Trace Element Supplementation in Sheep Flocks

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Introduction

Trace element deficiencies affect livestock's health, welfare, and performance. Providing adequate minerals may also reduce veterinary and medicine costs, and lower mortality rates.

Mineral deficiencies can be very localised. However, in parts of the UK, deficiency of certain elements including copper, cobalt, iodine and selenium, are prevalent.

Figure 1: Pasture concentration of minerals is highly variable

Age and the level of production of livestock influence their trace element requirements; young, pregnant and lactating animals have the greatest demands.

Trace element levels in pastures vary due to soil type, pH, drainage and fertiliser applications. Mineral systems are complex, therefore more than one test is generally required to confirm diagnosis. Soil tests are useful as a guide to major deficiencies, whilst herbage analysis may be misleading in part due to interactions between certain minerals. Blood and tissue tests are more accurate. When blood testing it is recommended that at least 8 sheep per management group are sampled to ensure the variation between animals is taken in to account.

Issue	Copper	Cobalt	Selenium	Iodine
Reduced production				
Reduced appetite				
Poor condition				
Reduced immune function				
Infertility				
Abortions				
Retained placenta or vaginal prolapse				
Anaemia				
Muscular disease				
Lameness				
Weak bones				
Skin/hair disease				
Enlarged thyroid				
Diarrhoea				
Eating non-food items				

High influence	
Moderate influence	
Possible influence	

Table 1: The effects of selected Trace Element deficiencies in sheep

Cobalt

The Role of Cobalt

A regular supply of cobalt in the sheep's diet is needed to produce vitamin B12. Vitamin B12 is required for both optimal energy and protein metabolism in ruminants. It is also connected to the production of red blood cells. Sheep are more vulnerable to cobalt deficiency (vitamin B12 deficiency) than cattle. Younger sheep are most susceptible due to their higher energy demands.

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Symptoms of Cobalt Deficiency

Symptoms of cobalt deficiency can include pining, anaemia, ill-thrift, reduced appetite, poor reproductive performance, weepy eyes and an open fleece, as well as the birth of small, weak lambs.

Cobalt Levels Required

It is suggested that cobalt deficiency in sheep occurs when grazing pasture with cobalt concentrations less than 0.08 mg/kg DM. It is typically recommended that the diet should contain 0.1 mg/kg DM of cobalt. Deficiency symptoms occur when the concentration of vitamin B12 in blood plasma falls below 0.2 µg/ml.

The availability of pasture cobalt is affected by soil pH. Cobalt deficiency is more likely to occur in iron-rich, alkaline, and manganese-rich soils, due to cobalt being locked up in non-available forms. In general, the level of cobalt in grassland decreases as soil pH rises therefore liming could induce cobalt deficiency. Clover typically contains higher concentrations of cobalt than ryegrass so benefits can be seen in mixed swards.

Climate affects cobalt availability. For instance, high winter rainfall levels leaches cobalt from the soil. High pasture growth rates in spring dilute the concentration of cobalt in the pasture. This may be an issue as lactating females need sufficient cobalt to provide vitamin B12 to their offspring through the milk.

Diagnosis of Cobalt Deficiency

Cobalt deficiency can be diagnosed with blood samples or post-mortem analysis for vitamin B12 concentrations in the liver. Testing is not 100% reliable but it is an indicator of potential issues. Pasture analysis for cobalt levels is another indicator.

Monitoring the response of livestock to supplementation is beneficial. High worm burdens reduce the ability of vitamin B12 being absorbed from the rumen, consequently worsening the deficiency, therefore correcting worm issues is the first point of call.

Cobalt Supplementation

Orally drenching cobalt increases blood vitamin B12 levels for approximately one week; however it is often suggested that drenching every 3-4 weeks is adequate at preventing deficiency in weaned lambs. Vitamin B12 injections can be highly effective, with newer products providing up to 6 months cover. A rumen bolus can last up to 6 months and is also relatively low cost. Cobalt sulphate can be applied to pastures - the recommended rate is 2 kg/ha every third year. However, this is not commonly practiced in the UK due to the cost compared to alternatives.

Selenium

The Role of Selenium

Selenium and vitamin E work together to protect tissues from oxidation and the breakdown of cell membranes. Selenium is essential for the synthesis of thyroid hormone. Selenium also plays an important role in immune function.

Symptoms of Selenium Deficiency

Selenium or vitamin E deficiency in pregnant ewes can cause White Muscle Disease (WMD) in lambs – also known as stiff lamb disease. WMD affects the muscles in young lambs' legs, making it difficult for them to stand. WMD can last up to six months in lambs and results in poor condition and performance in growing and adult sheep. Symptoms of selenium deficiency can include ill-thrift and poor reproductive performance. It can also cause early embryonic death 3-4 weeks after conception, thus resulting in a higher incidence of barren ewes and a poor scanning percentage. In males, deficiency can lead to poor fertility.

Selenium Levels Required

It has been suggested that a marginal risk of selenium deficiency in sheep is posed when the diet provides 0.025-0.05 mg/kg DM of selenium. The level of selenium uptake varies between plant species, with ryegrasses containing more selenium than clovers.

Diagnosis of Selenium Deficiency

Selenium deficiency is typically diagnosed with blood sampling. This can be supported with pasture and soil analyses.

Selenium Supplementation

Oral drenching, rumen boluses, injections and pasture applications can be used to supplement selenium. Drenching is a relatively short-term method of control whereas boluses can last six months, and slow-release injections can last up to one year. Applying selenium to the sward may result in toxic levels for several weeks, making it unsafe to graze immediately.

Figure 2: Rumen bolus

Selenium in the diet is absorbed reasonably efficiently at between 35-85% with the majority being absorbed in the duodenum (first part of the small intestine). Excess selenium can be toxic to sheep thus selenium should only be supplemented if required. However, cases of selenium toxicity in sheep are relatively uncommon. Symptoms of selenium poisoning include colic, diarrhoea, collapse, and can cause mortality. There is also a cost to over-supplementation of trace elements.

Copper

The Role of Copper

Copper is an essential component of a range of enzymes required for normal bodily functions including those involved in cell energy metabolism in the brain and signalling in the nervous system. Excess copper is stored in the liver. However, once capacity to store additional copper has been exceeded, the excess is released into the bloodstream leading to destruction of red blood cells, liver damage, and ultimately death.

Symptoms of Copper Deficiency & Toxicity

The most widely known copper deficiency in sheep is swayback in new-born lambs. This occurs when a ewe experiences a dietary deficiency of copper during mid-pregnancy, resulting in damage (lesions) to the developing lamb's spinal cord and cerebrum. Lambs are stillborn or weak and this is seen characteristically in hind leg weakness. In growing lambs, deficiency can lead to poor growth rates, scouring and poor fleece quality ("steely wool") where the wool loses its crimp.

Copper toxicity is one of the most commonly diagnosed inorganic poisonings in sheep, with certain breeds such as Texel found to be more susceptible, related to the breed's ability to absorb dietary copper more effectively.

Copper Levels Required

Deficiency symptoms occur when copper levels in the blood fall below 14 µmol/L with severe deficiency defined as under 6 µmol/L. Copper levels in UK pastures vary widely with 2-15 mg/kg DM being typical. Recommended copper levels in the diet are around 10 mg/kg DM, with maximum permitted levels to prevent toxicity being 17 mg/kg DM.

Copper deficiency can occur due to low levels of copper in soil and pasture but can also occur in situations where dietary copper appears normal. This is due to a three-way interaction between copper, sulphur and molybdenum. Iron can also play a role in this interaction. Excessive liming can lead to an increase in molybdenum, and so reduced copper availability.

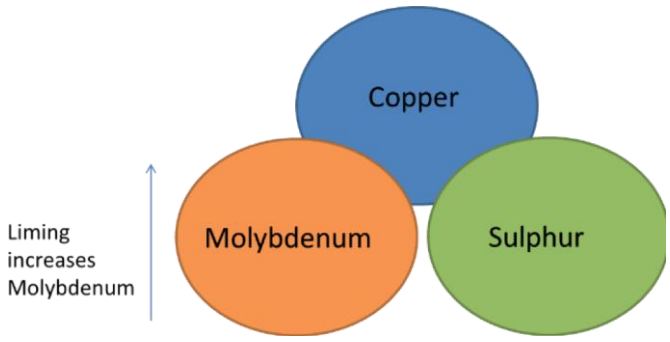

Figure 3: Copper can bind to Sulphur and Molybdenum which makes it less available

Copper is more readily available from cereals and concentrate feeds and feeds such as distillers dark grains and molassed sugar beet contain high levels. Pig manure also contains high levels of copper. Therefore feeding and grazing in these situations should be managed carefully.

Diagnosis of Copper Deficiency

If deficiency is suspected in growing lambs, the most reliable diagnosis is to carry out a dose response trial. Analysis of liver tissue in dead/slaughtered stock is the most reliable way of diagnosing copper deficiency or toxicity. Blood samples can be an effective diagnostic tool with plasma levels of below 9.4 µmol/L indicating depleting reserves of copper in the liver. However, lamb performance is not adversely affected until levels fall below 3 µmol/L.

Copper Supplementation

Prevention of copper deficiency is much more important than treatment as there is no treatment for swayback and it will impact lamb performance. Copper can be supplemented through feed rations and mineral buckets and blocks. However, toxicity must be considered. Long-term cover can be provided via copper heptonate injection or more commonly orally using gelatin capsules containing copper oxide needles given to ewes mid pregnancy.

Iodine

The Role of Iodine

Iodine is an essential component in the hormone thyroxine which plays a central role in energy metabolism. Iodine is essential for normal foetal growth and development. It plays a role in protein production, appetite control and adaptation to temperature changes. Along with selenium it has been found to play an important role in brown fat (adipose tissue) metabolism in new-born lambs, thus promoting lamb survival.

Symptoms of Iodine Deficiency & Toxicity

Deficiency can impact on fertility and result in reduced scanning rates. It can also typically cause late term abortions seen as stillborn or weak lambs, with poor survival rates in lambs. The latter is partly due to its role in brown fat. An enlarged thyroid gland known as goitre is typically seen and animals may show reduced appetite and performance. Adversely over-supply of iodine in late pregnancy can lead to increased neonatal lamb deaths (first 48 hrs) due to reduced antibody absorption, leaving lambs vulnerable to infection. A common cause of overfeeding iodine is where additional iodine is fed to ewes which have already been bolused.

Iodine Levels Required

Iodine levels in UK pasture are generally around 0.1-0.5 mg/kg DM with typical average levels of 0.15 mg/kg DM. Minimum recommended levels of iodine to prevent deficiency, are 0.2 mg/kg DM in growing stock and higher again for pregnant and lactating stock at 0.5 mg/kg DM. Care must be taken when grazing certain forage crops, in particular brassicas, as they are known to contain substances called goitrogens which interfere with thyroxine production and utilisation, resulting in an increased requirement of iodine when grazing brassicas compared to grass.

Iodine levels vary widely between farms but there is no clear relationship between grass concentrations and soil type. Levels are generally higher in improved grassland and in coastal areas as iodine is transpired from the sea during cloud formation and deposited on land through rainfall.

Diagnosis of Iodine Deficiency

Goitre is observed where thyroid weight to bodyweight ratio of 0.4g/kg is exceeded in new-born lambs. The most effective method of diagnosis is to have a sample of stillborn lamb thyroid gland analysed. In adult sheep, bloods can be taken and tested for thyroxine levels or for inorganic iodine. The latter only reflects dietary intake in the last 7 weeks. Where iodine deficiency is suspected, selenium should also be investigated as a deficiency as this can also lead to reduced thyroid hormones.

Iodine Supplementation

There is a range of options for supplementation of iodine including oral drenches, slow release boluses and injections with iodised oil.

Where more than one deficiency is known, long acting combination boluses containing iodine, cobalt and selenium (plus copper if required) administered pre-tupping provides a cost effective way of supplementing ewes.

Nutrient	Average supply from grass silage	Dietary requirements for lactating sheep (twins)	Dietary requirements for for Pregnant Sheep (single-twins)	Dietary requirements for for Lambs 30kg (DLWG +250g/ day)	EU Max legal limit	
	mg/kg DM	mg/kg DM			mg/kg DM	mg/kg FW @ 88% DM
Cobalt Co	0.1-0.2	0.2	0.1	0.2	2.3	2
Selenium Se	0.04-0.08	0.1-0.2	0.1-0.2	0.1-0.2	2	
Copper Cu	5-10	7.1	7.7-10.4	6.1	17	15

Table 2: Dietary requirements plus EU legal maximums for sheep and average supply from grass silage

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For more information on nutrition in sheep, visit our page on the FAS website: [Nutrition | Helping farmers in Scotland | Farm Advisory Service (fas.scot)]

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