Micro minerals

Micro Minerals	Iron (Fe)	Copper (Cu)
Function	Blood haemoglobin formation and oxygen transport. Roles in biochemical reactions	Energy utilisation. Immune system function. Fertility. Enzyme production. Wool and hair production
Source	Forage (grazing and conserved) – high iron in forage analysis can be an indicator of soil contamination. Drinking water from wells, streams and boreholes can be high in iron	Forage (grazing and conserved) Seaweed meal and some straight feeds. Pasture analysis is recommended.
Storage	90% of iron is combined with proteins	It is concentrated in the liver and re-directed to cells which need it.
Chemical sources	Bought-in feeds and supplements, not all are as readily available or absorbable. Should not need to supplement	Bought-in feeds and supplements. Some are slow release and others more immediate
Relationships	• Iron binds with phosphorus forming insoluble phosphates preventing its absorption • High iron can depress absorption of zinc and cobalt at specific sites • Elevated iron reduces manganese uptake High iron in combination with sulphur may inhibit copper absorption	• Elevated calcium may lower copper absorption • Copper may support transport of phosphorus • Elevated zinc depresses intestinal copper absorption. A ratio of less than 4:1 is recommended • Elevated iron in combination with sulphur inhibits copper absorption Molybdenum in combination with sulphur can inhibit copper absorption and utilisation in the body
Clinical signs (deficiency)	Anaemia and respiratory distress	Swayback, anaemia, depressed or silent heats, reduced fertility, lower immunity, impaired energy utilisation, poor growth, scouring and depigmentation of hair or wool
Clinical signs (toxicity)	No signs	Can take a long time to show clinical signs. However, they may reach an irreversible climax commonly resulting in jaundice, urine-stained blood and death
Warning/Note		Copper needs careful management as can be toxic if allowed to build up in the liver. Certain sheep breeds are more susceptible to toxicity and shouldn't be supplemented at all.

Micro Minerals	Zinc (Zn)	Manganese (Mn)
Function	Immunity. Tissue health. Acts as an activator of enzyme systems and supports growth of horn tissue in hooves. Required for hair and wool growth	Required for connective tissue and bone formation, blood clotting factors and production of sex hormones. It has a role in control of growth rates, fertility and ovarian function
Source	Forage (grazing and conserved) Seaweed meal and some straights. Pasture analysis is recommended.	Forage (grazing and conserved) Seaweed meal and some straight feeds. Levels will vary depending on soil type and pH so testing is recommended. High manganese and iron on a forage analysis is an indicator of soil contamination
Storage	Cannot be effectively stored by ruminants. Daily so needs to be continuously supplied	Only small amounts are found in the body in bones, liver, kidneys, pancreas and pituitary gland.
Chemical sources	Bought-in feeds and supplements	Bought-in feeds and supplements. Sources vary in their availability once consumed by ruminants
Relationships	• Elevated calcium may lower zinc absorption • Increased zinc will help form insoluble phosphates • Elevated sulphur may inhibit absorption through rumen sulphide formation	• Elevated calcium and phosphorus may lower manganese absorption • High iron can reduce manganese absorption at ratios over 2.5:1 • Manganese will compete directly with iron and cobalt for binding sites which can induce manganese deficiency
Clinical signs (deficiency)	Poor health, increased cell counts, lameness, skin and coat problems.	Skeletal formation problems during gestation, depressed immunity, poor fertility, impaired cell function and structure
Clinical signs (toxicity)	Very rare but signs include decreased feed intake and pica	Is rare but signs include reduced feed intake and growth and in some cases liver abscess
Warning/Note		

Micro Minerals	Cobalt (Co)	Iodine (I)
Function	It is the pre-cursor to the production of vitamin $B_{12.}$ Vitamin B_{12} is vital for body's nerve and blood cells and helps to make DNA. Cobalt is important for the rumen as the animals supply of vitamin B_{12} is produced by the rumen micro-organisms.	Thyroid function which controls energy metabolism.
Source	Forage (grazing and conserved). Seaweed meal and some straight feeds. Forage testing is recommended as levels vary.	Forage (grazing and conserved). Seaweed meal and some straight feeds. Forage testing is recommended as levels vary
Storage	Most is stored in the animals muscles and bones. These stores do not reflect useable cobalt so it is needed daily	80% stored in the thyroid gland
Chemical sources	Bought-in feeds and other supplements. They vary in release, some are slow and others faster. Needs to be available in the rumen else it has no value. Can supplement directly with vitamin B_{12} can be a substitute for cobalt	Bought-in feeds and other supplements. They vary in release, some are slow and others faster
Relationships	• Elevated calcium may lower cobalt absorption • Iodine when over supplied will compete with cobalt for absorption • Increased levels of iron will depress cobalt absorption	• Selenium is required for iodine utilisation in thyroid hormones • Increased levels of cobalt will depress iodine absorption • Calcium has been implicated in compromising iodine utilisation
Clinical signs (deficiency)	Anaemia, loss of appetite and ill-thriftiness	Calves or lambs born dead, extended calving and lambing periods and reduced growth rates in youngstock. A key sign of iodine deficiency is the development of a goitre (an enlargement of the thyroid gland)
Clinical signs (toxicity)	Rare but includes reduced feed intake, weight loss and anaemia	Nasal and ocular discharge, excess salivation, decreased milk production and loss of coat condition
Warning/Note	It is required to promote good rumen development	Over supply has a major detrimental effect on colostrum quality

Micro Minerals	Selenium (Se)	Molybdenum (Mo)
Function	It protects membranes from oxidative stress. Vitamin E also supports this role. They both support immune system function, growth and fertility.	A role in enzyme activity
Source	Forage (grazing and conserved). Seaweed meal and some straight feeds. Some fertilisers contain selenium so this can increase pasture content. Duration varies so forage testing is recommended	Forage (grazing and conserved). Seaweed meal and some straight feeds too
Storage	Absorbed selenium is found in the liver	Stored in the liver and kidneys but most is converted into molybdenum enzymes. Extremely low, needs are usually met by diets
Chemical sources	Bought-in feeds and other supplements. They vary in release, some are slow and others faster	It is not usually added to feeds unless they are trying to block uptake of copper
Relationships	• Iodine requires ruminants to have adequate levels of selenium to allow iodine usage • Selenium and sulphur share similar uptake systems in the body, increased levels of sulphur in the total diet will depress selenium uptake • Whilst rarely seen, arsenic is closely related to selenium and can depress uptake	• Elevated calcium may increase molybdenum absorption • Molybdenum in combination with sulphur has the capacity to interfere with copper absorption and in the absence of available copper in the digestive system may bind to copper in body enzymes rendering them inactive
Clinical signs (deficiency)	Poor fertility as a result of poor egg and sperm quality, White Muscle Disease (WMD), sudden death, retained placentas and depressed immunity	None ever reported
Clinical signs (toxicity)	Toxicity is rare with non-supplemented diets. Signs of toxicity include sloughing of hooves, lameness, hair loss and emaciation	Diarrhoea, reduced growth, weight loss, anorexia and poor fertility
Warning/Note		

Micro Minerals	Aluminium (Al)	Lead (Pb)
Function	It is not considered to have a role in the body and isn't required to support livestock production	It is not considered to have a role in the body and isn't required to support livestock production
Source	Aluminium is reported on forage reports as it can cause problems. If it is high it is usually contaminated forage with soil	Can be airborne or in soil
Storage	Toxicity can be checked via post mortem and bone marrow analysis	Post mortem can diagnose lead via the liver or bone marrow
Chemical sources	Can be found in bought-in feeds	Sources of lead from industrial waste, waste engine oil, old batteries or contaminated water supplies are most likely to contaminate grazing pasture or curious animals find and ingest them
Relationships	• High aluminium affects phosphorus metabolism • High aluminium can induce a phosphorus deficiency, which can then induce a calcium deficiency	• Lead competes with calcium and zinc for absorption • Lead disrupts vitamin D metabolism
Clinical signs (deficiency)	N/A	N/A
Clinical signs (toxicity)	Excess aluminium is most likely to have an effect by inducing a phosphorus deficiency. It is rare but excess aluminium can be fatal, most likely when dietary calcium or phosphorus is low. Signs of toxicity are weakness, seizures, skeletal deformity and depressed growth rates	Anorexia, rumen stasis, colic and constipation followed by diarrhoea. If the condition progress beyond this, neurological signs will develop such as blindness, head pressing, loss of co-ordination and death

Micro Minerals	Arsenic (As)
Function	Not considered to be essential to support livestock production or have a role in the body
Source	Pasture can be an issue if the soils are contaminated at sufficient levels. Concentrations are highest in the roots so low swards are more of a risk. Can be from contaminated water. If suspected, test soil, water and pasture
Storage	It alters the function of many of the body's enzymes. Short term exposure can be diagnosed via analysis of blood and urine concentrations. Longer term exposure can be diagnosed through hair or wool analysis
Chemical sources	Insecticides, wood preservatives and herbicides. It can persist for a long period so despite bans it can still cause issues. Leeching into soil or water are the main ways of livestock ingesting it
Relationships	• Arsenic is considered to have antagonistic effects on iodine and selenium • Although not well evidenced, arsenic may influence copper absorption and accumulation
Clinical signs (deficiency)	N/A
Clinical signs (toxicity)	Severe gastroenteritis (diarrhoea) in the short-term following exposure. Chronic exposure causes ill thrift, weakness and impaired co-ordination, milk reduction, and abortion. Acute exposure to arsenic is associated with sudden death