# Minerals & Trace Elements

**Why Minerals and Trace Elements are Important**

In very simple terms, minerals maintain life.

Minerals are the basic components of all matter, being a component part of enzymes, hormones, all cells, bone, blood and body fluids. They function in all aspects of life, from hormone and energy production, digestion, muscle contraction, regulation of body fluid and pH levels, to digestion and reproduction. They are also critical to provide all of the production parameters such as fleece, fibre and muscle tissue, as well as normal growth rate, reproductive rates, and feed conversion efficiencies required in our production animals.

Minerals and trace elements, along with vitamins, are absolutely essential nutrients which operate in every animal body in exactly the same manner. They are critical components of almost every aspect of how a body grows, develops, functions, performs and reproduces.

The reliance on, and demand for minerals, is increased significantly in all performance and production animals. In fact, the availability of sufficient minerals is more vital to an animal's physical health than is the intake of energy or vitamins, or on the precise proportions of starch, protein, fats or carbohydrates animals consume on a daily basis. While horses, cattle, sheep, goat, camelids and pigs can manufacture a wide variety of energy sources from available feed supplies, they cannot manufacture essential minerals or trace elements. These must be provided from the feed or pasture. If the essential minerals and trace elements are not present in soil or pasture, the animal has no chance to get them unless supplementation occurs. In some animals levels of trace minerals are more critical than others. For example, horses do not have as critical a requirement for copper and cobalt as do ruminants like sheep, cattle and goats.

*Adequate mineral and trace element nutrition has very significant implications on athletic performance, reproduction, immunity, lactation and growth, as well as production of fibre or meat.*

The macro or micro (trace) minerals supply neither energy, protein, or fuel for the body, but they are pivotal as to how energy, protein and fuels are used in the body. Any amount of vitamins consumed daily will do no good without adequate minerals as well. Also adequate amounts of fat soluble vitamins such as Vitamin A, D and E are necessary for mineral uptake and assimilation in the body.

So, minerals are biological facilitators. They are the critical components of the structure of animals, and also of the many chemicals that allow the animal body to work and produce.

Mineral and trace element deficiencies and imbalances are so common that there is tendency among farmers and livestock owners to assume that if stock are not thriving the cause is likely to be a mineral or trace element deficiency. This is not strictly true, as in the vast majority of cases of "failure to thrive" faulty nutrition (such as a deficiency of protein), underfeeding, parasitic infections, poor feeding practices and chronic infections, are far more likely to cause a failure to thrive. But, when these common causes have been eliminated under good livestock management, a mineral or trace element deficiency should be investigated.

In practice, deficiency or lack of balance of the various minerals and trace elements is a frequent cause of poor health, failure to thrive, and actual disease conditions, as well as a more general failure or reduction of production. Inadequate trace mineral nutrition is one obvious, well recognised factor limiting livestock production in many regions of the world.

Of the 100 odd elements in the biosphere, only about 25 are known as essential for animal life. Of these, 14 are trace minerals, occurring in biological tissue at concentrations of less than 0.01%. These elements function in many different ways, usually in close synergy with other minerals and trace elements, but when deficient they result in classic deficiency diseases.

Minerals and trace elements have three broad types of functions;

1. Structural components of body organs and tissues - calcium, phosphorus, magnesium, fluorine in bones, and phosphorus and sulphur in proteins
2. Constituents of body fluids and tissues as electrolytes concerned with body fluid balance, acid-base balance, membrane permeability, tissue irritability (including nerve transmission and muscle contraction) - sodium, potassium, chloride, calcium and magnesium in blood, cerebrospinal fluid and gastric juices, for example
3. Catalysts in enzyme and hormone systems

There are more than 100 mineral elements on earth. Five of these- oxygen, hydrogen, carbon, sulphur and nitrogen, make up about 96% of the animal body, and are generally freely available, although nitrogen may need to be supplemented in drought conditions to maintain protein intake.

This remaining 4% is made up, in part, of all of the other available minerals, in varying levels depending on where the animal lives. They comprise the macro and micro minerals;

The next level- calcium, magnesium, phosphorus, potassium, sodium and chloride (known as the "Macro" minerals, required in relatively large amounts because they are so heavily involved with structure of the body) are not so universally available in feeds, so supplemental supply is much more critical, especially in performance and production animals. Mineral levels of feeds can vary wildly depending on the type of feed and growing location, harvesting technique and storage practices. For example, grass hays tend to be low to moderate in levels of calcium & phosphorus, while legumes are usually high in calcium and cereal grains are very low in calcium and quite high in phosphorus

Finally, there are the "Micro" minerals, or trace elements. These are minerals required in almost minute levels, but still essential for the maintenance of life and production:

**What Trace Minerals Are Known To Be Required By Animals?**

Iodine, Cobalt, Copper, Iron, Manganese, Molybdenum, Selenium and Zinc are known to be essential to animals for health and production. In addition to these, chromium, cadmium, fluorine, nickel, silicon, tin and vanadium have been recorded to have some biological action.

Aluminium, arsenic, boron, bromine, silver and strontium have all been recorded in animal tissues in small amounts, but their requirements or functions are still unknown. (At this point it may be wise to remember that, until 1935, Cobalt was thought to be unnecessary in animals).

Many factors influence the actual level of mineral requirement in production animals, including the nature and level of production, age of livestock, interrelationship with other elements, mineral uptake from pastures, breed, location and climate. Mineral concentrations, for example, tend to be low in tropical forages during the dry season, yet specific mineral deficiencies tend to be more prevalent during the wet season, when livestock gain weight rapidly since energy and protein supplies are adequate.

Typical mineral intake in most animals represents only about 0.3% of an animal's total intake of nutrients, yet minerals are so potent that without them animals could not adequately utilise the other 99.7% of food components they eat.

The animal body can tolerate a deficiency of vitamins much more readily than it can tolerate a mineral deficiency.

**Macro minerals**

There are seven major (or macro) minerals - calcium, magnesium, potassium, phosphorus, sulphur, sodium and chlorine. Every animal body must contain adequate amounts of all of these minerals at all times, and some or all of these are generally supplemented in livestock mineral supplements to ensure supply.

**Micro minerals or Trace Elements**

There are then many trace (micro) minerals. There are about 16 well recognised trace elements. These are present in the body in often very small amounts; often less than one hundredth of one percent of body weight, yet they are still critical to life (for example, the trace element cobalt is a critical component of the B group vitamin, cyanocobalamin, or Vitamin B12. Without this vitamin blood haemoglobin cannot be formed, and oxygen transport around the body would reduce seriously. Even though it is so vital to life, this vitamin, and the mineral cobalt, only need to be present in the body at amounts of about one billionth of a gram!) Because an animal requires only a few thousandths of a gram of some trace elements, and perhaps a few millionths of a gram of others such as iodine or selenium, people tend to think they are less important than, say, calcium. This is very wrong! A deficiency of any trace element is likely to significantly reduce production.

**You've Heard About Electrolytes - They Are Minerals As Well**

Electrolytes are minerals. When they are dissolved in water in the body they take on a electrical charge that allows them to take critical roles in the regulation of body heat, fluid balance and acid-base balance in all animals. If a diet is low in sodium, for example, the thirst reflex will usually reduce, and water intake decreases, leading rapidly toward dehydration. Feed intake also reduces. Electrolytes are lost in sweat, and therefore need replacing in athletic animals.

Many diets include free choice salt. Salt is simply the two electrolyte salts, sodium and chloride. As well as maintaining body fluid balance and pH balance, these electrolytes have hundreds of other separate functions within the body.

Magnesium, often an overlooked electrolyte is a critical cofactor in over 300 separate and unrelated enzyme reactions within the body. That means that if magnesium is not present in the right quantities in the diet, over 300 different chemical processes and reactions in the body may not be able to continue as required

**Trace Element Deficiencies in Sheep & Cattle**

The trace elements of major traditional concern to graziers and livestock producers are cobalt, selenium and copper, and deficiencies are generally seen in higher rainfall, coastal areas. There are many complex interactions which determine trace element availability for plants and animals;

Pasture growth requires adequate soil copper, however excessive iron, molybdenum and sulphur levels will reduce the amount of copper available to ruminants. Excessive use of molybdenum in fertilisers should be avoided generally. Copper deficiencies usually manifest as abnormalities of wool (loss of crimp, depigmentation), then anaemias, scouring, ill-thrift and infertility in more extreme cases. Lambs may develop bone fragility in spring, with fractures. Cattle lose coat colour and the coat becomes rough, often with no production losses evident. Classically the hair around the eyes can lose pigmentation. Ill-thrift, decreased milk production, infertility and anaemia can occur in adults, and calves show poor growth rates commonly. Scouring is often present when copper deficiency is due to excess molybdenum, but not when due to direct copper deficiency.

Cobalt is required in minute amounts by bacteria that fix nitrogen in legume plants, but livestock require higher levels and availability, primarily to produce vitamin B12 by the action of rumen microbes. Traditional lime treatment of soils to increase soil pH generally decreases plant uptake of cobalt. Intensively cropped land can often be cobalt deficient. Cobalt deficient sheep generally lose appetite and fail to thrive in spring and early summer. Growth, lactation and wool production are severely affected and wool may be broken or tender. Weeping eyes, leading to a matting of facial wool, is a classic sign of cobalt deficiency. Cattle develop a wasting syndrome similar to sheep.

Selenium is not essential for plant growth, but is essential for animal health and production. Deficiencies are usually seen in high rainfall, lighter soil types. The higher the rainfall, the worse the deficiency because of leaching in soil, in many regions. Selenium and/or vitamin E deficiencies cause nutritional myopathy in lambs and weaners. Calves may develop myopathies, and young cattle develop ill-thrift. Marginal selenium deficiency can reduce milk volume and conception rates, and causes increased levels of retained foetal membranes and mastitis commonly.

Clovers in pasture are less efficient at taking up selenium from soils than grasses, but they are more efficient at taking up cobalt and copper.

Poor drainage of paddocks can increase cobalt and selenium uptake by pasture plants, but reduce copper availability.

The trace element concentration in plants is reduced by the dilution effect of rapid growth during summer. In addition, higher levels of sulphur in green feed may reduce the availability of copper and selenium.

Stress to livestock can easily increase the effect of a mineral deficiency, and particularly in the case of selenium, may trigger clinical disease episodes. All livestock show increased trace mineral requirements during pregnancy, lactation and rapid growth stages.

Paddock management is important - rotational grazing may increase an animal's chance of correcting a mineral deficiency, as there are often subtle differences in mineral availability even at local farm level.

**Where Do Minerals Come From?**

The main source of nutrition for animals comes from plants. Plants grow in soil, and soil is produced initially by the breakdown of rocks. Rocks are the foundation for the development of topsoil. Soil bacteria thrive when minerals are readily available

*The health and survival of all plants depends on the health of the soil, and its ability to provide a constant supply of essential minerals.*

Grazing livestock usually depend largely on forages which can only rarely completely satisfy each of the mineral requirements for grazing animals. The mineral and trace element content of the forage depends wholly on the soil content in that locality, as well as the stage of growth and environmental conditions at the time. For grazing animals, the most prevalent mineral deficiency throughout the world is lack of Phosphorus. Next to P, the minerals most likely to be deficient on a world scale are Cobalt and Copper. Extensive regions of the world show copper deficiency, for example, as the severe mineral limitation to grazing cattle production.

In the distant past, before man significantly influenced the mineral content of soils through overgrazing, over-cultivation, overcropping, etc, the soil generally contained many more minerals than it presently contains in many productive areas. Up to 80 minerals were generally available in soil almost everywhere long ago before farming practices were used.. Some highly productive soils contained almost 100 minerals. When humans began to cultivate and continuously crop soils, wind and rain erosion began to remove many minerals, and continuous cropping began to remove much higher levels of these critical nutrients. Overgrazing, excessive fertilisation and poor farming practices rapidly reduced available soil nutrient levels, to the point where, now, may regions of the world produce pastures which reflect the poor soil quality by having very low essential nutrient content.

Most naturally occurring mineral deficiencies in livestock are associated with specific regions or localities, and are directly related to soil characteristics. These are generally well known for minerals such as phosphorus, magnesium, calcium, selenium, but are less well understood for many other minerals or trace elements. Presently, soil tests from all over the world reveal that soils generally are severely lacking in minerals. This has no other result than to leave plants mineral deficient, with very little food value in many cases. How can an animal produce adequately when it is deficient in minerals? How can an animal even remain healthy when it is deficient in minerals? The simple answer is that it cannot.

Animals use up to 60 minerals, in varying amounts.(for many trace elements actual levels required are still not known). Most farmers have only ever focussed on replacing about 6 of these minerals through synthetic fertilisers. Most farming regions now have well accepted mineral and trace element deficiency or excesses in soil and pastures. In addition to the soil deficiencies and excesses, pasture type can significantly influence the availability of minerals (for example, phytates, or kikuyu grass reducing calcium availability), often exaggerating any existing mineral deficiencies.

**How To Help Diagnose Mineral & Trace Element Deficiencies**

There are several avenues for diagnostic tests, including:

- Soil Tests - to assess the likelihood of deficiencies, but soil test results must be adjusted for soil type, the presence and importance of competing minerals, the plant species present, and seasonal conditions, so little definitive information may be available form soil tests alone.
- Plant Tests -may be useful to diagnose copper deficiency, especially to determine the relevance of molybdenum and sulphur, but great care needs to be taken when interpreting pasture levels of cobalt and selenium when test results are at marginal levels.
- Animal Tests -animal tissues are obviously a better guide to what is happening in livestock, but these tests again require careful history and consideration of soil and plant test information, as well as clinical signs. Response to Treatment - remains the most effective test for trace mineral deficiencies, even to determine marginal deficiencies. In other words, supplement the livestock and see what happens. At the very least you know that livestock are then receiving adequate nutrition, particularly of minerals and trace elements.

In practical terms, regular supplementation of livestock may well result in the cheapest manner to correct mineral deficiencies, as any option for soil and pasture remediation will require long term input.

**What Options Do We Have To Replace Essential Minerals?**

Producers can only attempt to either;

1. Improve mineral & trace element levels in soils by improving soil and pasture quality over time. This is costly and time consuming, and is the basis of the organic farming movement

2. Supplement production animals with balanced nutritional supplements in the shorter term to ensure that individual animals receive all essential nutrients necessary for survival and optimum production.

Developing a mineral supplementation programme for livestock can be challenging, particularly because of;

1. Changes to animal requirements with varying stage and levels of production
2. Differences in levels of minerals in forage supply seasonally
3. Methods to supply cost-effective supplemental minerals that ensure adequate intake

The level of minerals in local forages or crops depends on many factors, including soil characteristics, stage of plant growth, climatic conditions, fertilisation practices, etc. Sandy soils allow minerals to leach readily compared to heavier clay soils. Soil acidity affects the availability of soil minerals for uptake by plants. The type of plant forage alters mineral availability as well - for example, legume forages contain over twice the calcium as grasses in general, and zinc is the most likely mineral to be low in legumes.

Consider these simple scenarios:

All farmers know and understand the value of legumes for animals. These are the plants that are able to provide high quality protein in easily digested form for most grazing animals. Specific trace minerals allow the legume plants such as alfalfa (lucerne) to produce protein. The trace element molybdenum is essential for the growth of nitrogen fixing bacteria in the roots of the legume plants. These bacteria convert nitrogen in the atmosphere into soluble nitrates which are absorbed by plants to make proteins. The protein content of these plants is high or low in about the same proportion as the mineral.

**All Minerals & Trace Elements Have Multiple Roles in the Body**

Performance animals, particularly working horses and dogs, often show muscle cramps and various muscle problems. These all have origins in calcium, magnesium and other electrolyte mineral deficiencies. Calcium, the major macro mineral, is the major structural element in bones and teeth, maintains the strength of bone, and yet also helps blood to clot, helps muscles to contract, helps the heart to beat and the brain to function, allows nerves to send signals, allows blood vessels to constrict and relax, and allows hormones such as insulin to be secreted normally. The mineral calcium is so vital to the animal body that very complex mechanisms have evolved to maintain body levels within very strict levels. Deficiencies of calcium will see the body preferentially take calcium out of bones just to maintain blood levels so the body can function.

We have already mentioned that Magnesium, for example, is a critical component in at least 300 separate enzymes in the body.

Copper is a critical component in an enzyme essential for energy production in the body, is an essential component of the major body antioxidant system in conjunction with mineral zinc, is important in regulating iron uptake and the utilisation of iron to make red blood cells (anaemia is one

clinical sign of copper deficiencies), is critical to normal nerve development, and is an essential factor in skin pigmentation, joint cartilage formation and maintenance, and tendon and ligament collagen, for example.

Manganese is present in only relatively tiny amounts in the body, but is essential in the formation and maintenance of normal connective tissues and joint cartilage, as well as being critically involved in fat metabolism processes, the creation of new DNA, and the formation of many essential hormones in the body.

**What Are Essential Nutrients**

In very general terms, about 13 vitamins, 22 minerals, 6 cofactors, 11 amino acids and 2 essential fatty acids are recognised as essential to the body.

The term “essential” means that:

1. the nutrients must be present in adequate amounts, at the right time, or function is impaired;
2. the body cannot make these nutrients; or
3. they must be available from the diet. If they are not available from pasture they must be supplemented.

All of the essential nutrients interact with each other in very precise ways to produce, maintain and renew the animal body. If even one of these essential nutrients is missing at a critical time, then the functions of all others involved in that particular process are impaired.

**Synergy**

The prime principle that must be understood is that nutrients (including minerals and trace elements) *only operate by multiple interactions with each other.*

There is never any nutrient activity by itself! - it is the multiple interactions of nutrients that is the basis for their biological function. For example, the minerals copper, iron, cobalt, calcium, magnesium, plus the electrolytes sodium, chloride, and the vitamins A, E & B group, are all involved, working in synergy, in the supply of oxygen to, and the provision of energy to, working muscles

The utilisation of iron to make red blood cells requires copper, as does the formation of healthy nerve tissue, skin pigments and joint collagen

**Method of Mineral Supplementation**

Meeting the mineral requirements for grazing animals can be a real challenge. Identification of the deficient minerals is necessary, and in itself can be a challenge. Compounding this, the many mineral interactions and imbalances that occur must be considered to some degree; all before a choice of supplementation method is made.

Minerals may be provided directly or indirectly. Indirect methods of supplementation include using mineralised fertilisers, altering soil pH to influence the uptake of certain minerals such as Mo and Se (but it can also reduce uptake of Cu and Co simultaneously), and encouraging certain forage species known to be adequate in required minerals. Foliar application of minerals is effective in some scenarios, particularly with magnesium, copper and zinc). Foliar application is best practiced to improve production characteristics of forage, and is not an efficient way to increase mineral uptake by animals.

Direct methods of mineral supplementation include:

- Adding minerals to water - can be easy to administer, but may be variation in amount consumed by individuals, depending on how much they drink daily. Fruitless if livestock have access to other water sources simultaneously.
- Adding minerals in protein/energy feeds - ensures consumption, but may still be intake variation between animals. These feeds are not needed year-round, and will not be cost effective as a means of continually delivering minerals.
- Oral drenching -effective, but often costly and not very practical. Oral drenches pass through the digestive tract rapidly with little time for absorption. Continual drenching on multiple days would be more effective than a one-time dose, but is highly labour intensive.
- Injection - copper and selenium are often injected. They can increase levels of single minerals, but the effect is not long-lived
- Ruminal boluses - is an acceptable method of providing specific trace minerals, but is generally not for large volume macro-minerals, and is more intended for trace minerals.
- Free choice supplementation - the most widely used current option. Requires a palatable base, and this alone can be an art form. Free choice intake can vary dramatically between individual animals. Regulation of consumption is a real issue. Cattle will consume sodium chloride (salt) in excess, so it is often used as the base for a free choice supplement. Other inorganic minerals such as magnesium and phosphorus are not as palatable as salt, and will not be well consumed

**What’s The Message Here?**

Simply supplementing one mineral or trace element does not consider the multiple complex interactions between minerals. Provision of a balanced mineral and trace element supplement takes these synergies into consideration, and allows animals to maintain health and optimum production by ensuring that no mineral or trace element imbalances or deficiencies occur.

Because most soils are now so depleted in nutrient levels, the pastures grown on those soils are inevitably nutrient deficient. The only way to improve access to minerals and trace elements quickly is to supplement the production animals. This has traditionally been accomplished by using licks or powdered supplements such as trace mineralised salt, as an ad lib supplement or on feed.

In many applications, choosing a liquid mineral & trace element supplement for regular supplementation at low doses in a variety of dosing options (application directly onto feed, oral dosing, drinking water medication, inclusion in urea/molasses licks or other liquid supplements) will provide the versatility to suit many management programmes. Add the benefit of being totally prepared from plant material, 100% natural & 100% organic, and supplying over 60 chelated nutrients, and there is only one product that can do all of that - DYNAVYTE.

**DYNAVYTE - a water dispersible liquid mineral & trace element supplement**

Dynavyte is a carefully blended mineral and trace element liquid supplement for administration to performance and production animals either by spreading over feed, or by administration in drinking water.

Being totally water soluble, Dynavyte not only provides adequate minerals and trace elements in highly bioavailable chelated form, just as the plants originally made them, it also supplements a wide variety of plant complexes, sterols, humic and fulvic acids, alginates, and other essential phytocomplexes only now found in highly fertile, nutrient rich soils.

Dynavyte is 100% natural, and 100% organic, and is made wholly from plant materials, thus providing all of the nutrition capable from plants grown on ideal soils, under ideal conditions.

Regular administration of Dynavyte provides over 60 minerals and trace elements in low doses to ensure that deficiencies don't limit production.

With all minerals and trace elements being provided in chelated form there is a significantly reduced likelihood of toxicity or overdose as seen with traditional inorganic mineral supplements.

Dynavyte has the potential to improve most conditions which may be caused by nutritional deficiencies when fed regularly. For this reason it can be difficult to describe all likely benefits, as the nutritional state of livestock depends largely on the soil and pasture conditions on the particular property, as well as the level and type of production the animal is involved in. Age, individual animal health status, condition score, pregnancy, lactation, parasite level, disease state, type and amount of of nutrition, season and climate, etc, can all vary individual production capability tremendously, and response to Dynavyte may vary accordingly. No matter what the positive response, consistent observations include improved appetites, healthy coats, improved feed conversion efficiency, improved reproductive rates. These responses all relate to improved health and better nutritional status.

**Drought Feeding**

When drought feeding the primary aim is to preserve breeding stock for future use, while making sure that saleable stock survive in good condition. These valuable breeding animals need adequate mineral nutrition to ensure good reproductive capability in future. Dynavyte is the perfect option to ensure adequate nutrition while drought feeding.

**Grain Feeding**

Grain feeding provides energy and protein, but grain has very low mineral and trace element levels. Dynavyte poured onto grain supplements daily, or administered through drinking water, boosts essential mineral and trace element levels, as well as supplies all of the plant complexes normally available from healthy plants grown in highly fertile soils. Dynavyte is safe for administration when molasses/urea licks are provided, and may be included in the lick, if desired, at the dose rates for water administration.

**Administration in Drinking Water**

Dynavyte is water soluble, and may be added to drinking water for ease of application. For daily inclusion in drinking water, livestock should receive 20-40mL daily for horses and cattle over 300kg, 10-20mL daily for horses, ponies, cattle and calves under 300kg. Sheep, goats and alpaca should receive 5-10mL daily.

The dose required may be added to drinking water as a bolus. Automated water systems will replenish with fresh drinking water as levels reduce during the day, and no further Dynavyte is required after the daily dose is administered.

In cases where daily administration is difficult, weekly or bi-weekly administration is safe and effective. In these circumstances of bi-weekly dosing, the recommended dose should be;

- Horses, Cattle over 300kg: *60mL*
- Horses, Ponies, Cattle, Calves under 300kg: *40mL*
- Sheep, Goats, Alpaca, Pigs: *20mL*

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