Trace Element Supplementation of Beef Cattle and Sheep

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Key messages

+ Copper, cobalt, selenium and iodine are essential trace elements required by cattle and sheep in England and Wales.

+ Deficiencies of trace elements can cause poor production. However, there are other common causes of low productivity such as parasite infestations or energy deficiency.

+ Trace element requirements vary with age and production level - young, pregnant and lactating animals have greatest need.

+ A trace element deficiency should be confirmed by independent testing and advice before buying and feeding supplements.

+ Grass and forage varies widely in trace element content due to soil type, pH, drainage, plant species and fertiliser use.

+ Clay soils generally have higher trace element levels than sandy soils.

+ Soil testing may reveal gross deficiencies but should only be used as a guide when considering the trace element status of livestock.

+ Herbage analysis can be misleading and needs careful interpretation.

+ Deficiencies are more accurately diagnosed from blood or tissue tests.

+ Diagnosis of a deficiency should be confirmed by monitoring the response to supplementation.

+ Over-supplementation could cause toxicity or cause other undesirable interactions in the animal.

+ Over-supplementation could waste money.

Keywords:
Trace element deficiency, Trace element supplementation, Copper, Cobalt, Selenium, Iodine, Forage analysis, Blood trace element tests, Tissue trace element tests.
Introduction

Cattle and sheep need at least 15 different minerals for good health and productivity. The major elements such as calcium (Ca) and phosphorous (P) are required in relatively large amounts. Others known as trace elements are required in much smaller quantities.

In England and Wales, the most economically important trace elements are copper (Cu), selenium (Se), cobalt (Co) and iodine (I). Zinc (Zn) and manganese (Mn) deficiencies are much less important. Other minerals can interfere with the utilisation of essential trace elements in the body, for example the presence of molybdenum (Mo) and sulphur (S) can precipitate a copper deficiency.

This report reviews the role of the important trace elements for beef and sheep production in England and Wales, and provides guidance on assessing deficiencies and the need for supplementation.
Part 1

Trace element deficiencies in England and Wales

Farmers are usually well aware of the potential impact of a number of trace element deficiencies on their stock. Examples include cobalt deficiency causing ill-thrift, or ‘pine’ in weaned lambs; selenium deficiency linked with ‘White Muscle Disease’ (WMD) and infertility in cattle; and ‘swayback’ problems resulting from copper deficiencies on peaty land in sheep.

However whilst a trace element deficiency is often blamed for poor production, rations short of energy or the presence of gut parasites or liver fluke, are often more common causes of ill-thrift.

The classic clinical signs associated with trace element deficiencies can be slow to develop. Leading up to this, the only signs may be lighter weights or poorer lambs at slaughter.

A deficiency state should always be confirmed by independent testing and advice before supplementing stock with extra trace elements.

Geology and soil

The main reason for different trace element deficiencies across England and Wales is variable geology and soils. Cattle and sheep production is largely grass and forage based. If the soil cannot supply sufficient trace elements to the plants that animals are eating, a deficiency will occur. This is more likely to show up where the ration is mainly grazed grass or conserved forage, such as a spring calving herd fed no concentrates or minerals, store cattle or grass finished lambs.

In general:

+ Sandy soils contain less trace elements than clay soils
+ Free draining soil contains less trace elements than poorly drained soils
+ Soil derived from acid rocks such as granite is low in trace elements
+ Excessive liming will reduce herbage cobalt levels but increase the amount of molybdenum present. The latter can reduce the availability of copper to livestock

The trace element content of plants can vary widely even in the same soil. In general herbs and weeds have much higher trace element levels than grasses, and clover is generally richer in trace elements than grass. Re-seeding can reduce trace element intake by reducing the diversity of plants present. Rapidly growing, lush pasture following fertiliser application will also have low trace element content. Encouraging greater sward diversity and incorporating clover can often reduce the need to supplement the animals' diet with trace elements.

The important trace elements

Copper

Copper is an essential part of a number of different enzymes which allow the body to function. The amount of copper that ruminants absorb from the diet is very variable. Excess copper is stored in the liver. Ruminants are susceptible to copper toxicity, either if a very large amount of copper is ingested or injected at one time, or if copper accumulates in the liver over a long period of time.

Deficiency

Copper deficiency occurs when there is not enough copper available for the animal to use. The signs of copper deficiency vary.

‘Swayback’ in lambs occurs when a lack of copper results in damage to the spinal cord. In cattle copper deficiency can cause ‘spectacling’ of dark coated cattle due to reduced pigmentation of the hair around the eyes.

A more serious deficiency results in poor growth and scouring, and in extreme cases a thickening of bones around the joints. Infertility in cattle is also often linked to copper deficiency.

Swayback is becoming increasingly rare, possibly due to lambing taking place indoors and/or a clear recognition of the risk on certain soils and farms.

Copper absorption varies considerably in different breeds. Texels absorb copper very efficiently to the extent that they can be put at risk of copper toxicity, whereas Scottish Blackface are less efficient and more likely to suffer copper deficiency.

Copper deficiency can be diagnosed from copper analysis of blood samples or liver tissue. The latter is considered the gold standard and gives a better indication of an animal’s copper status. Liver biopsy can be carried out on live animals, but more commonly liver samples are taken from slaughtered/dead animals.
Copper deficiency is either a primary deficiency due to low copper intake, or occurs due to the interference of other elements, specifically a three-way interaction between copper, molybdenum and sulphur, which reduces the availability and absorption of copper from the rumen. This is sometimes referred to as secondary deficiency.

The interaction between copper and molybdenum was first discovered in Somerset where ‘teart’ pastures which are excessively high in molybdenum caused diarrhoea in cattle. Supplementation with copper prevented the condition occurring. Excessive iron intake can also interfere with copper availability.

Copper is more readily available from cereals and other concentrate feeds than from grass or conserved forage. Compound feeds and minerals formulated for sheep do not have added copper, but cattle feeds and minerals do and should never be fed to sheep.

Preventing deficiency

Due to the risk of causing toxicity, animals should only be supplemented with copper when laboratory tests confirm that extra copper is needed. Sheep are more susceptible to copper toxicity than cattle. For cattle, extra copper may be added to the feed, given orally or by injection. Or copper may be applied to the pasture, usually in combination with other trace elements.

Example 1

Investigations on a farm with 760 ewes and 22 Welsh Black suckler cows highlighted copper and selenium deficiencies. Grass samples were analysed in May and September and blood samples were taken from a representative number of sheep and cattle. Liver analysis was carried out on some finished lambs and cattle.

There was low copper availability from pasture with deficiency in cows and growing cattle. Selenium deficiency was also identified in cattle and sheep.

Cattle

The blood and forage results and the colour of the coats of the young calves (rusty rather than black) persuaded the farmer to give all the cows and young calves copper boluses and slow release selenium injections in July.

Figure 1 shows the spring and autumn copper levels for the cattle blood results. The grey area represents the recommended reference range for copper in cattle. This shows that only after supplementation in the summer were blood levels satisfactory.

Sheep

Liver samples from lambs showed that five out of six lambs were selenium deficient. White Muscle Disease had been a problem on the farm and supplementation was in place to address this. These lambs had been given a multi-vitamin drench three weeks before slaughter and this had not corrected the deficiency. An alternative method of supplementation was therefore considered.

Autumn blood sampling showed all ewes and lambs to be deficient in selenium.

The results highlighted the extent of the copper and selenium deficiencies on the farm. Consequently the farmer has treated both cattle and sheep differently compared to previous years with additional supplementation. Performance will be monitored carefully in future to see if the supplements have been cost effective.

![Figure 1: Blood copper levels](image1)

![Figure 2: Blood selenium levels in the cattle](image2)
Cobalt

Cobalt is an essential component of vitamin B\textsubscript{12}, which is associated with energy metabolism. In ruminants this vitamin is produced by rumen micro-organisms which require a regular supply of cobalt in the animal’s diet. Vitamin B\textsubscript{12} is secreted in milk which provides an early source to suckling lambs and calves. Cobalt is only required as the rumen develops.

Deficiency

Also known as 'pine', cobalt deficiency results in ill-thrift accompanied by poor appetite. Weaned lambs are most at risk, then adult sheep, followed by growing cattle and adult cattle. Where sheep and cattle are grazed on the same pastures, deficiency may be diagnosed in the sheep flock but not in the cattle. Other signs of deficiency include lethargy, poor appetite, an ‘open’ fleece, tear staining of cheeks and poor condition despite adequate grazing. In severe cases, animals become emaciated, weak and anaemic.

As a consequence of ill-thrift, lambs are more prone to clostridial disease and pasteurellosis. Heavy worm burdens reduce the absorption of vitamin B\textsubscript{12} from the gut, so may induce cobalt deficiency even when dietary cobalt is adequate.

Diagnosis based on clinical signs can be supported by low blood or liver vitamin B\textsubscript{12} levels. There is usually a lag period before deficiency symptoms develop in lambs grazing deficient pasture as the vitamin B\textsubscript{12} reserves become depleted. Cobalt deficiency in adult ewes may be associated with reduced fertility and increased peri-natal lamb mortality.

Pasture levels

Pasture cobalt availability is affected by soil pH. Acid, iron-rich and alkaline, manganese-rich soils are often associated with increased incidence of cobalt deficiency. Work in Scotland carried out by the Moredun Institute, has indicated that soil cobalt may be poorly absorbed by upland/moorland pastures on very acid soils at a pH of less than 5.

Different plant species take up different amounts of cobalt, for example clover will contain much higher levels of cobalt than ryegrass in the same sward. Cobalt levels in pasture tend to be lower in spring than the autumn.

Soils have much higher cobalt levels than pasture, so soil contamination can be a source of cobalt. On marginally deficient pastures a low stocking rate is more likely to induce a deficiency than heavy grazing which forces the animals to graze closer to the soil. In general the concentration of cobalt in pasture grasses declines as soil pH rises, hence liming can induce a cobalt deficiency.

Preventing deficiency

Oral drenching with cobalt raises blood vitamin B\textsubscript{12} level for about seven days only. In practice, drenching every three to four weeks is often sufficient to maintain vitamin B\textsubscript{12} levels in weaned lambs. Vitamin B\textsubscript{12} injections are an alternative to drenching but also need to be given every three to four weeks.

For longer term supplementation, cobalt can be supplied in a rumen bolus, either on its own, or in combination with other trace elements. Boluses provide several months supply of cobalt. As with all boluses, care must be taken when giving them to avoid injury to the back of the throat.

Top dressing pastures with cobalt sulphate (at the rate of 2kg/ha every third year) can be carried out, but is not considered cost effective in the UK.

Selenium

Selenium acts with vitamin E to protect tissues against oxidation and the breakdown of cell membranes. It is also important for immune function. The selenium requirements of stock are related to the vitamin E content of the diet. For diets low in vitamin E the requirements for selenium are increased and vice versa.

If pregnant ewes are fed diets low in selenium and/or vitamin E, their lambs can suffer from WMD (stiff lamb disease) for up to six months.

Deficiency

Lack of selenium is mostly widely recognised as White Muscle Disease (WMD), ill-thrift, and infertility. The occurrence of WMD is generally low now.

A typical example would be when young animals not used to exercise, are newly turned out onto lush pasture. They suffer muscle damage which can prove fatal.

A deficiency in young lambs can show as an inability to stand because their leg muscles are affected. In young animals, selenium deficiency may be a cause of ill-thrift.
Lack of selenium can also cause poor reproductive performance. In females, it can cause early embryonic death, resulting in poor scanning figures in sheep and an extended calving period in cattle. Retained placenta in cattle can also be associated with selenium deficiency.

Inadequate selenium also affects male fertility, so where a deficiency is identified, it is important that rams and bulls are also supplemented.

Excess selenium is toxic to sheep and cattle. Currently, cases of selenium toxicity are still relatively rare. Diagnosis is usually by blood sampling and measuring levels of the enzyme, glutathione peroxidise, which contains selenium.

**Pasture levels**

Unlike most trace elements, there is a direct relationship between selenium levels in soil, grassland and the animal. So, if soil or pasture levels are known, the likelihood of animals developing a deficiency can be predicted with some confidence.

Different plant species take up different amounts of selenium for example, clovers contain less than ryegrass. A herbage analysis can be misleading if it does not represent what the animals are actually eating in a diverse sward. The selenium content of pasture varies widely from about 0.02-0.15mg/kg DM. The typical level is 0.06-0.08mg/kg DM.

Although experience shows that cattle and sheep grow normally on pastures containing 0.06mg/kg DM, it is widely recommended that the whole diet should contain 0.1mg/kg DM or more.

Sulphur, increasingly used in fertilisers for grass silage, can interfere with selenium uptake by plants and over-use can exacerbate a marginal deficiency of selenium.

**Preventing deficiency**

Oral drenching with selenium salts can provide adequate supplementation for one to three months. Selenium can also be given by injection, with slow release formulations providing up to 12 months supply from a single shot. Selenium can also be given in a rumen bolus, or applied to pasture in combination with other trace elements.

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**Example 2**

A significant selenium deficiency in sheep was discovered on a mixed farm in England. The farm carries a total of 800 breeding ewes; 500 Welsh Mules and 300 Lleyns. Typically ewes scan at around 180% with 160% lambs reared. The farm also has a herd of 240 suckler cows.

Analysis of four grass fields in 2010 showed all to be below the recommended minimum for cobalt and selenium. Cobalt levels averaged 0.07mg/kg (satisfactory level 0.1mg/kg) and selenium 0.03mg/kg (satisfactory level 0.06mg/kg).

The estimated daily trace element intake for the suckler cows and breeding ewes from forage and supplements was plotted throughout the year and compared to the recommended daily allowance. This annual trace element profile highlighted a potential shortfall in selenium for breeding ewes particularly towards the end of the summer when they had been reliant on grass alone for several months (see Figure 3 opposite).

Blood samples taken from ewes in May showed selenium levels to be satisfactory, but by September levels for most were below the target minimum. Liver samples taken from finished lambs in September confirmed marginal selenium deficiency in some animals.

Following these results the decision was taken to supplement all the breeding ewes with a multi-trace element bolus in late September. They were blood sampled around a month later. The results showed cobalt and selenium had increased three to four fold.

Performance of the flock will be monitored to assess the cost-effectiveness of the treatment. However scanning had already improved by 10%.

**Figure 3: Intake of selenium compared to the recommended allowance**
Iodine

Deficiency

Iodine is a component of the important hormone thyroxine which controls the animals’ energy metabolism. It is also essential for foetal growth and development. Iodine deficiency is typically associated with an enlarged thyroid, commonly known as goitre. Typical signs are late abortions, presenting as still-born or weak calves and lambs. Neonatal mortality is markedly increased. Cows deficient in iodine tend to retain their afterbirths.

Pasture levels

The level of iodine in pasture varies depending on species, soil type, fertiliser treatment, climate and season. There is no clear relationship between levels in herbage and rock or soil type. Iodine can be deposited by rainfall, especially when clouds form over seawater, with coastal regions seeing the highest level of pasture iodine.

The typical level in pasture grasses is 0.2-0.3mg/kg DM. Improved grassland usually has higher iodine levels than un-improved - a high percentage of pastures in upland Wales are recognised as being low in iodine.

Pregnant and lactating animals have a much higher iodine requirement compared to dry stock, and pasture is often unable to fully satisfy requirements on its own. Some forage crops such as brassicas contain substances called goitrogens, which interfere with thyroxine production or utilisation. Animals grazing brassica crops have an increased requirement for iodine compared with those grazing grass.

Taking samples from the thyroid gland from stillborn lambs or calves is the best way of diagnosing iodine deficiency. In adult animals, blood can be tested for the hormone thyroxine, or for inorganic iodine, although the latter only reflects the dietary intake over the previous week.

Preventing deficiency

Iodine may be given by oral drench or in a slow release rumen bolus. It can also be applied to pasture in combination with other trace elements.

Manganese

Deficiency

Manganese is an important trace element which is essential for the correct functioning of several enzyme systems within the body. Deficiency in livestock is uncommon. Symptoms are reported as joint and bone abnormalities often linked with a ‘stiff’ gait. Low manganese intakes are also reported to cause delayed or irregular oestrus and poor conception. In England and Wales, deficiency is unlikely in grazing animals.

Pasture levels

Manganese levels vary widely in pasture and soil pH has a major influence on plant uptake. Legumes are a richer source than grasses.

Acid soil and poor drainage are associated with a greater increase in the accumulation of manganese in plants. So a deficiency is extremely unlikely in hill and upland pastures. Over liming to more than pH 6.5 will significantly reduce manganese levels in pasture.

Zinc

Zinc occurs widely throughout the body with the greatest concentration in skin, wool, hair and horn. High concentrations are found in the male sex organs and their secretions. Zinc is involved in many biochemical processes and a deficiency affects a wide range of body functions. Deterioration of hair or wool texture, stiff joints and thick, scaly, cracked skin are accompanied or preceded by poor growth. Reproductive function is also impaired.

A zinc deficient diet will not produce all of these symptoms. Usually clinical signs do not appear unless the diet contains levels well below those recommended as acceptable.

Pasture levels

As zinc is not easily mobilised within the body, the animal relies on a continuous dietary supply. Herbage analyses often report inadequate dietary intake, but there is little evidence to suggest a deficiency with levels above 25 mg/kg DM.

Table 1: Trace element levels in pasture and recommended levels

<table>
<thead>
<tr>
<th>Trace Element</th>
<th>Typical levels in pasture (mg/kg DM)</th>
<th>Typical average level in UK pastures (mg/kg DM)</th>
<th>Recommended minimum levels in pasture to prevent deficiency (mg/kg DM)</th>
<th>Recommended levels in the total diet (mg/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>2-15</td>
<td>8</td>
<td>5* / 8**</td>
<td>10</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.05-0.25</td>
<td>0.1</td>
<td>0.11* / 0.08**</td>
<td>0.12</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.02-0.15</td>
<td>0.07</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>Iodine</td>
<td>0.1-0.5</td>
<td>0.15</td>
<td>0.2^ / 0.5^^</td>
<td>0.5</td>
</tr>
<tr>
<td>Manganese</td>
<td>25-250</td>
<td>100</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Zinc</td>
<td>20-60</td>
<td>50</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

Methods of Supplementation

Free-choice minerals
Widely used but intake can be variable. The widespread belief that animals are aware of any mineral deficiency and will only take what they need is wrong.

Intake of mineral mixes, licks and blocks, both between animals in the same group and across breeds and farms is significant. Some animals take little or none at all, others take several times more than they require. Self-help minerals contain a lot of common salt to control intake and it is this which stock is attracted to.

In-feed minerals
Compound feeds and balancers are generally well fortified with trace elements, although the level of feeding dictates the amount of trace elements the stock receives.

When the concentrate is a mix of straight feeds, it is often prudent to add a mineral supplement. The rate of inclusion can be calculated from the recommended daily intake per head, for example if a pregnant ewe requires 25g per head per day, and is being fed 1kg of concentrates, the mineral inclusion rate should be 25kg per tonne.

Chelated - where the trace element is bonded to another compound, or organic sources of trace elements, may be absorbed by the animal more effectively than cheaper inorganic sources. However, the benefits of using these have not always been seen in practice, as absorption varies.

Drenches
An effective method for ensuring each animal receives the required level of trace elements for optimum performance.

Drenches containing iodine and cobalt need to be repeated at regular intervals. As cobalt is required by rumen microorganisms for the production of vitamin B12, it has to be supplied through the diet. However, another way of rapidly overcoming a deficiency is by directly injecting the vitamin.

Copper supplementation for sheep must only be given under veterinary advice, as copper is extremely toxic to sheep.

There is a variety of products available that deliver a cocktail of trace elements and vitamins. Before using any of these products it is advisable to identify deficiencies on the farm and supplement only according to specific need.

Slow release bullets or boluses
These can be very effective in targeting individual trace element deficiencies, providing supplementation for a longer period than oral drenches. For example copper oxide needles administered in a gelatine capsule at a dose rate of 0.1g copper oxide per kg liveweight to remedy copper deficiency.

Cobalt bullets have been widely used, but stock may suffer from rumen regurgitation or the coating sometimes prevents the cobalt from releasing. They may be an expensive method of cobalt supplementation for lambs, which only require a short period of supplementation.

Soluble glass boluses and trace element bullets containing copper, cobalt, selenium and iodine are very effective, especially where a marginal deficiency of more than one trace element is a problem.

Top dressing pasture
This provides a longer term solution to raise the level of trace elements in grassland. This can be effective in the case of simple deficiencies but not where availability is restricted by other factors, such as alkaline soils.

This method requires a disciplined approach with accurate records of application rates and timing.

Table 2: Comparison of different methods of trace element supplementation

<table>
<thead>
<tr>
<th>Option</th>
<th>Cost</th>
<th>Effectiveness</th>
<th>Ease of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free choice minerals</td>
<td>£</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>In feed minerals</td>
<td>£</td>
<td>**</td>
<td>***</td>
</tr>
<tr>
<td>Drenches</td>
<td>£</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Injections</td>
<td>££</td>
<td>***</td>
<td>**</td>
</tr>
<tr>
<td>Bolus</td>
<td>££</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Top dressing pasture</td>
<td>£££</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

Conclusion
It is important to monitor trace element levels in ruminants on a regular basis, in all situations, at least annually.

Bear in mind that changes to pasture, such as reseeding or liming, may change the availability of trace elements.

The weather can also affect availability – in wet seasons, animals ingest more soil than in dry years, making cobalt more available, but copper less so.

Where routine supplementation is practiced, monitoring levels in the animals is important to check that the level of supplementation is appropriate - sufficient to make up any shortfall and not providing more than is necessary, which would waste money.

A monitoring programme should be drawn up with the vet as part of an active health plan.
Part 2

Trace element case studies for cattle and sheep

Method

Seven suckler beef and sheep farms, four in England and three in Wales, were identified for the study (see below). The farmers were asked to provide background information including basic performance data and details of all trace element inputs into their animals for a year from October 2009 to September 2010.

Table 3: Case study farms – area and stock numbers

<table>
<thead>
<tr>
<th>Case study</th>
<th>Area (ha)</th>
<th>Breeding ewes</th>
<th>Suckler cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lleyn peninsula</td>
<td>280</td>
<td>850</td>
<td>200</td>
</tr>
<tr>
<td>2 Gwynedd</td>
<td>140</td>
<td>700</td>
<td>35</td>
</tr>
<tr>
<td>3 Powys</td>
<td>150</td>
<td>760</td>
<td>22</td>
</tr>
<tr>
<td>4 Shropshire</td>
<td>518</td>
<td>800</td>
<td>240</td>
</tr>
<tr>
<td>5 Northumberland</td>
<td>650</td>
<td>1200</td>
<td>130</td>
</tr>
<tr>
<td>6 Warwickshire</td>
<td>465</td>
<td>1700</td>
<td>160</td>
</tr>
<tr>
<td>7 Somerset</td>
<td>530</td>
<td>430</td>
<td>60</td>
</tr>
</tbody>
</table>

Detailed analysis of all seven case studies can be viewed on-line in the R&D section of the AHDB Beef & Lamb website at beefandlamb.ahdb.org.uk.

Sample collection and analysis

Forage samples

Four grazing/conservation fields were sampled on each farm in May/June and September. Samples were taken from representative areas with care taken to minimise soil contamination by soil, which can lead to unusually high levels of some trace elements (such as iron and cobalt) in forage samples.

Forage samples were sent for analysis where they were analysed for cobalt, selenium, copper, iron, sulphur, molybdenum, zinc and iodine.

Blood and liver samples

Blood samples were taken in the spring and the autumn by each farm’s vet and sent for analysis. The aim was to sample eight ewes and eight lambs and six cows and six calves for copper, cobalt (by measuring Vitamin B_{12}) and selenium (measuring GSH-Px), with half this number being analysed for thyroxine (T_{4}) to indicate iodine status.

Cobalt is essential to ruminants as it is converted to vitamin B_{12} in the rumen. Blood and liver B_{12} levels were used to assess cobalt status.

Measuring selenium in blood is costly, and most UK labs measure a selenium-containing enzyme, glutathione peroxidise, to determine levels in the blood.

This study chose to use the iodine-containing enzyme thyroxine (T_{4}) as the indicator of iodine status.

Where finished stock was sold deadweight the aim was to examine liver samples from six lambs and six finished cattle. These liver samples were analysed for copper, selenium, iron, manganese and zinc.

Sources of trace elements

The study aimed to capture all the trace elements supplied to the stock from; forage, compound feeds (including feed blocks), straight feeds, in-feed minerals, free-access mineral and trace element buckets/licks, mineral/vitamin drenches, trace element boluses, injections, anthelmintic products containing selenium and cobalt, pasture dressing.

Assumptions used to calculate the trace element profiles

Trace element profiles were drawn up for each farm to give a rough indication of the likely adequacy of the total diet across the year for the breeding stock. Some specific assumptions have been applied to the data:

+ In each case the recommended daily allowance or requirement and estimated total daily intakes have been calculated using average dry matter intakes of 2.5% of liveweight for ewes and 2% for suckler cows. These are assumed to remain constant throughout the year
+ Total daily allowances of cobalt, selenium and iodine have been based on information produced for the ARC (1980) technical review on the nutrient requirements of ruminant livestock. In reality the amount necessary to prevent deficiency in an animal may be lower
+ To simplify the calculation, the daily allowances for cobalt, selenium and iodine have been assumed to be constant throughout the year irrespective of the physiological status of the animal
+ Copper requirements (rather than allowances) are based on information provided by ‘The Mineral Nutrition of Livestock’ (3rd edition)
+ The daily amount of trace element released from boluses has been assumed to be constant throughout the active life of the product although in reality, roughening of the surface in the rumen means that for some products, the rate increases over time
+ Oral drenches which typically contain high levels of trace elements have been spread over a seven day period for all elements
+ The manufacturers’ declared analysis has been used wherever possible
James Evans farms in partnership with his father and brother on two holdings in Shropshire. The case study farm is an upland farm extending to around 518ha. Much of it is in a Less Favoured Area (LFA) and is managed under a contract farming arrangement.

The farm sits on sandy, clay loam soils at 120-365m above sea level and receives around 900mm rain annually. No grassland improvement has been carried out in the last ten years and 160ha are classified as rough grazing. Conserved forage is made on 80ha of grassland.

**Sheep**

The farm carries a total of 800 breeding ewes. In the past these have been Welsh Mules but Mr Evans is moving to Lleyn ewes, with around 300 lambed in 2010.

After tupping on grass, ewes spend December to February on stubble turnips. In 2010 Lleyn ewes were lambed outside from the third week of March, receiving feed buckets rather than being trough fed. Typically ewes scan at around 180% with 160% reared. Lambs are weaned at 16 weeks of age in July and finished lambs are sold off grass from 1 August. Some late finishing lambs are finished off turnips.

Lambs are sold deadweight at an average of 19kg carcass weight. A proportion of the lambs is sold as stores.

**Cattle**

The farm carries spring and autumn calving herds of suckler cows. The 160-cow spring herd consists of purebred Stabiliser and Limousin cross Holstein cows all put to Stabiliser bulls. A further 80 Stabiliser and Limousin cross cows calve in the autumn. The aim is to move to Stabiliser cows in both herds.

The spring calving cows are typically housed in early November and fed a grass silage and straw ration with 100g/head of a specially formulated mineral. All cows receive a multi-trace element/vitamin bolus in early March before being turned out to grass as they calve. Calving spread is around 12 weeks with 96 calves per 100 cows typically being reared. Calves do not receive creep feed until the autumn; they are weaned at six to eight months and are sold as stores.

**Trace element sampling**

Analysis of four grass fields showed all to be low in cobalt and selenium, although levels were slightly higher in the autumn. On average copper levels were adequate and only moderate levels of antagonistic trace elements were present. However, individual fields did show elevated sulphur and molybdenum which can affect copper absorption in animals.

<table>
<thead>
<tr>
<th>Trace Element</th>
<th>Spring</th>
<th>Autumn</th>
<th>Shropshire Farm Average</th>
<th>Typical Average Level in Pasture</th>
<th>Satisfactory Pasture Levels to avoid deficiency risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (mg/kg DM)</td>
<td>9.53</td>
<td>9.18</td>
<td>9.35</td>
<td>9</td>
<td>&gt;8</td>
</tr>
<tr>
<td>Cobalt (mg/kg DM)</td>
<td>0.046</td>
<td>0.088</td>
<td>0.067</td>
<td>0.1</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td>Selenium (mg/kg DM)</td>
<td>0.023</td>
<td>0.038</td>
<td>0.031</td>
<td>0.07</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Zinc (mg/kg DM)</td>
<td>36.73</td>
<td>60.03</td>
<td>48.38</td>
<td>51</td>
<td>&gt;25</td>
</tr>
</tbody>
</table>

The trace element profile for cobalt, selenium and iodine throughout the year has been plotted using the forage results and the declared analyses of other feeds offered.

The results are presented in Figures 4 and 5. In each case the recommended daily allowance (Allowance) and estimated total daily intakes (Total intake) have been calculated.
Trace element profiles for sheep

Figure 4a: Annual cobalt profile for the breeding ewes

Figure 4b: Annual selenium profile for the breeding ewes

Figure 4c: Annual iodine profile for the breeding ewes

Trace element profiles for cattle:

Figure 5a: Annual cobalt profile for the breeding suckler cows

Figure 5b: Annual selenium profile for the breeding suckler cows

Figure 5c: Annual iodine profile for the breeding suckler cows
The graphs indicate that the predicted supply of all three trace elements should have fully met the requirements of suckler cows throughout the year. The profiles for ewes show adequate levels of cobalt and iodine, but selenium levels are below the recommended allowance for around eight months of the year. The prolonged period of low selenium intake between May and September leaves ewes vulnerable to deficiency at the end of summer. This is reflected in the blood samples taken in September (Table 5).

Predicted copper requirements are influenced by interactions with molybdenum, sulphur and iron which affect the amount of absorbable copper in the diet. Figure 6 shows that copper intakes for sheep and cows exceed requirements throughout the year. It can be seen however, that for the cows, forage alone does not meet their full requirements for around six months of the year.

Table 5a: Blood results for the ewes

<table>
<thead>
<tr>
<th>Ewes</th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
<th>Post bolus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (umol/l)</td>
<td>9 to 19</td>
<td>14.3</td>
<td>14.6</td>
<td>17.6</td>
</tr>
<tr>
<td>Cobalt (Vit B₁₂) (pmol/l)</td>
<td>&gt;188</td>
<td>382</td>
<td>414</td>
<td>1257</td>
</tr>
<tr>
<td>Selenium (GSH-Px) (U/ml RBCs)</td>
<td>&gt;50</td>
<td>119</td>
<td>28.1</td>
<td>114.5</td>
</tr>
<tr>
<td>Iodine (T₄) (nmol/l)</td>
<td>35 to 75</td>
<td>79.4</td>
<td>36.1</td>
<td></td>
</tr>
</tbody>
</table>

Table 5b: Blood results for the lambs

<table>
<thead>
<tr>
<th>Lambs</th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (umol/l)</td>
<td>9 to 19</td>
<td>16.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Cobalt (Vit B₁₂) (pmol/l)</td>
<td>&gt;188</td>
<td>362</td>
<td>271</td>
</tr>
<tr>
<td>Selenium (GSH-Px) (U/ml RBCs)</td>
<td>&gt;50</td>
<td>120</td>
<td>49</td>
</tr>
<tr>
<td>Iodine (T₄) (nmol/l)</td>
<td>35 to 75</td>
<td>132.5</td>
<td>48.0</td>
</tr>
</tbody>
</table>

Table 6a: Blood results for the cows

<table>
<thead>
<tr>
<th>Cows</th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (umol/l)</td>
<td>9 to 19</td>
<td>14.4</td>
<td>15.3</td>
</tr>
<tr>
<td>Cobalt (Vit B₁₂) (pmol/l)</td>
<td>&gt;100</td>
<td>141</td>
<td>127</td>
</tr>
<tr>
<td>Selenium (GSH-Px) (U/ml RBCs)</td>
<td>&gt;30</td>
<td>127</td>
<td>76</td>
</tr>
<tr>
<td>Iodine (T₄) (nmol/l)</td>
<td>26 to 84</td>
<td>53.9</td>
<td>54.7</td>
</tr>
</tbody>
</table>

Table 6b: Blood results for the calves

<table>
<thead>
<tr>
<th>Calves</th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (umol/l)</td>
<td>9 to 19</td>
<td>12.1</td>
<td>9.9</td>
</tr>
<tr>
<td>Cobalt (Vit B₁₂) (pmol/l)</td>
<td>&gt;100</td>
<td>198</td>
<td>142</td>
</tr>
<tr>
<td>Selenium (GSH-Px) (U/ml RBCs)</td>
<td>&gt;30</td>
<td>93</td>
<td>44</td>
</tr>
<tr>
<td>Iodine (T₄) (nmol/l)</td>
<td>26 to 84</td>
<td>82.1</td>
<td>69.7</td>
</tr>
</tbody>
</table>

Figure 6a: Annual copper profile for the breeding ewes

Blood results for the cows and calves were satisfactory for all tests in the spring (Table 6). In the autumn, although average results were satisfactory, half of the calves sampled were low in copper and one was low in selenium. At the time of the blood sampling calves had not received any creep feed. The results for the cows remained satisfactory for all tests.

Blood sampling of ewes and lambs showed all results to be above the minimum in the spring (Table 5). By the autumn,
selenium levels in most of the sheep were below the minimum, so the decision was taken to supplement all the breeding ewes with a multi-trace element bolus.

Liver samples taken from finished lambs in September confirmed the low selenium levels in some animals. Results for the other elements were satisfactory for ewes and lambs.

Ewes were bolused in late September with a multi-trace element bolus and blood sampled around a month later. The results showed levels of cobalt and selenium to have increased by three to four times (Table 5). Mr Evans is monitoring the performance of the flock to assess the cost-effectiveness of the treatment.

**Summary**

+ Forage analysis showed all fields to be low in cobalt and selenium
+ Individual fields had marginally low copper and/or raised sulphur and molybdenum
+ Blood samples in 2010 showed:
  • All cattle and sheep results satisfactory in the spring
  • Some copper levels in calves were below the reference range in the autumn
  • Breeding ewes and lambs were low in selenium in autumn
  • Breeding ewes were satisfactory following administration of a trace element bolus

**Changes made/future actions**

+ Breeding ewes were given a multi-trace element bolus pre-tupping – cost effectiveness to be monitored
Case Study - Northumberland

Simon Bainbridge farms 650ha near Morpeth in Northumberland. Managed organically, the farm sits on sandy loam soils at 200 - 260m above sea level and receives around 1200mm of rainfall annually.

Most of the land is classed as rough grazing, but around 80ha are used for grass silage with a further 60ha for arable crops. Crops grown include barley and red clover. In 2010 a pasture dressing was applied to the red clover and grass silage fields in May. This contained a wide range of minerals and trace elements and was applied as a granule/dust using a lime spreader.

Sheep

In total there are 1200 Swaledale and North Country Mule ewes on the farm. Swaledales are either bred pure or put to Blue Faced Leicester rams. The Mule ewes are mated with Suffolk rams.

In October/November prior to tupping all ewes receive a trace element bolus containing cobalt, selenium and copper, but do not receive any other supplements during tupping. Ewes are offered hay and organic feed buckets over winter. Twin bearing Mules are housed from mid/late February until April on a TMR ration of silage, wholecrop barley and purchased protein. A specially formulated mineral supplement including copper is mixed into the diet.

Ewes lamb at grass from mid-April, do not receive any supplements. The Swaledale ewes typically scan at around 150% and the Mules at 180% with around 150% reared overall. Lambs are weaned at around 14 – 16 weeks of age and are sold finished between August and the following April. At weaning Swaledale and Mule lambs are given a trace element bolus containing cobalt, selenium and copper, whilst the Suffolk cross lambs receive monthly injections of vitamin B₁₂.

Lambs are finished on silage aftermaths and red clover. Later finishing lambs move onto forage rape or turnips before being finished indoors.

Cattle

The farm carries 130 Aberdeen Angus and continental cross suckler cows. A total of 65 calve down in the autumn (from 20 September) and 55 in the spring (from 20 March).

Cattle are housed from the end of October and are fed a TMR ration based on silage and straw with specially formulated high copper minerals. Autumn calvers also receive some home-grown barley. All cows receive a trace element bolus containing cobalt, selenium and copper pre-turnout in May.

Spring born calves are weaned at seven months and autumn born calves at eleven months of age. Finished cattle are sold deadweight with some stock supplying a local farm shop.

Trace element sampling

Three grass fields and one of red clover were sampled and average results for the four fields are shown in Table 7.

The spring results identified low copper levels in all fields. However, minerals affecting copper availability were also low. All the fields were also below recommended levels for cobalt and one field was low in selenium. Selenium levels were however high in two fields that had received the pasture dressing, raising the overall average. With the exception of selenium, levels of all trace elements were higher at the autumn sampling. Although copper levels were at satisfactory levels, sulphur and molybdenum had also increased, reducing copper availability.

Table 7: Northumberland farm – forage results (highlighted figures indicate levels outside the recommended range)

<table>
<thead>
<tr>
<th></th>
<th>Spring</th>
<th>Autumn</th>
<th>Shropshire Farm Average</th>
<th>Typical Average Level in Pasture</th>
<th>Satisfactory Pasture Levels to avoid deficiency risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (mg/kg) DM</td>
<td>6.33</td>
<td>11.43</td>
<td>8.88</td>
<td>9</td>
<td>&gt;8</td>
</tr>
<tr>
<td>Cobalt (mg/kg) DM</td>
<td>0.048</td>
<td>0.103</td>
<td>0.075</td>
<td>0.1</td>
<td>&gt;0.1</td>
</tr>
<tr>
<td>Selenium (mg/kg) DM</td>
<td>0.44</td>
<td>0.11</td>
<td>0.27</td>
<td>0.07</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Zinc (mg/kg) DM</td>
<td>33.10</td>
<td>47.18</td>
<td>40.14</td>
<td>51</td>
<td>&gt;25</td>
</tr>
<tr>
<td>Minerals affecting availability of copper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum (mg/kg) DM</td>
<td>0.54</td>
<td>1.84</td>
<td>1.19</td>
<td>1.3</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Sulphur (%)</td>
<td>0.16</td>
<td>0.32</td>
<td>0.24</td>
<td>0.15</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Iron(mg/kg) DM</td>
<td>79.2</td>
<td>315.75</td>
<td>197.48</td>
<td>150</td>
<td>&lt;500</td>
</tr>
</tbody>
</table>
There was some variation between fields with the red clover typically having higher levels of cobalt and selenium than the grass fields, and dressed fields higher than the undressed. Quantities of minerals and trace elements applied to these fields are shown in Table 8 and a comparison of copper, cobalt and selenium levels in forage for dressed versus undressed fields is shown in Table 9.

Table 8: Levels of minerals and trace element applied in pasture dressing

<table>
<thead>
<tr>
<th>Major minerals Kg/ha</th>
<th>Trace Elements Kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium 300</td>
<td>Silicon 150</td>
</tr>
<tr>
<td>Phosphorus 11</td>
<td>Manganese 750</td>
</tr>
<tr>
<td>Potassium 11</td>
<td>Copper 750</td>
</tr>
<tr>
<td>Magnesium 45</td>
<td>Zinc 750</td>
</tr>
<tr>
<td>Sodium 64</td>
<td>Boron 300</td>
</tr>
<tr>
<td>Sulphur 23</td>
<td>Iodine 80</td>
</tr>
<tr>
<td></td>
<td>Selenium 60</td>
</tr>
<tr>
<td></td>
<td>Cobalt 50</td>
</tr>
</tbody>
</table>

Table 9: Comparison of trace element levels in pasture (mg/kg DM)

<table>
<thead>
<tr>
<th></th>
<th>Top dressed in May (red clover and grass silage)</th>
<th>No top dressing (grazing)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring</td>
<td>Autumn</td>
</tr>
<tr>
<td>Copper</td>
<td>6.8</td>
<td>13.2</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.06</td>
<td>0.13</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.83</td>
<td>0.16</td>
</tr>
</tbody>
</table>

The trace element profile for cobalt, selenium and iodine throughout the year has been plotted using the forage results and the declared analyses of other feeds and supplements offered. The results are presented Figures 7 and 8. In each case the recommended daily allowance (Allowance) and estimated total daily intakes (Total intake) have been calculated.
The graphs indicate that the predicted supply of all three trace elements should have fully met the requirements of suckler cows throughout the year. Supplies of selenium and iodine appeared to be above the requirements for the ewes throughout the year, but cobalt supply was marginally low throughout the summer grazing. Predicted copper requirements are influenced by interactions with molybdenum, sulphur and iron which affect the amount of absorbable copper in the diet. Figure 9 shows that total copper supply for the cows was above requirements throughout the year.

The supply for ewes is above requirements over the winter feeding period but falls to closely match requirements over the summer. Blood samples for cows and ewes should have been above the recommended minimum based on these intakes.

Cattle blood results were satisfactory for all tests for both cows and calves in the spring (Table 10). However, in the autumn blood samples for cows remained satisfactory but the majority of calves had copper levels below the reference range. Levels for other tests were satisfactory. However, the practice vets considered selenium levels in calves to be marginal and therefore likely to respond to supplementation.

**Table 10a: Cow blood results**

<table>
<thead>
<tr>
<th></th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper (umol/l)</td>
<td>9 to 19</td>
<td>13.2</td>
<td>11.4</td>
</tr>
<tr>
<td>Cobalt (Vit B12) (pmol/l)</td>
<td>&gt;100</td>
<td>182</td>
<td>166</td>
</tr>
<tr>
<td>Selenium (GSH-Px) (U/ml RBCs)</td>
<td>&gt; 30</td>
<td>98</td>
<td>91</td>
</tr>
<tr>
<td>Iodine (T4) (nmol/l)</td>
<td>26 to 84</td>
<td>52.7</td>
<td>48.6</td>
</tr>
</tbody>
</table>
**Table 10b: Calves blood results**

<table>
<thead>
<tr>
<th></th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper</strong></td>
<td>9 to 19</td>
<td>11.7</td>
<td>5.6</td>
</tr>
<tr>
<td>(umol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cobalt</strong></td>
<td>&gt;100</td>
<td>312</td>
<td>210</td>
</tr>
<tr>
<td>(Vit B12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(pmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Selenium</strong></td>
<td>&gt; 30</td>
<td>53</td>
<td>40</td>
</tr>
<tr>
<td>(GSH-Px)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(U/ml RBCs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Iodine</strong></td>
<td>26 to 84</td>
<td>77.5</td>
<td>69.2</td>
</tr>
<tr>
<td>(T4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 11a: Ewes blood results**

<table>
<thead>
<tr>
<th></th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper</strong></td>
<td>9 to 19</td>
<td>14.6</td>
<td>17.0</td>
</tr>
<tr>
<td>(umol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cobalt</strong></td>
<td>&gt;188</td>
<td>236</td>
<td>709</td>
</tr>
<tr>
<td>(Vit B12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(pmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Selenium</strong></td>
<td>&gt; 50</td>
<td>245</td>
<td>160</td>
</tr>
<tr>
<td>(GSH-Px)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(U/ml RBCs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Iodine</strong></td>
<td>35 to 75</td>
<td>58.5</td>
<td>48.1</td>
</tr>
<tr>
<td>(T4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 11b: Lambs blood results**

<table>
<thead>
<tr>
<th></th>
<th>Reference Range</th>
<th>Spring</th>
<th>Autumn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copper</strong></td>
<td>9 to 19</td>
<td>14.6</td>
<td>17.0</td>
</tr>
<tr>
<td>(umol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cobalt</strong></td>
<td>&gt;188</td>
<td>197</td>
<td>158</td>
</tr>
<tr>
<td>(Vit B12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(pmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Selenium</strong></td>
<td>&gt; 50</td>
<td>255</td>
<td>270</td>
</tr>
<tr>
<td>(GSH-Px)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(U/ml RBCs)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Iodine</strong></td>
<td>35 to 75</td>
<td>83.4</td>
<td>56.1</td>
</tr>
<tr>
<td>(T4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nmol/l)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Blood sampling of Mule ewes in June showed two out of six to be marginally low in cobalt, but with satisfactory levels for all other tests (Table 11). Four out of the six Suffolk cross lambs were low in cobalt and two had raised iodine levels.

Lambs were weaned in July and received either a trace element bolus (for Swaledale and North Country Mule lambs) or monthly injections of vitamin B12 (for Suffolk cross lambs).

The second sampling took place in October and all ewes had satisfactory levels for all blood tests. Sampling of Suffolk cross lambs revealed six of the eight sampled to have cobalt levels below the reference minimum.

Blood sampling of suckler cows has confirmed the benefits of the bolus given at turnout and this will continue.

Results for the young calves revealed some low copper and marginal selenium results. As a result the decision was taken to give a trace element bolus containing cobalt, selenium and copper to autumn born calves at turn out, and to spring born calves in mid-summer once they are at least two months old and weigh over 100kg.

The blood results for lambs highlighted the cobalt issues on the farm. The Swaledale and Mule lambs continue to receive a bolus, whilst the terminal sire cross lambs still have a vitamin B12 injection. This decision is based largely on the relative costs of the two treatments.

Previously all ewes received a bolus pre-tupping, but in 2010 this was only given to the hill ewes. The mule ewes were housed for longer and received adequate trace elements in their winter ration.

The practice of formulating bespoke minerals based on forage analysis continues. This is particularly relevant for this farm which, as an organic unit, has to justify any supplementation it provides to protect its organic status.

**Summary**

- Forage analysis showed fields to be low in copper in spring and cobalt throughout the year
- Pasture dressing was effective in raising trace element levels in forage
- Blood samples in 2010 showed:
  - All cattle results satisfactory in spring
  - Some low copper and marginal selenium levels in calves in autumn
  - Breeding ewes had satisfactory levels in spring and autumn
  - Suffolk cross lambs had low cobalt levels in June and October

**Changes made/future actions**

- Suffolk cross lambs to continue with injection of B12 as more cost-effective than a bolus. Mr Bainbridge is considering reducing the interval between injections to three weeks
- Swaledale and mule lambs to continue with a trace element bolus
- Autumn born calves receive a bolus containing cobalt, selenium and copper at turn out in spring
- Spring born calves receive a bolus mid-summer once they are at least two months of age and weigh over 100kg
Case Studies Summary

This study has highlighted the potential benefits of establishing the trace element status of livestock farms. The approach taken was to assess the trace element content of grazed forage in conjunction with targeted blood and liver sampling in cattle and sheep.

Forage

+ Establishing a reliable iodine value for forage proved to be difficult in this study, although standard industry techniques gave a broad indication.
+ On some farms there was significant variation in the trace element content of different fields/areas of the farm.
+ Sampling a good cross section of available grazing and conservation fields can help target supplementation more precisely.
+ On most of the case study farms overall levels of trace elements tended to be higher in autumn forage samples than in spring.
+ The potential for pasture dressing to raise the trace element content of forage was demonstrated in the Northumberland case study.

Blood and liver samples

Cattle

+ None of the cattle blood samples taken had levels of cobalt or iodine below the reference range.
+ Around a third of cattle blood samples (affecting six of the farms) had copper levels below the reference range, with twice as many cows as calves affected. Liver samples gave a more accurate indication of copper deficiency, but were only available from cattle on two farms.
+ 13% of cattle blood samples were below the reference range for selenium, although most of these were from one farm.

Sheep

+ Very few (5%) of sheep blood samples had copper levels below the reference range and these were split evenly between ewes and lambs and spring and autumn. Twice as many samples showed marginally high copper levels.
+ 12% of sheep blood samples were below the reference range for cobalt, with most affecting lambs. It was a problem for one farm in spring and two in the autumn.
+ Selenium levels in the spring were all satisfactory. In the autumn however 36% of the blood samples were below the reference range, affecting the breeding ewes on three farms and lambs on two. Liver samples of finished lambs from the two farms showed a marginal deficiency which supported the blood results.
+ Iodine levels were marginally low in around 10% of samples, affecting twice as many ewes as lambs. The vast majority of these were sampled in the autumn with four farms affected.

Methods of supplementation

+ The farms studied employed a wide range of supplementation methods including free-access minerals, trace-element boluses, oral drenches and injections.
+ During the study two of the farms had either changed or were considering changing their supplementation method:
  - The first was using drenches for sheep and free-access minerals for cattle, but changed to boluses.
  - The second considered changing from free-access mineral blocks to boluses to ensure all cattle received their requirements.
+ Following blood sample results from this study four farmers gave additional supplementation as a:
  - Pre-tupping bolus for breeding ewes
  - Copper bolus and slow release selenium injections for cows and calves
  - Cobalt, selenium and copper bolus for calves
  - Copper bolus for cattle at grass.
References and further information


For more information:

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