour is cheap and highly recommended, especially during spring and early lactation. Dusting is often used but it is less efficient and less reliable than feeding lime via the shed through a Conedose system.

Phosphorous - P

Function
The majority of phosphorous is found in the skeleton, but it is a key mineral in energy metabolism and essential for buffering the blood, saliva and other body fluids. It is essential for in nearly every biochemical aspect of metabolism. It is necessary for sound bones and teeth and a vital ingredient of proteins and phospholipids. Milk contains high levels of phosphorous at about 10g/kg MS which is continually excreted in the milk, even if the cow has low levels of phosphorous.

Availability
Phosphorous in NZ pasture is usually adequate unless milk production is high. Increasing use of fodder beet in lactating cow diets can create an increased demand for supplemental phosphorous. Cows wintered on fodder beet are likely to develop shortages and should always be supplemented. Adequate Vitamin D is required for the efficient use of phosphorous.

Symptoms
Cows deficient in phosphorous may have reduced intakes, slower growth, decreased milk production, lower reproduction, lethargy and a lack of thriftiness. Chronic cases may become stiff in the joints and show anoestrus and low conception rates. In severe cases on fodder beet cows can be seen knuckling over. Cows may develop milk fever around calving time and respond poorly to treatment. Not all cases show a depraved appetite. Blood plasma levels can indicate subnormal levels. Clinical signs are similar to cobalt deficiency.

Supplementation
Mono calcium phosphate (MCP) and di-calcium phosphate (DCP) are the most common sources of supplementation. Liquid forms are also appearing on the market. Phosphates can be fed in a salt lick to dry cows or as a slurry over dry cow silage. For lactating cows it can be added to the in shed blend or fed via the Conedose system.

Magnesium - Mg

Function
Magnesium is important in skeletal development and is an important constituent of bones. It is also important in neuromuscular transmission and in many enzyme activities. Magnesium is also required for the production of hormones which are important in the mobilisation of calcium from the bones to help prevent milk fever. Magnesium stored in bones is mobilised very slowly during times of deficiency and cows are more dependent on their daily supply.

Availability
Typical levels of magnesium in NZ pasture is at best only adequate, but is lowest in early spring when cows have the highest demand. Cool weather, lush pastures and high potassium levels can increase the likelihood of magnesium deficiencies occurring.

Symptoms
Classic symptoms of magnesium shortages are increased nervousness, unusual alertness, staring eyes with head held high. In severe cases this can be followed by staggering (grass staggers) and tetany.

Supplementation
Supplementing magnesium through spring which coincides with calving is standard practice. This is typically applied by dusting pastures with magnesium oxide which can be inaccurate and wasteful. It is also supplemented with magnesium sulphate or chloride in the drinking water. It can also be fed as an additive in the shed or with molasses via the Conedose system.

Potassium - K

Function
Potassium is the third most abundant mineral element in animal tissues. It is essential for enzyme, muscle and nerve function. It is also important in maintaining osmotic pressure and acid-base balance.

Availability
NZ pastures usually contain more potassium than required. Lush growing pastures, especially during cool periods, can contain excessive amounts of potassium.

Symptoms
High levels of potassium can interfere with magnesium metabolism and result in grass staggers. This can be particularly troublesome in springing cows and the reason why effluent paddocks (which are high in potassium) should be avoided during late pregnancy. By reducing the amount of magnesium available to help mobilise the calcium from the bones, high levels potassium can indirectly increase milk fever in lactating cows.

Supplementation
Highly unlikely to be deficient in pasture based systems. Sometimes supplemented in very hot areas to help deal with heat stress but not usually supplemented in NZ.

Salt - Sodium and Chlorine – Na and Cl

Function
Sodium and chlorine are the components of salt and discussed as salt. (If the sodium requirements are met it is likely chlorine requirements will also be met) Sodium is important in maintaining body fluid balance, osmotic pressure regulation and acid-base balance.

Availability
Plants can be divided into two types when it comes to sodium, namely those that store sodium in roots and others that store it in stems and leaves. Examples that store sodium in roots are lucerne, red clover, kikuyu, brown top and maize, while ryegrasses and white clover store sodium in leaves and stems. High levels of potassium can depress the sodium content in plants and it is likely that marginal deficiencies of salt are widespread. Sodium excreted in the milk is a substantial part of the lactating cow's sodium requirement.

Symptoms
Rough hair coat, unthrifty haggard appearance, lower milk production and poor weight gains are all symptoms of a salt deficiency, some being less obvious. Cows with a salt deficiency often show a depraved appetite (like with phosphorous) and chew and lick on foreign objects and lick each other.

Supplementation
Best to include salt with the Conedose mixture, with supplement or fed as a mineral lick or offer free access to a salt lick.

Sulphur

Function
Sulphur is an essential component of protein. The amino acids methionine and cystine, and B vitamins, thiamine and biotin, all require sulphur in their synthesis.

Availability
Sulphur is unlikely to be lacking in NZ pasture based systems as it is usually applied as a fertilizer component.

Symptoms
It may be a problem where high levels on corn silage and urea based protein is fed.

Supplementation
Sulphur is usually added as a component of the fertiliser on pastures.

TRACE MINERALS

Copper

Function
Copper plays an essential role in the formation of blood and incorporating iron in the haemoglobin molecule. Copper is also required in the development of the skeleton through the calcification of the bone any deficiency can negatively affect growth rates in young animals. Copper is essential in the enzyme process involved with the formation of the pigment in hair.

Availability
Copper deficiency in grazing cattle is recognised as a major practical problem in many parts of the world. Deficiencies in NZ are widespread, especially on volcanic, peats, pumice and sandy soils. High pH soils, interactions with zinc, iron, molybdenum and sulphates can reduce copper availability. The typical content of NZ pastures shows that copper is likely to be deficient.

Symptoms
A lack of copper is often seen as a loss of pigment around the eyes with black hair appearing reddish. Copper also plays an indirect role in reproductive performance and a lack of copper can negatively affect reproduction. Excessive copper can be toxic and more caution is required when high levels of palm kernel extract are fed.

Iodine

Function
Iodine is used mainly by the thyroid gland to synthesize hormones that regulate the body's rate of energy metabolism. A lack of iodine can slow down the energy metabolism. Milk also contains iodine with about 10% of the iodine intake excreted via the milk.

Availability
Typical pasture content is likely to be insufficient for lactating dairy cows. Some plants like white clover, rape, swedes, turnips and kales contain goitrogens which interfere with the uptake of iodine by the plants increasing the demand for iodine.

Symptoms
A lack of iodine can cause the classic enlarged thyroid gland, hair loss and dry scaly skin. Lower milk production and possible reduced reproductive efficiency are less obvious symptoms and more difficult to detect.

Cobalt

Function
Cobalt is required by the microbes in the rumen to synthesize Vitamin B12 (cobalamin) which is then used by the animal. The animal has a Vitamin B12 requirement rather than a cobalt requirement. As cobalt is required by the rumen microbes, sufficient cobalt is necessary to ensure healthy digestion and utilisation of forages. Vitamin B12 is necessary for the synthesis of haemoglobin and normal growth and production in animals.

Availability
Shortages are likely to occur on pumice and granite soils, especially well drained soils. Soils with a high pH or leached low pH soils can both be deficient in cobalt. Cereal straws are very low in cobalt which needs to be considered when higher levels of straw are fed to dry cows.

Symptoms
Animals deficient in Vitamin B12 (cobalt) suffer ill thrift, become lethargic, lose their appetite, lose weight or have poor growth, and have reduced fertility. In severe cases this is known as wasting or coast disease in parts of the world, in marginal cases it can be less obvious and more difficult to detect.

Zinc

Function
Zinc plays a role in protein synthesis and Vitamin A utilisation. It is important for epithelial tissue integrity and the maintaining the immune system. Zinc therefore plays an important part in combatting mastitis and foot rot in animals.

Availability
Zinc is often marginal in pastures and needs supplementing. Higher levels of calcium in the diet can increase the zinc requirement.

Symptoms
General dermatitis with abnormal lesions on legs, neck, head, around nostrils and failure of wounds to heal are more common symptoms. A lack of zinc can also negatively affect fertility and reduce testicular growth and development.

Selenium

Function
Selenium is a component of the antioxidant enzyme glutathione peroxidase. Selenium also plays a key role in thyroid hormone metabolism. There appears to be an association between the functions of selenium and Vitamin E which is important maintaining a healthy immune response.

Availability
NZ is are notoriously deficient in selenium. Diets are very likely to be deficient in selenium.

Symptoms
Deficiencies can cause muscular cramping, poor stress tolerance, impaired immunity and poor performance. In some parts of the world selenium toxicity is perhaps better known, but it is very deficient in NZ and should be supplemented.

Supplementation of the 5 Trace Minerals

There are a number of commercial blends of trace minerals available in NZ. Trace minerals come in different forms, from inorganic minerals to different chelated (bonded) minerals.

The inorganic minerals are the cheapest. Examples are copper sulphate and zinc sulphate. The sulphates are usually more palatable and bioavailable than the oxides. The problem with inorganic forms of minerals is the possibility of interaction between the minerals which could form chemical bonds less available to the animal. A surplus of one could induce a deficiency in another. The bioavailability of some inorganic minerals can be inherently low. Comparing 10 grams of an inorganic mineral that is only 30% bioavailable to the animal to 10 grams of a chelated mineral that is 100% available can be misleading.

Chelated minerals are minerals that are bonded to something else which may be for example a protein molecule or peptide. In this form the mineral is absorbed as part of the protein molecule and does not interact with other minerals to form unavailable complexes. Discussing the various chelated minerals and their benefits, is an article on its own.

Trace minerals can be in a powder, which may or may not be soluble, or could be in an aqueous solution. Because small amounts of trace minerals are required, it is best to feed each lactating cow her required amount in the shed. This can be included in the grain blend or fed as a pellet or conveniently included via the Conedose system.

Sub optimal levels of minerals can cause losses that may not even be detected but could be costing the farmer money in lower animal performance, poorer growth rates, lower milk production and lower reproductive performance. Feeding minerals should be seen as an insurance policy. Can you afford not to be supplementing minerals?

HDeKlerk
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